SVCE | Sri Venkateswara College of Engineering

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

National Conference on Signal Processing,Communication and Networking

NCSPCN-2024

APRIL 16th,2024

Computer Networking

Communication and Networks

Robotics and Automation

Proceedings of the

NATIONAL CONFERENCE ON SIGNAL PROCESSING, COMMUNICATION & NETWORKING

(NCSPCN-2024)

16th APRIL 2024

MESSAGE FROM THE PRINCIPAL
SRI VENKATESWARA COLLEGE OF ENGINEERING

First of all, I would like to congratulate the organizers of National Conference on Signal Processing, Communication and Networking (NCSPCN-2024) for bringing together, the experts from different academic institutions, researchers, postgraduate students to present their research findings and benefit from it.

It gives me great pleasure to know that the conference has always been a keen supporter of such technical events. I am sure that the conference will serve as a platform for researchers, professionals, and academicians to get ample exposure inknowing the cutting-edge technologies and create new opportunities for creation of innovative ideas and their implementation aspects.

The challenges in the implementation of the new technologies necessitates the forum of researchers to come together and share their knowledge on solutions adopted in Engineering and Technology across the globe. The proceedings of this conference will serve as a repository of information that will inspire and make the participants ready for the next level in their digital transformation journey. I'm sure that this conference will provide you with a memorable experience.

I wish you all the very best for a fruitful deliberation.

Dr.S.Ganesh Vaidyanathan
Principal
Sri Venkateswara College of Engineering

MESSAGE FROM HOD-ECE

It gives me great pleasure to note that the ECE department is organizing the National Conference on Signal Processing, Communication, and Networking (NCSPCN-2024) in association with IETE Chennai. Today's economy and society are heavily dependent on data related to communication networks and associated information. Recent advances in emerging wireless applications are enabling us to access the internet from anywhere at any time.

Wireless communication is unquestionably the primary driving force, and the present challenge is to build an adaptive system with less noise to accommodate the channel's real-time variations. The task involves a huge challenge in developing a suitable communication system that is innovative and high-performing. All of these necessitate a conference of this sort. The National Conference is a platform to share ideas on signal processing, communications, and networking. The department of ECE is always doing a commendable job of disseminating the latest knowledge and bringing together experts from diverse domains for deliberations on the latest advancements and trends through workshops, seminars, and symposiums. This national conference will provide the perfect forum for faculty and participants to interact and possibly discuss future collaborations in the fields of communication systems, communication networks, signal processing, cognitive radio, microwave, optical communication, and soft computing.

This will be done through a combination of interesting presentations by the esteemed participants that will enrich our current knowledge and technical skills in doing innovative research and writing research papers. A holistic and interactive approach has been employed in planning the NCSPCN 2024, in which we shall discuss the latest techniques and concurrent innovations.

On behalf of SVCVE, Sriperumbudur, I would like to extend a warm invitation to all enthusiastic participants in this event. I wish the dignitaries and participants, especially the organizing team and publishing committee, a grand success in making this event a grand success. I wish all success for the national conference. All the best!!.

Dr.G.A.Sathish Kumar
Professor & Head of the Department
Electronics and Communication Engineering

ABOUT THE COLLEGE

Sri Venkateswara College of Engineering (Autonomous), a premier self-financing engineering college was established in the year 1985 and is managed by Sri Venkateswara Educational and Health Trust. The college offers 12 under-graduate programs and 7 post-graduate programs in Engineering and Technology. These programs are approved by AICTE and affiliated to Anna University, Chennai. The college attained autonomous status in the year 2016. The college is accredited by National Assessment and Accreditation Council (NAAC) with A+ Grade in the year 2022. The National Board of Accreditation has accredited many of the eligible programs. The college is an ISO 9001:2015 certified institution. The college is situated in serene environment about 37 Kms from Chennai and located in Chennai – Bangalore National Highway (NH4) at Pennalur,Sriperumbudur in Kancheepuram district.

ABOUT THE DEPARTMENT

The Department of ECE was started in the year 1985 and is presently accredited by the NBA. The post graduate program (M.E) in Communication Systems was started in 2002 and Applied Electronics in 2012. There are about 39 faculty members in the department and 15 of them are doctorates. The department is well equipped with lab facilities and software tools like IE3D, ADS, CST Studio, Lab View, Tanner Tools, Cadence, MATLAB, PCB Prototype Machine.

Vision

To excel in offering value based quality education in the field of Electronics and Communication Engineering, keeping in pace with the latest developments in technology through exemplary research, to raise the intellectual competence to match global standards and to make significant contributions to the society.

Mission

To provide the best pedagogical atmosphere of highest quality through modern infrastructure, latest knowledge and cutting edge skills.

To fulfill the research interests of faculty and students by promoting and sustaining in house research facilities so as to obtain the reputed publications and patents.

To educate our students, the ethical and moral values, integrity, leadership and other quality aspects to cater to the growing need for values in the society.

Sri Venkateswara College of Engineering

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IoT Based Smart Wheelchair for Enhanced Mobility and Independence

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***Abstract*—The development of an IoT-based smart wheelchair system that aims to provide attention-based control over wheelchair movement using brainwave signals. It emphasizes the potential of brain-computer interfaces BCIs in empowering individuals with physical impairments, offering an alternative to traditional joystick or button-based interfaces. The systemutilizes a BCI headset to capture and interpret brainwave signals, translating them into commands for controlling the wheelchair's movement. Additionally, it explores the different types of brainwaves, their frequencies, and their association with various states of mind. It also highlights the potential role of BCIs in rehabilitation for individuals with neurological conditions, emphasizing the need for further research and development to improve accuracy and reliability. Moreover, underscores the significant potential of the technology in enhancing independence and control over movement for individuals with limited or no physical control over their limbs.**

Keywords— Brainwaves, Attention and Meditation Levels, Blink Intensity, Brain Computer Interface, Gyroscope Sensor, Bluetoothcommunication, ESP8266 Node MCU,EEG Signals.

I. INTRODUCTION

The nervous system serves as our body's decision-making and communication hub. Comprising the central nervous system, which includes the brain and spinal cord, and the peripheral nervous system, composed of nerves, it facilitates the transmission of information. Sensory nerves collect data from the environment and relay it to the spinal cord, which then swiftly transmits the message to the brain. Within the brain, various brainwave patterns constantly emanate, with the dominant waves dictating an individual's conscious state. Employing technology to influence brainwaves towards a desired frequency can effectively induce various mental and emotional states, such as meditation, arousal, motivation, anxiety, and relaxation.

Brainwaves, generated by currents coursing throughneural pathways, are categorized by their pulsation frequency, which correlates with different states of mind. Although one brainwave state may prevail at a given moment, multiple patterns typically coexist. Understanding these brainwave states allows for harnessing their specialized characteristics, including heightened focus, relaxation, creativity, and restful sleep. For instance, individuals with Attention Deficit Disorder often exhibit a predominant theta brainwave pattern, while those without Attention Deficit Disorder typically fall within thebeta range. This knowledge of brainwave states can significantly enhance a person's ability to be mentally productive across a wide range of activities, fostering intense focus, relaxation, creativity, and restful sleep.

In conclusion, the technology offers significant potential for individuals with limited or no physical control over their limbs, granting them greater independence and control over their movement. This could improve quality of life and participation in daily activities.Also highlights the limitations of current BCI technology and the need for further researchand development to improve accuracy and reliability, as wellas safeguarding against unintended movement or hacking of the BCI system to ensure user safety and prevent misuse.

II. PROPOSED SYSTEM

A sensor has been designed employing an electromagnetic loop antenna in conjunction with a preamplifier, low-passfilter, and low-pass frequency mixer, as depicted in Figure 1. This sensor is tailored for detecting extremely low-frequency waves, with the added functionality of incorporating EEG for controlling an additional parameter. Utilizing both hardware components and a DSP-based amplifier, we can effectively sense and analyze these low-frequency signals.

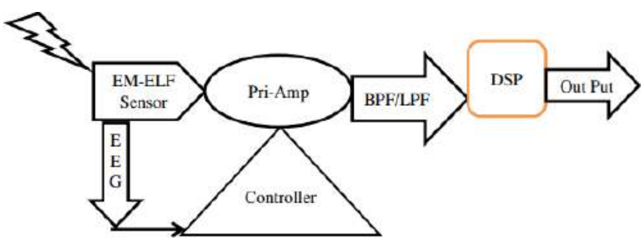

Figure 1: Block Diagram for ELF Electromagnetic Sensor

Electromagnetic Sensor

Induction sensors find diverse applications across various fields such as geophysics, audio frequency applications, and magnetic recording techniques. In geophysics, they areutilized to measure the micro pulsations of the Earth's magnetic field and to detect secondary magnetic fields generated by Earth's currents following artificial excitations within the audio frequency range. Geophysical explorationoften relies on natural variations in the electromagnetic field within the 1 Hz to 20 kHz band.

Additionally, induction coils are employed in plasma experiments, space research, submarines, and trains. Magnetic antennas serve navigation and communication purposes in these contexts. The sensors discussed in Figure 2 operate based on changes in sensor inductance and require excitation.

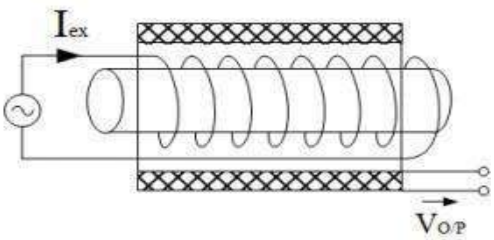

Figure 2: Electromagnetic sensor

Wheel Chair

A wheelchair is a mobility aid equipped with wheels, designed for individuals to sit in while moving. This device offers flexibility, with options for manual propulsion where the user turns the rear wheels by hand, or electric propulsion powered by motors. Handles are typically located behind the seatto facilitate pushing by others. Wheelchairs serve individuals who face challenges with walking due to illness, injury, or disability. Various types of wheelchairs cater to different needs and circumstances, making it essential to grasp their limitations and operate them safely.

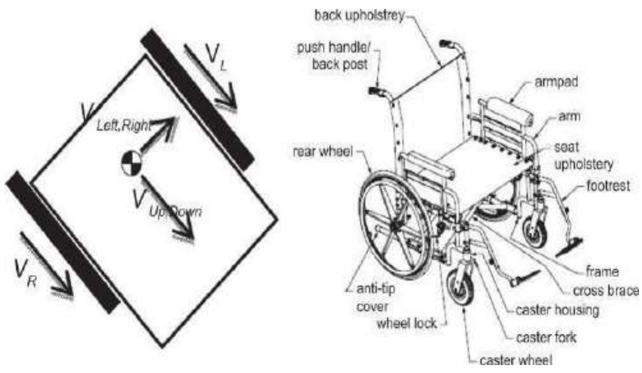

Figure 3: Wheel Chair

III. SYSTEM SPECIFICATIONS

The wheelchair's operation involves two primary components: brainwave sensors and the types of brainwaves they detect.

The brainwave sensor used in the experiment is positioned at the frontal area and the earlobe, as depicted in Figure 4. It comprises three electrodes, with two placed at the frontal region and one serving as the earlobe ground. These specific positions were selected due to the challenge of electrode placement caused by hair on the scalp. Circuit design incorporates isolation principles to prevent electrical shock resulting from power supply or instrument leakage.

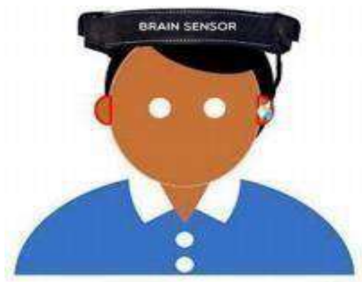

Figure 4: Electrode Placement

The Notch Filtering Circuit features three terminals for capturing brain signals. The first and second terminals capture signals from the right and left hemispheres, respectively, with the latter integrated into the headband. The third terminal functions as the ground. This circuit aims to eliminate unwanted noise originating from the human body, with a filter range starting from 1Hz.

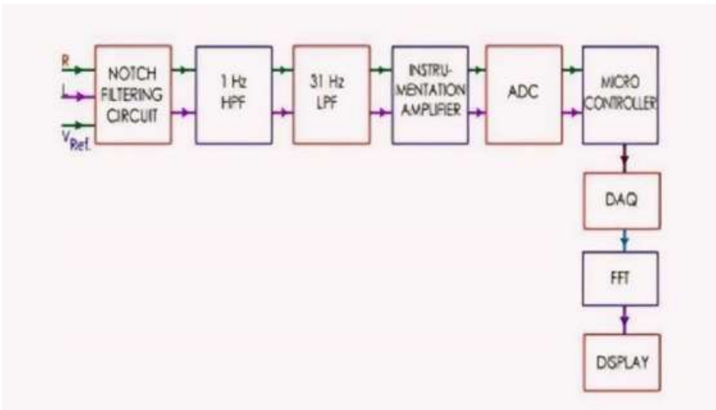

Figure 5: Inner blocks of Brainwave Sensor

A High Pass Filter (HPF) permits signals with frequencies of 1Hz and above, filtering out lower frequency signals. Conversely, aLow Pass Filter (LPF) eliminates higher frequency signalssurpassing 31Hz. As brain signals typically exhibit low voltage in microvolts, which may not be discernible, amplification is necessary. This is achieved using an Instrumentation Amplifier, as depicted in Figure 5.

Since brain signals are in analog form, they must be converted to digital format for comprehension by the microcontroller. This conversion is facilitated by an Analog-to-Digital Converter (ADC). The microcontroller oversees the entire system, processing data and transmitting it to the Data Acquisition System (DAQ).

The DAQ stores processed data received from the microcontroller. Brain signals generally exist in the time domain, posing challenges for mapping or display due to the presence of multiple signals with varying frequencies at specific time intervals..

FLOW CHART

Firstly, the initialization of essential peripherals such as the Serial Port, Analog-to-Digital Converter, and Serial Peripheral Interface is performed. Subsequently, a conversion rate is established to convert analog values to digital ones. Following the configuration of the conversion rate, the microcontroller is set with the slave address of the EEG sensor. With thesesettings in place, the analog EEG signals from the brain undergo conversion to digital values. These digital values are then transmitted to the microcontroller, which reads and converts them into ASCII code. Eventually, the gathered information is relayed to a PC server. There, corresponding graphs depicting the EEG signals from the brain are generated, aiding in the interpretation of the user's brain activity, as illustrated in Figure 6.

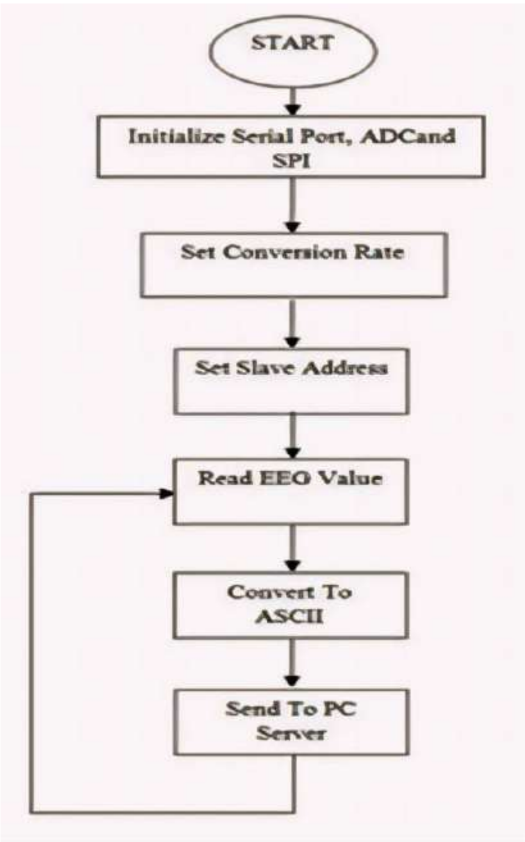

Figure 6: Work Flow of the System

Brain Waves

Brainwaves represent a prominent area of research in today's technological landscape, offering a plethora of potential solutions to future challenges. These electrical patterns are intricately linked to our brain's activity, serving as carriers for our emotions, thoughts, and chemical processes via neurons. The dynamic nature of brainwaves means they can fluctuate with shifts in our mental and emotional states, making them invaluable indicators of a person's well-being. Any deviations inbrainwave patterns can have profound effects on our emotional and neurological health, potentially manifesting as conditions such as obsessive-compulsive disorder, panic attacks, or migraines, among others. Two primary conditions of instability in brainwaves are recognized:

Over arousal: Characterized by heightened activity, this state may lead to sleep disturbances, spasms, anxiety disorders, as well as feelings of anger and aggression.

Under arousal: Marked by diminished activity, this condition can result in insomnia, depression, reduced attention span, and chronic pain. Detection of brainwaves typically involves the placement of sensors on the scalp, facilitated through a procedure known as an electroencephalogram (EEG).

TYPES OF BRAINWAVES

Brainwaves encompass a spectrum of frequencies typically ranging from 1Hz to 100Hz.

BrainWave Type	**Frequency range**	**Mental states and conditions**
Delta	0.1 Hz to 3 Hz	Deep, dreamless sleep, non-REM sleep, unconscious
Theta	4 Hz to 7 Hz	Intuitive, creative, recall, fantasy, imaginary, dream
Alpha	8 Hz to 12 Hz	Relaxed, but not drowsy, tranquil, conscious
Low Beta	12 Hz to 15 Hz	Formerly SMR, relaxed yet focused, integrated
Midrange Beta	16 Hz to 20 Hz	□inking, aware of self & surroundings
High Beta	21 Hz to 30 Hz	Alertness, agitation

Figure 7: Types of Brain wave and its range and condition

The spectrum is categorized into five major types:

1. Delta Waves:

Delta waves operate within the frequency range of 0 to 4 Hz. In infants, delta wave activity surpasses that of adults, which correlates with their extensive periods of sleep. Interruptions in delta waves can stem from changes in nutrient metabolism, physiological damage, or chemical alterations.

2. Theta Waves:

Theta waves oscillate between 3 to 8 Hz. They manifest during light meditation, dreaming sleep stages, and are particularly prominent during learning processes. Theta waves facilitate internal focus, encapsulating our fears, nightmares, and psychological challenges.

3. Alpha Waves:

Alpha waves operate within the frequency range of 8 to 12 Hz. They surface during periods of mental rest and relaxation, indicating a state of cerebral coherence and mind-body integration.

4. Beta Waves:

Beta waves signify alertness, logical reasoning, and conscious wakefulness. While crucial for daily functioning, excessivebeta activity can lead to stress and anxiety. Beta waves are further categorized into three bands:

- Low Beta (12-15Hz): Characterized by fast idle thoughts.
- Beta (15-22Hz): Reflects high engagement and cognitive activity.
- Hi-Beta (22-38Hz): Indicates heightened complexity and may correlate with states of anxiety or excitement.

5. Gamma Waves:

Gamma waves oscillate between 38 to 42 Hz. Previously overlooked in analog EEG recordings, they are associated with adaptability, rapid learning, and heightened brain activity. Gamma waves are prevalent during states of intense emotion such as love and altruism but diminish under anesthesia..

IV. PROJECT OUTLINE

This project explores the development of a brain-controlled robot leveraging Brain-Computer Interfaces (BCIs). BCIs offer the ability to circumvent traditional communication channels, as depicted in Figure 8 below. The primary objectiveis to design a wheelchair robot capable of assisting individuals with disabilities in performing daily tasks independently. The focus lies in analyzing brainwave signals.

Existing system

- Based on remote control operation
- Depends on others to operate
- No muscle contraction sensing

Proposed system

- Utilizes Brain wave analysis
- Robot control using Human thoughts
- Features self-controlled operation
- Bluetooth Communication

The human brain is composed of interconnected neurons, generating patterns of interaction representing thoughts and emotional states. These patterns result in varying electrical waves. Control commands are then transmitted to processing modules based on these patterns. With this system, the wheelchair can be maneuvered according to human thoughts, and directional changes can be initiated through muscle contraction, such as blinking.

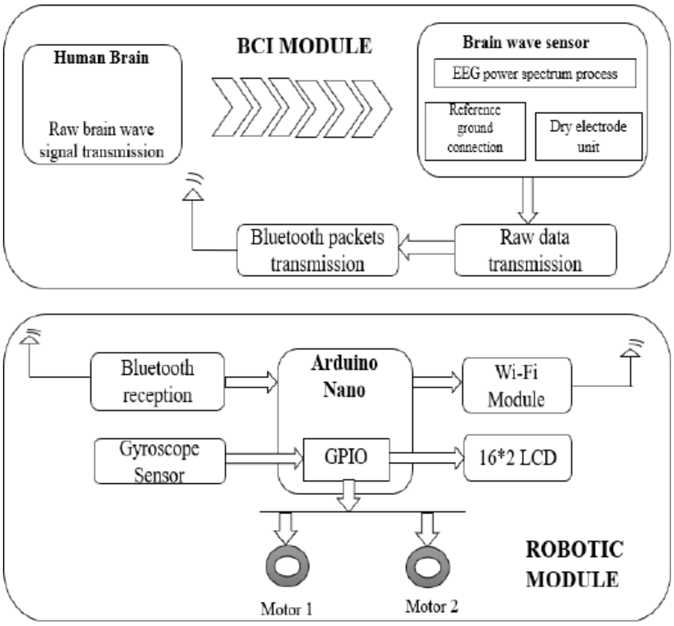

Figure 8: Block Diagram of the Proposed System

Think Gear is the technology inside every Neuro Sky product or partner product that enables a device to interface with the wearer brainwaves as shown in the figure 9. It includes the sensor that touches the forehead, the contact and reference points located on the ear pad, and the on-board chip that processes all of the data. Both the raw brainwaves and the eSense. Meters of Attention and Meditation values arecalculated on the think Gear chip.

Figure 9: Brainwave sensor

ESense is a proprietary algorithm developed by NeuroSky for evaluating mental states. Utilizing NeuroSky's ThinkGear technology, the raw brainwave signal is amplified and refined by filtering out ambient noise and muscle movements. Subsequently, the eSense algorithm is applied to the processed signal, yielding interpreted eSense meter values.

ATTENTION LEVEL:

The Attention meter gauges the intensity of a user's mental "focus" or "attention" during periods of concentrated mental activity. Its scale ranges from 0 to 100. Factors such as distractions, wandering thoughts, lack of focus, or anxiety may diminish the Attention meter level.

MEDITATION LEVEL:

The Meditation meter indicates the level of a user's mental "calmness" or "relaxation," with values ranging from 0 to 100. It's essential to note that Meditation measures mental states rather than physical relaxation levels. While relaxing the body can often lead to a relaxed mind, this isn't an immediate correlation for all individuals in all circumstances. Meditation is associated with a reduction in activity within the brain's active mental processes. It's been observed that closing one's eyes can decrease mental activity related to processing visual stimuli, thereby potentially boosting the Meditation meter level. Conversely, distractions, wandering thoughts, anxiety, agitation, and sensory stimuli may lower the Meditation meter levels.

BLINK INTENSITY

This byte value, which ranges from 1 to 255, represents the intensity of the most recent eye blink detected from the user. It is reported whenever an eye blink occurs. The value signifies the relative strength of the blink and is unitless.

GYROSCOPE SENSOR

The MPU6050 is a Micro-Electro-Mechanical System (MEMS) designed as a 6-axis motion tracking device. It standsout as the sole device in the world engineered for the demanding requirements of smartphones, tablets, and wearable sensors, emphasizing low power consumption, affordability, and high performance. Combining gyroscopes and accelerometers, it forms what is commonly known as an Inertial Measurement Unit (IMU).

ESP8266 NodeMCU

The NodeMCU is an open-source firmware and development kit tailored for prototyping and constructing IoT (Internet of Things) products. It features firmware optimized for the ESP8266 Wi-Fi System-on-Chip (SoC) developed byEspressif Systems, and hardware based on the ESP-12 module. Its hallmark is its unparalleled ability to integrate Wi-Fi capabilities into other systems or operate as a standalone application with minimal space and cost requirements. The module supports the standard IEEE 802.11 b/g/n agreement and a complete TCP/IP protocol stack. Users have the flexibility to incorporate modules into existing device networks or build standalone network controllers. The ESP8266EX offers a comprehensive Wi-Fi networking solution, capable of hosting applications or offloading Wi-Fi networking functions from another application processor. In scenarios where the ESP8266EX hosts the application, it directly boots up from an external flash. Additionally, it features integrated cache to enhance system performance in various applications.

V. WORKING

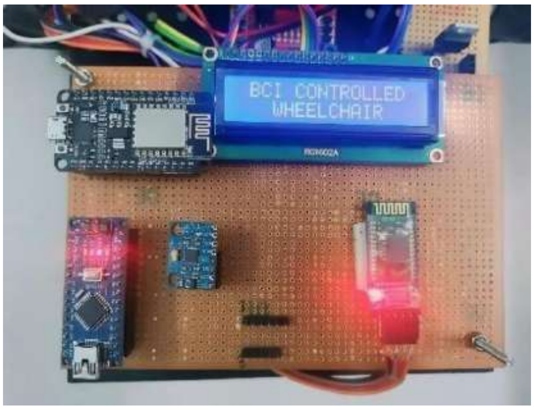

Figure 10: Hardware Configuration

Figure 11: Hardware Prototype

VI. RESULTS

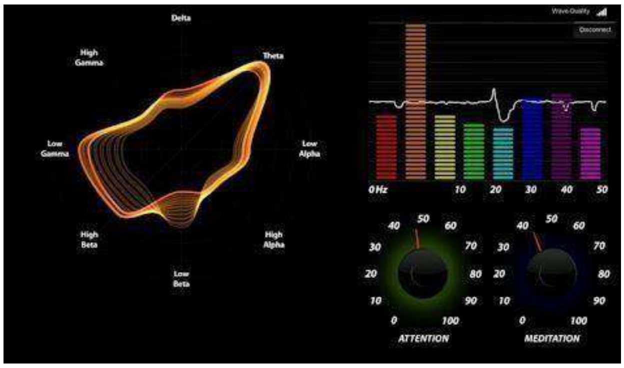

Figure 12: Brainwave Visualizer

The prototype of the brainwave-controlled wheelchair, depicted in Figure 12, has been meticulously designed and developed. It comprises an Arduino Nano microcontroller, IoT modules, and DC motors integrated with wheels. The outcomes obtained from correlating the brainwave interface with the DC motors, once triggered by the user's attention and meditation levels, effectively govern the wheelchair's movement. This ensures precise control over its mobility, fostering independence for the user.

VII. CONCLUSION

This technology holds immense promise for individuals who have limited or no physical control over their limbs, offering them increased independence and mastery over their movements. Such advancements have the potential to elevate their quality of life and engagement in everyday activities. Brainwave control introduces a novel and intuitive method of interacting with wheelchairs, potentially surpassing conventional joystick or button controls for certain users. BCIs could serve as a valuable tool in the rehabilitation process for individuals with neurological conditions, aiding in the restoration of lost motor function or the development of alternative control mechanisms.

Various approaches to BCI technology exist, each presenting unique advantages and constraints. User training and calibration are imperative to ensure optimal performance. Integration with other assistive technologies could further augment functionality.

However, current BCI technology still grapples with limitations in accurately deciphering brain signals, leading to potential errors or challenges in control. Continued research and development efforts are necessary to enhance accuracy and reliability. It's paramount to implement safeguards against unintended movement or unauthorized access to the BCI system to uphold user safety and deter misuse.

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Accurate breast cancer detection using ANN and GMM segmentation

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Abstract: The diagnosis of breast cancer using automated algorithms remains a challenge in the literature. Despite the fact that a plethora of work has been done to solve this problem, an exact solution has yet to be identified. This dilemma is compounded by the fact that most current datasets are imbalanced, i.e. the number of instances of one class far outnumbers those of the others. In this article, we propose a method focused on the concept of transfer learning to solve this problem, with an emphasis on histopathological and image classification using GMM Segmentation.To increase the overall efficiency of the machine, we use the common VGG-19 as the base model and supplement it with many cutting-edge techniques. We extend the acquired information in the target domain of histopathological images using the Image Net dataset as the source domain. Experimentation on a large-scale dataset of 277,524 images demonstrates that the method presented in this paper outperforms those available in the existing literature. We obtained better results in this proposed approach by numerical simulations using an Artificial Neural Network.

Keyword: GMM segmentation; ANN; MATLAB.

I. INTRODUCTION

Breast cancer is the most common form of cancer in women worldwide. Despite advances in cancer theranostics during the last decade, this illness ranks second only to lung cancer as the world's leading cause of death, according to the cancer mortality survey [1]. Invasive Ductal Carcinoma (IDC) is the most common subtype of breast cancer, accounting for about 80% of all cases [2], [3]. The cells in the IDC infiltrate through the basement membrane through the adjacent stroma and are no longer restricted to the affected duct [4].The prognosis of IDC may worsen over time as the infiltrating cells spread to the lymph nodes and other parts of the body. The aggressiveness of the disease is determined by the locations of invasive cancer. Early diagnosis increases patient recovery significantly; however, the procedure is time-consuming, labor-intensive, and necessitates the use of professional pathologists.

Physical testing, mammography, magnetic resonance imaging (MRI), ultrasound, fine needle aspiration cytology (FNAC), and histopathological examination of tissue parts are also used to diagnose IDC. [5, 6] Formalized adverbial adverbial Non-invasive methods such as SPR biosensor assays and multiplexed immunoassays have also been investigated for cancer serological diagnosis, but none of these techniques are currently in clinical use. [7, 8], and 9] If a patient has a suspicious area, histopathological analysis of the biopsy is the best way to confidently conclude breast cancer. Histopathological analysis of Hematoxylin and Eosin (H&E) stained tissue parts is typically performed by qualified pathologists and is subject to intra-observer as well as inter-observer heterogeneity, with an average interclass agreement of 68.39 percent between pathologists. To detect the involvement of IDC, tissue regions containing invasive regions must be distinguished from non-invasive tissues. Recent advances in oncology and computer engineering have also helped in the creation of computer-aided diagnosis (CAD) applications to assist pathologists in their diagnosis procedures and reduce their workload. Identifying and categorising invasive and non-invasive tissues accurately is a critical clinical challenge, and automatic approaches will significantly speed up identification, minimise complications, and contribute to improved healthcare and treatment. As a result, researchers recognised the potential of automated systems in this regard. As a result, there is a lot of testing going on in the field of medical imaging.

II. LITERATURE SURVEY

In this paper, Ruobing Hua et al. [1] introduce an analogue artificial neural network (ANN) classifier based on a common-source amplifier-based nonlinear activation mechanism. In 65nm CMOS, a shallow ANN is designed to perform binary classification on breast cancer datasets and classify each patient data as benign or malignant. The use of a common-source amplifier structure simplifies the ANN, resulting in a core region of just 240m2 and only 39fJ/classification at 0.8V power supply. Matlab is used to prepare the classifier, and Spectre simulations are used to test it.

Tarun Jayaraj et al. [2] A statistical data processing technique inspired by the functionality and configuration of the biological nervous system is an Artificial Neural Network (ANN). An ANN is made up of computing components known as neurons that are linked together and work together to solve a problem. Because of their exceptional capacity to derive significance from imprecise or nuanced problems, neural networks can be used in situations where identifying trends and extracting patterns are too difficult to be identified by humans or other computer techniques.

Imran Hossain Showrov et al. [3] Centered on a specific testing dataset, they learned various sections of SVM, ANN, and Nave Bayes (WBCD). We choose the best model from the mentioned models in this paper based on the highest accuracy and will use it in the future for the client dataset (clinical data). Linear SVM is the best model for the WBCD dataset, with an accuracy of 96.72 percent.

Hassan Jouni and colleagues [4] Early diagnosis of cancer, or other illness, is one of the most important keys to the cure. Machine learning, specifically ANNs, is one of the cutting-edge approaches of cancer detection (Artificial Neural Networks). Because of their ability to learn and generalise from results, ANNs have proven to be effective. This paper suggests a low-complexity architecture of an ANN that uses pattern recognition to classify breast cancer as benign or malignant. It focuses on determining the best activation mechanism for minimising classification error with the fewest number of blocks. As a result, the difficulty of CMOS application deployment is reduced.

III. PROPSED METHOD

In this article, we propose a method focused on the concept of transfer learning to solve this problem, with an emphasis on histopathological and image classification using GMM Segmentation. To increase the overall efficiency of the machine, we use the common VGG-19 as the base model and supplement it with many cutting-edge techniques. We extend the acquired information in the target domain of histopathological images using the Image Net dataset as the source domain. Experimentation on a large-scale dataset of 277,524 images demonstrates that the method presented in this paper outperforms those available in the existing literature. We obtained better results in this proposed approach by numerical simulations using an Artificial Neural Network.

i. ANN

ANNs are well-known for their ability to generalise and classify data in the nonlinear domain. The organisation of the ANN is well established in terms of layers, neurons, weights, and activation mechanism (AF). The capacity to change and robustness in pattern recognition are characteristics that distinguish ANN from other approaches. Furthermore, ANN is readily aligned with other image and signal processing approaches, such as fuzzy logic, genetic algorithms, and others. ANN can be used in two different functions: image segmentation and filtering.

ii. GMM

The segmentation stage is crucial and very necessary since the outcome of all subsequent steps (feature extraction and classification) is dependent on it. The GMM is recommended for obtaining the ROI from breast tissue. GMM estimates the GMM parameters using the Expectation Maximization (EM) algorithm [10]. The ROI area is segmented by optimising the probability of the ROI components.

GMM was chosen to undertake this phase in this work for the following reasons: (1) It is the statistical estimation methods that are being investigated. (2) It provides greater consistency in component delivery selection. (3)It estimates the density for each group. (4) GMM is capable of constructing soft aggregate boundaries. This implies that with a given probability, points in space will belong to any subclass (i.e. rather than K-means as an example). The GMM is written as follows:

$$\sum_{i=1}^{k} piN(xi|\mu i,\sigma i) \qquad (1)$$

Where N( )is a Gaussian distribution given by

$$(\mu i,\sigma i) = \frac{1}{\sigma i\sqrt{2\pi}} exp\left[-\frac{1}{2\sigma_i^2}(xs-\mu i)2\right]$$

The parameters above represent the mean, variance, and probability that a voxel belongs to the class, respectively. There are a predetermined number of groups that can be used.

The number of clusters k in our proposed GMM-based segmentation is determined automatically using thresholding to be optimal for each image based on its density, which is measured. The mammogram image is segmented into k cluster regions after the GMM parameters are computed using the EM algorithm. Each pixel belongs to a cluster. The ROIs segmented by GMM from three types of mild, benign, and malignant tissues are shown below.

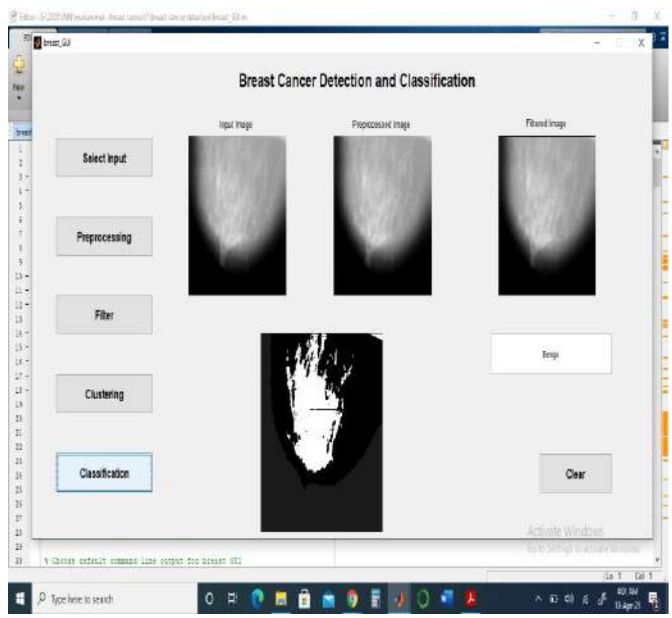

Figure1. Image segmentation and classification result For benign tumor

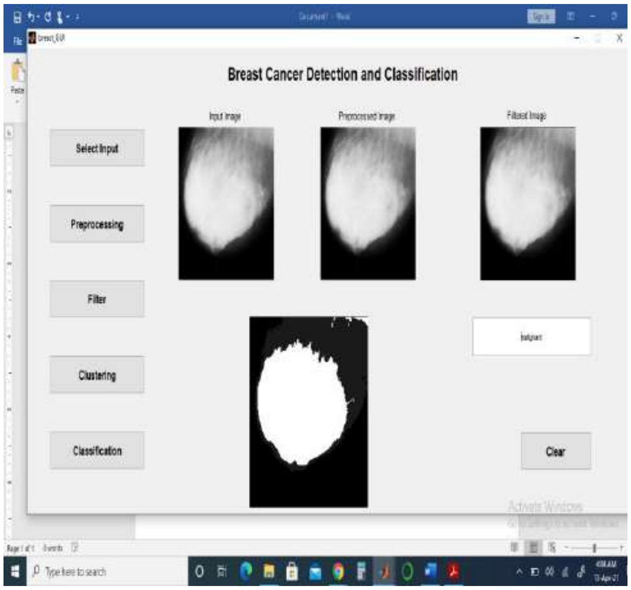

Figure2. Image segmentation and classification result For Malignant tumor

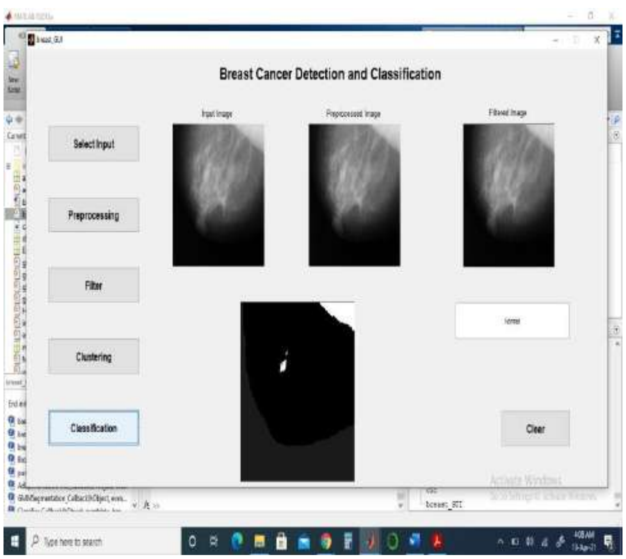

Figure3. Image segmentation and classification result for normal breast

By using ANN and GMM segmentation on the input images we found that the results outperform the existing methods by a small margin for detection of the Breast cancer by using our proposed method.

IV. CONCLSUION

To address this concern, we proposed a system based on the concept of transfer learning and focused our efforts on histopathological and image classification using GMM Segmentation. To increase the overall efficiency of the machine, we used the common VGG-19 as the base model and supplemented it with many cutting-edge techniques. We extend the acquired information in the target domain of histopathological images using the Image Net dataset as the source domain. Experimentation on a large-scale dataset of 277,524 images demonstrates that the method presented in this paper outperforms those available in the existing literature.We obtained better results in this proposed approach by numerical simulations using an Artificial Neural Network.

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Early Crack Detection of Railway Track

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Abstract*—This project proposes the crack detection in Railway Track in advance. Manual inspection methods are labour- intensive, time-consuming, and prone to human error. Therefore, there is a need for automated crack detection systems to enhance the efficiency and accuracy of railway maintenance. The Internet of Things(IoT) framework involves strategically placed sensors along the inspection car, capable of detecting structural anomalies such as cracks. These sensors continuously monitor the track's condition and wirelessly transmit real-time data to a central embedded system. The embedded system processes the incoming data, employing advanced algorithms to identify and classify potential cracks at an early stage. Furthermore, the embedded system is equipped with additional sensors designed to measure the thickness of the railway track. This information is crucial for maintenance planning and ensuring the structural integrity of the tracks. The thickness data, along with crack detection results, is then made transmitted through wireless transceiver, allowing railway authorities to make informed decisions regarding maintenance schedules and infrastucture investments.

***Keywords*—Crack Detection, Embedded System, Internet of Things, Wireless Transceiver**

I. Introduction

The railway network is essential to effective transport and is crucial to the growth of the economy. To avoid mishaps and service interruptions, railway tracks must be made safe and dependable. Early structural problem detection, such as the identification of fractures that may eventually jeopardize the integrity of the rails, is one of the most important tasks facing railway operators.

In order to overcome this difficulty, a unique strategy for early fracture detection in railroads using the Internet of Things (IoT) is presented in this research. Railway tracks experience wear and tear due to a variety of stresses, such as large weights, dynamic pressures from passing trains, and environmental factors. Conventional inspection techniques are frequently reactive and could miss new problems before they get worse.

By combining IoT technology, a proactive approach is provided, allowing for ongoing observation and real-time railway infrastructure study. Advanced sensors, such as Laser Ranging sensors and Light Dependent Resistor (LDR) sensors, are included into the proposed system and are positioned strategically along the railway lines. These sensors gather information on distance measurements, monitor surface properties, and ambient light conditions continually. Wireless transmission of the data to a centralised platform for processing and analysis is used. Through the early detection of structural anomalies or cracks, this Internet of Things strategy enables train operators to carry out maintenance interventions on time. Real-time notifications from the system enable quick action, averting any mishaps and reducing service interruptions.

The system's sensitivity and accuracy in detecting minute variations in the track's condition are improved by the combination of LDR sensors and laser-ranging sensors. We will examine the design, elements, and specifics of an IoT- based early fracture detection system in railroads in the parts that follow. Through the use of this technology, railway operators may transition to a predictive and preventative maintenance approach, guaranteeing the durability, security, and effectiveness of their infrastructure amidst changing transportation requirements.

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II. LITERATURE SURVEY

Akhil N, The author[1] has presented an efficient and cost effective solution suitable for railway application. This paper consists of GPS module, GSM module, an Ultrasonic sensor, a microcontroller LPC2148 and motor driver L293D. This system is applicable in detection during both day and night. The proposed system immediately notices cracks in tracks and inform the railway authority and hence reduce railway accidents. It concludes that this system is more accurate and can be operated in tunnels without any interruption. In future, more sensors can be adopted for faster work. CCTV system with IP based camera for monitoring can be used.

Er. Nisthul G[2], The author has suggested that have a project for addressing an issue of crack detection on railway track by developing a automatic detection system using Infrared (IR) crack sensing module and a communication module based on GSM technology. It concludes that it will help in preventing train accidents to a large extent.

M. Kalaimathi, In this paper they are working on Innovative Railway Track Surveying with Sensors and Controlled by Wireless Communication system[3], in which they used MEMS,GPS,GSM,ARM7TDMI-S microcontroller, RF transmitter, LCD Display , LVDT. The system is design in this paper is cheap in cost and used in both ballast and slab tracks, and because of LVDT sensor it is very accurate and take less time to inform to station and railway which on that track and also it operate in tunnel without interruption.

M. Benisha, This paper is base on Crack Detection & Fire Safety Monitoring System for Railway Inspection[4]. In this paper, the robotic module is place in the train and ZigBee Network is in it which is used to inform the controller. Ultra sonic sensors are used to monitor the track status & detect the exact location of crack on track. MEMS Technology is used to detect the obstacle on track and also Fire alarm are used alert the passenger, driver, and fire service station. LCD help to display crack position to the train operator. It concludes that the system is beneficial because it detect the crack without human intervention. This system has some advantages like less cost, low power consumption, less analysis time.

III. PROPOSED SYSTEM

This suggested technique uses an Internet of Things-based technology to locate cracks in rail rails. Using IoT technology, a notification is transmitted to the control centre once a fracture has been spotted. Information is sent to the control room as soon as a fracture is found on the track.

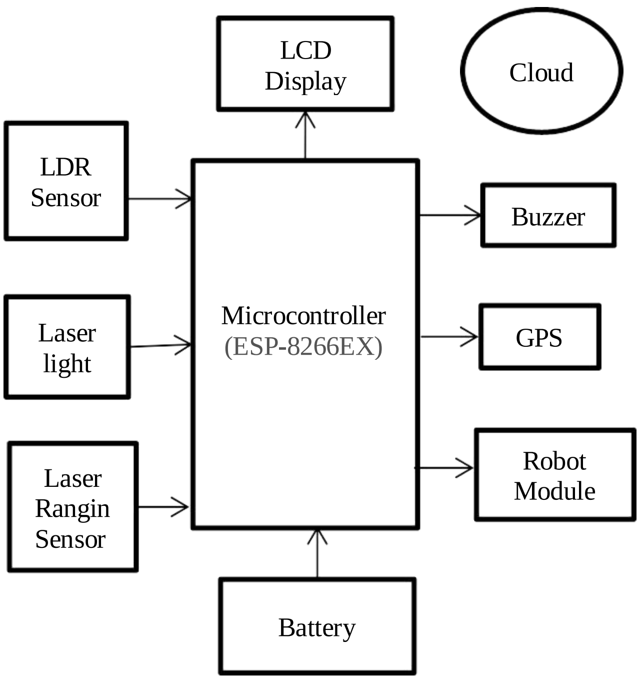

Fig.1. Block Diagram

IV. COMPONENTS USED

A. *WeMos D1 R1(ESP-8266EX)*

ESP-8266EX is a highly-integrated solution for Wi-Fi-and-Bluetooth IoT applications, with around 20 external components. ESP-8266EX integrates an antenna switch, RF balun, power amplifier, low-noise receive amplifier, filters, and power management modules. As such, the entire solution occupies minimal Printed Circuit Board (PCB) area. ESP-8266EX uses CMOS for single-chip fully-integrated radio and baseband, while also integrating advanced calibration circuitries that allow the solution to remove external circuit imperfections or adjust to changes in external conditions. As such, the mass production of ESP-8266EX solutions does not require expensive and specialized Wi-Fi testing equipment.

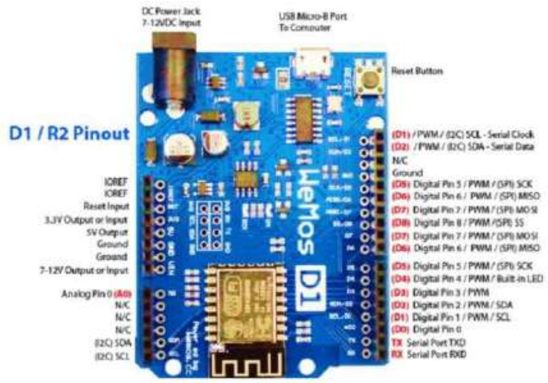

Fig. 2. WeMos D1 R1

B. *LDR Sensor*

A photoresistor (or light-dependent resistor, LDR, or photoconductivecell) is a light-controlled variable resistor. The resistance of a photoresistor decreases with increasing incident light intensity; in other words, it exhibits photoconductivity.

A light dependent resistor works on the principle of photo conductivity. Photo conductivity is an optical phenomenon in which the materials conductivity is increased when light is absorbed by the material. When light falls i.e. when the photons fall on the device, the electrons in the valence band of the semiconductor material are excited to the conduction band.

These photons in the incident light should have energy greater than the band gap of the semiconductor material to make the electrons jump from the valence band to the conduction band. Hence when light having enough energy strikes on the device, more and more electrons are excited to the conduction band which results in large number of charge carriers. The result of this process is more and more current starts flowing through the device when the circuit is closed and hence it is said that the resistance of the device has been decreased.

Fig. 3. LDR Sensor

C. Laser Ranging Sensor

To determine the distance between the sensor and the reflecting surface on the opposite side, one can use a laser ranging sensor, commonly referred to as a LIDAR sensor. This aids in precisely identifying any surface alterations brought on by fractures.

This method enables us to obtain distance measurements with millimeter-level accuracy, making the LiDAR sensor an ideal choice for applications where precise distance measurement is crucial.

By integrating the LiDAR sensor into our system, we ensure robust and reliable distance measurement capabilities, contributing to the overall accuracy and effectiveness of our project's functionality.

Fig. 4. Laser Ranging Sensor (TOF10120)

D. GENERATED SYSTEM

The prototype of railway route crack detection system is shown by figure.5. In this model all the component that is sensor, microcontroller and LCD displaying unit are mounted on the movable robot. In order to detect the cracks on the railway track the robot moves on the track and sensor detects the crack if any and alert the user with the help of microcontroller. The microcontroller also controls the movement of the robot as required by the user. It shows the actual distance, measured distance and difference between actual and measured distance.

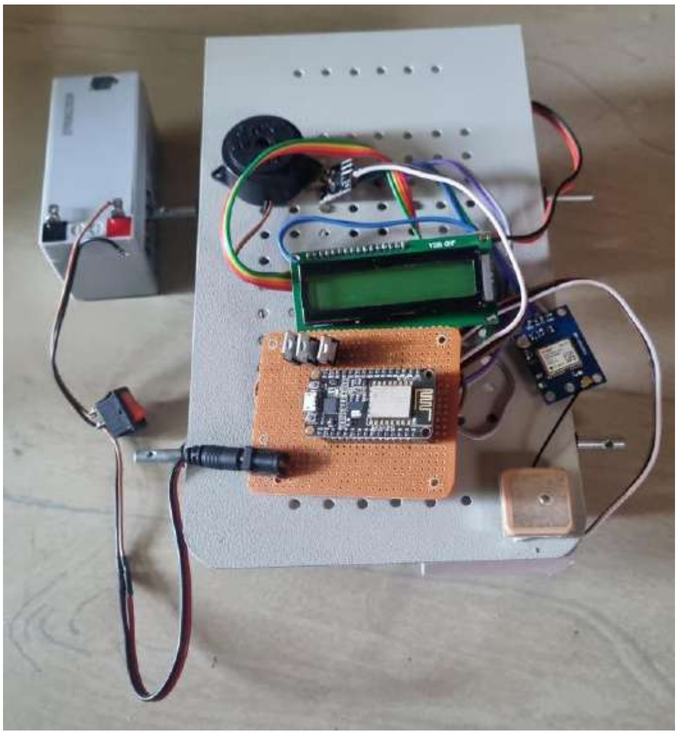

Fig. 5. System to detect Crack

V. WORKING

Our project focuses on implementing an early crack detection system for railway tracks using advanced sensor technologies. The core components of our system include the ESP8266EX microcontroller, a laser ranging sensor for measuring track thickness, and an LDR (Light Dependent Resistor) photodiode sensor for crack detection. Here, we outline the working principle of each component and their collective operation in detecting cracks in railway tracks at an early stage.

The ESP8266EX microcontroller serves as the brain of our system, responsible for data processing, sensor interfacing, and decision-making tasks. It connects wirelessly to a central monitoring station or control room, transmitting real-time data and alerts regarding track conditions.

The laser ranging sensor is mounted on a moving platform or inspection vehicle that travels along the railway tracks. It emits laser pulses towards the track surface and measures the time taken for the reflected light to return. Based on this time- of-flight measurement and the speed of light, the sensor calculates the thickness of the track at various points along its length. Deviations from the expected thickness can indicate potential issues such as wear, deformation, or irregularities in track .

Alongside the laser ranging sensor, LDR photodiode sensors are strategically placed to monitor specific sections of the track. LDR sensors detect changes in ambient light conditions caused by cracks or gaps in the track surface. When a crack is present, it alters the amount of light reaching the LDR sensor, triggering a change in its resistance. The ESP8266EX microcontroller continuously monitors the LDR sensor readings, and significant variations indicative of cracks prompt immediate alerts or corrective actions.

As the inspection vehicle equipped with the sensor array traverses the railway tracks, the laser ranging sensor measures track thickness, while the LDR sensors detect cracks. Data from these sensors are relayed to the ESP8266EX microcontroller, which processes the information in real time. Any anomalies such as reduced track thickness or detected cracks beyond permissible limits trigger the microcontroller to send alerts wirelessly to the central monitoring station. Maintenance teams can then promptly assess the identified areas, conduct necessary repairs or preventive measures, ensuring the safety and integrity of the railway infrastructure.

By combining precise track thickness measurements with early crack detection capabilities, our system aims to enhance railway track maintenance practices, minimize downtime due to track failures, and ultimately improve overall railway safety and efficiency.

VI. CONCLUSION

In conclusion, our project addresses a critical aspect of railway infrastructure maintenance by developing an innovative early crack detection system using advanced sensor technologies. The integration of the WeMOS microcontroller, laser ranging sensor for track thickness measurement, and LDR photodiode sensors for crack detection represents a robust solution for ensuring the safety and reliability of railway tracks.

Through our system, we have demonstrated the feasibility and effectiveness of leveraging IoT (Internet of Things) principles and wireless communication to monitor track conditions in real time. The continuous monitoring of track thickness and the detection of minute cracks before they escalate into major defects are pivotal in preventing potential derailments, accidents, and service disruptions.

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Design and Analysis of Reconfigurable Microstrip PatchAntenna for Multi Band Frequencies

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Abstract* – *This paper presents the design, simulation, and analysis of a reconfigurable microstrip patch antenna employing four switches. The primary objective is to achieve multi-band functionality and adaptability across various operating frequencies through switch configurations. The antenna design integrates a microstrip patch element alongside strategically positioned switches, enabling adjustments to current distribution and resonantfrequency. Performance characteristics, including return loss, radiation pattern, and gain, are thoroughly evaluatedusing CST Studio electromagnetic simulation software. The proposed system consists of 4 PIN diode switches. The proposed system achieves a maximum gain of 3.9 dB. Additionally, this unique redesigned system exhibits improved return loss across a wide frequency range (4 to 18 GHz), achieving an impressive maximum return loss of -58 dB at 17.138 GHz. Furthermore, the proposed system's efficiency surpasses that of the existing system, reaching approximately 65% compared to the existing 51% efficiency.

Keywords* – *Microstrip patch antenna, PIN diode, Return Loss, Gain, VSWR, Multiband Frequencies

I. INTRODUCTION

Microstrip patch antennas are commonly employed in wireless communication due to their ease of manufacturing and design. Additionally, the theory behind microstrip patch antennas has seen significant development in recent years. Bob Munson created patch antennas in 1972, but Dechamps did some earlier work in 1953. These antennas became widespread in the 1970s. Patch antennas, also known as microstrip patch antennas, are important for modern wireless communication systems. They have many benefits, such as small size, easy integration, and flexibility. In this thorough introduction, we'll discover the basic concepts of patch antennas, how they are made, and what makes them useful for wireless communication. A patch antenna operates in the microwave frequency range and has a low-profile design. It is unlike traditional antennas, which are large and heavy. A patch antenna can be directly printed on a circuit board, which is great for devices with little space. Patch antennas are used in mobile phones, tablets, laptops, and other handheld devices that require wireless connectivity. Patch antennas provide reliable and efficient communication in different frequency bands, such as GSM, CDMA, LTE, Wi-Fi, Bluetooth, and GPS. Patch antennas can also support multiple-input multiple-output (MIMO) technology, which is a technique that uses multiple antennas at both the transmitter and the receiver to increase the data rate and the reliability of the communication. The heart of the antenna is the radiating patch, usually made of conductive materials like copper or gold. The shape of the patch (square, rectangular, circular, or elliptical) influences its operating frequency and radiation properties. We can adjust the patch size to suit different microwave frequencies. The radiating patch is over a dielectric material, which supports it mechanically and isolates it electrically. We use low-loss materials with high dielectric constants (such as fiberglass-reinforced epoxy or ceramics).

The substrate properties impact antenna performance, bandwidth, and efficiency. Under the substrate is the ground plane, which completes the planar structure. The ground plane ensures the antenna works properly by providing a reference point for electromagnetic waves. The patch receives RF signals through a transmission line (often microstrip or coaxial feed). This feeding mechanism enables the patch to emit electromagnetic waves. Patch antennas are space-efficient, which makes them ideal for portable devices like mobile phones and wireless routers. They have a flat, lightweight design that aligns with modern miniaturization trends. Unlike protruding antennas, patch antennas lie flat on the substrate, which minimizes visual impact. These antennas have directional radiation patterns, which enhances signal focus. They are also cost-effective because of mass production and easy fabrication. Patch antennas are used in Mobile communication devices, Wireless routers, Satellite communication systems, Radar technology. In recent years, significant advancements have been made in the theory of microstrip patch antennas. These antennas consist of three main components: the patch, substrate, and ground plane [1]. In this article, researchers explore a reconfigurable microstrip antenna that can be tuned for wideband frequency and adjusted for polarization [2]. In the context of antenna design, a lumped element strategically placed between the monopole and the parasitic patch serves to transform the antenna's behavior from a single band to a dual band configuration [3].

II RELATED WORK

The authors focus on an antenna tailored for the ISM band, with compact dimensions of 40mm x 16mm x 1.6mm. The antenna is built on an FR4 substrate, known for its high performance in microwave applications, with a relative permittivity of 4.3.
The FR4 material is chosen for its recent popularity as a robust and versatile substrate in microwave technology.

To enable the antenna to tune to various frequencies, the design includes two PIN diodes, allowing it to switch between six frequency bands ranging from 1GHz to 5GHz. This feature makes the antenna highly adaptable for different ISM applications.The antenna's efficacy, including its radiation pattern and impedance matching, was assessed using CST software simulations.

The results are significant, indicating the antenna's potential in enhancing the design of low-profile, adaptable antennas for ISM uses. The antenna utilizes a reconfigurable microstrip patch design with two PIN diode switches to facilitate frequency adjustment. At 3.4GHz, it achieves a maximum return loss of -31 dB, indicating some power reflection and inefficiency.

The operational frequency range of 3 to 4 GHz limits its use to devices that operate below 5 GHz, suggesting a scope for further broadening its applicability.
This research is a valuable contribution to the field of antenna technology, particularly for ISM applications.

III PROPOSED SYSTEM

In this proposed Microstrip patch antenna is designed based on the standard formula to ascertain the dimensions of the Patch, Substrate, and Ground.
In this design, Copper is the chosen material for both the ground and patch in this design due to its excellent conductive properties. Copper is an exceptional choice for antenna construction due to its remarkable properties. Copper is an efficient conductor of electrical energy. In fact, it's second only to silver in terms of conductivity. When used in antennas, copper ensures that more of your RF energy is efficiently transmitted and radiated, rather than being trapped or lost as heat energy. This increased electrical efficiency results in better antenna performance. Because copper is twice as conductive as aluminum and six times more conductive than steel, it allows for optimal radiation efficiency. When you transmit a signal, more of it will go up and out of the antenna, contributing to better signal propagation. The enhanced electrical properties of copper mean that you can safely run higher power levels through a copper antenna. For instance, J-Pole antennas made from copper have been tested up to 500 watts without issues.

There's no reason why they couldn't handle the full legal limit of power if needed. Copper tubing used in antennas strikes a balance between being soft and malleable while still maintaining rigidity. It's well-suited for base antennas. In contrast, stainless steel has higher tensile strength, making it suitable for mobile whip antennas where flexibility is crucial. Unlike aluminum or stainless steel, which may require larger or better-designed antennas, copper ensures reliable transmission and reception of signals. Its excellent conductivity contributes to stable and consistent antenna performance. Copper's combination of high conductivity, efficientradiation, and robustness makes it an ideal material for antennas. However, keep in mind that copper's cost has been rising, and it's essential to consider both its benefitsand limitations when designing antennas. In Substrate, FR-4 material is used. Because FR-4 has better signal transmission properties compared to other materials due to its lower dielectric constant. This property ensures efficient signal propagation within the antenna structure. FR-4 substrates provide excellent electrical insulation and mechanical strength. They protect the electrical components on the board and maintain structural integrity. FR-4 is resistant to heat and chemicals, making it suitable for various applications. Its robustness ensures reliable performance even under challenging conditions. FR-4 is widely available and relatively cost-effective, making it a preferred choice for many antenna designs.

FR-4's combination of good signal transmission, insulation, strength, and cost-effectiveness makes it a reliable substrate material for antennas

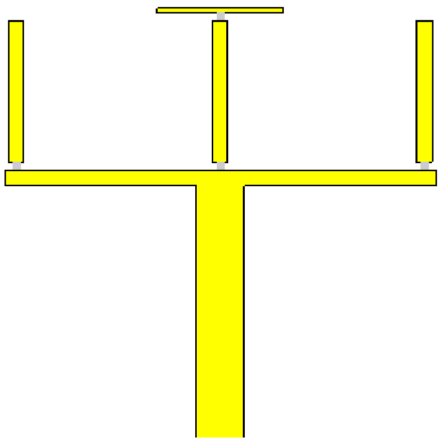

Fig. 1 Structure of the Patch

In Fig. 1, This design consists of 4 switches, PIN diode is used for switches. They contribute to a clearer signal with less interference. This allows for quick switching between different states or frequencies. This results in better high-frequency performance. It enables the diode to handle higher power levels and voltages. PIN diodes can be used to create reconfigurable antennas, which can switch between different frequencies, polarizations, or radiation patterns, enhancing versatility and performancein various applications. They are relatively inexpensive and straightforward to integrate into antenna designs. These properties make PIN diodes particularly useful for modern communication systems where performance, efficiency, and adaptability are key. The dimensions of the patch are represented in Fig. 3 and the dimensions of the ground are represented in Fig 4. The design has yielded improved outcomes in return loss and efficiency for wideband frequencies by iteratively modifying the patch structure through a trial and error process.

In Fig. 2, The introduction of a slot in the ground plane has led to a marked improvement in both return loss and gain.

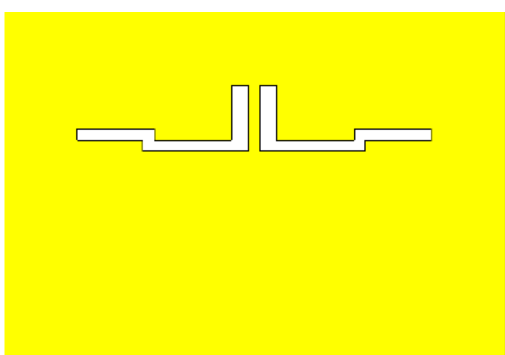

Fig 2 Structure of the Ground

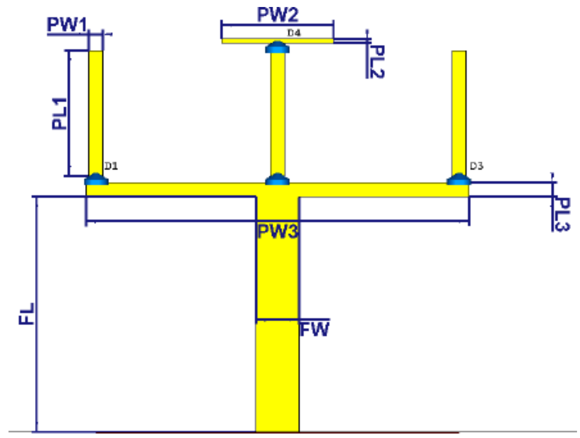

Fig. 3 Dimensions of the Patch

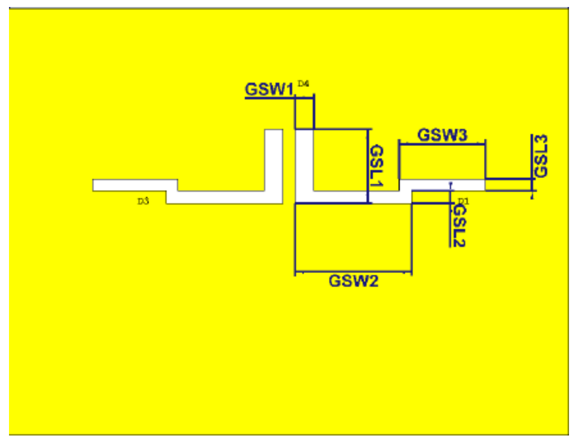

Fig. 4 Dimensions of the Ground

S.No.	Parameters	Description	Values (mm)
1.	**PL1**	Patch 1 length	9
2.	**PW1**	Patch 1 width	1
3.	**PL2**	Patch 2 length	0.30
4.	**PW2**	Patch 2 width	8
5.	**PL3**	Patch 3 length	1
6.	**PW3**	Patch 3 width	27.40
7.	**FW**	Feed width	3.08
8.	**FL**	Feed length	16.90
9.	**Sl**	Substrate length	34.80
10.	**Sw**	Substrate width	45.64
11.	**Th**	Thickness of ground and patch	0.035
12.	**H**	Thickness of the substrate	1.6
13.	**Gl**	Ground length	34.80
14.	**Gw**	Ground width	45.64
15.	**GSL1**	Ground slot 1 length	6
16.	**GSW1**	Ground slot 1 width	1.5
17.	**GSL2**	Ground slot 2 length	1
18.	**GSW2**	Ground slot 2 width	9.50
19.	**GSL3**	Ground slot 3 length	1
20.	**GSW3**	Ground slot 3 width	7

Table 1 Dimensions of the Antenna

The Dimensions of the overall antenna and the slots are represented in the Table 1.

The performance of the antenna depends on its dimension and materials. Based on this radiation efficiency, gain, directivity, return loss, VSWR and other parameters are also influenced.

The proposed antenna design consists of 4 PIN diode switches with maximum return loss of -58db atfrequency of 17.1GHz. In Existing System, Maximum efficiency is about 51%, In proposed system the efficiency is about 65%.

In existing system, the maximum gain obtained is about 2dB. In this proposed system the Gain obtained is about maximum of 3.955dB. This system obtained better return loss across wide range of frequencies about 4 to 18GHz.

IV RESULTS AND DISCUSSIONS

Return loss measures the mismatch between an antenna and its transmission line (usually coaxial cable). It quantifies how much power is reflected back from the antenna due to impedance mismatches. Return loss is typically expressed in decibels (dB).A higher return loss value indicates a better match between the antenna and the transmission line.

Formula - The return loss (RL) can be calculated as :

RL=−20log10(VSWR+1VSWR−1)
where VSWR (Voltage Standing Wave Ratio) represents the ratio of the maximum voltage to the minimum voltage along the transmission line.A low return loss (close to 0 dB) means significant reflection and poor impedance matching.

A high return loss (closer to infinity dB) indicates minimal reflection and excellent impedance matching. Antenna designers should strive to minimize return loss to ensure efficient power transfer and optimal performance.

A lower return loss is desirable for efficient energy transfer from the transmitter to the antenna. For a standard antenna, the minimum return loss should be less than -10 dB. Consequently, in this proposed system, the return loss has been enhanced.

In Table 2 the observations obtained after the simulation in the CST Software is tabulated:
1 - **ON** Condition
0 - **OFF** Condition

* - Best Output obtained in this proposed system

SWITCH CONDITION	FREQUENCY	RETURN LOSS	GAIN	VSWR
"1001"	**17.138**	***-58.318****	2.26	***1.002****
"0000"	**13.502**	-51.466	0.812	1.005
"0000"	**4.898**	-50.14	3.858	1.007
"1111"	**4.916**	-44.251	***3.9553****	1.012
"1101"	**13.088**	-42.387	2.266	1.015
"0000"	**17.084**	-41.085	1.774	1.018
"0111"	**17.102**	-40.861	2.466	1.018
"0101"	**13.232**	-39.485	1.536	1.022
"0100"	**17.066**	-36.099	1.804	1.032
"0110"	**13.358**	-34.281	1.987	1.039
"1011"	**12.692**	-33.928	1.996	1.041
"0110"	**17.048**	-32.976	2.109	1.046
"0001"	**13.538**	-32.659	0.732	1.048
"1110"	**13.052**	-32.418	2.111	1.049
"1111"	**13.034**	-30.777	2.117	1.06
"1011"	**17.156**	-29.644	1.899	1.068
"0100"	**13.322**	-28.871	1.391	1.075
"0010"	**13.628**	-27.753	1.557	1.085
"1001"	**13.682**	-24.645	1.472	1.124
"0011"	**13.683**	-24.64	1.472	1.125
"0011"	**12.674**	-23.264	2.066	1.148
"1010"	**13.772**	-20.67	1.015	1.204
"1011"	**13.826**	-19.352	0.821	1.242

Table 2 Simulated Observations

Antenna gain is a measure of how well an antenna can radiate a signal in a specific direction, compared to an ideal antenna that radiates equally in all directions. Antenna gain is usually expressed in decibels relative to isotropic (dBi), which means the ratio of the power radiated by the antenna to the power radiated by the isotropic antenna. Antenna gain depends on the directivity and the efficiency of the antenna. Directivity is the ability of the antenna to focus the signal in a certain direction, while efficiency is the ratio of the radiated power to the input power of the antenna. Antenna gain can be increased by increasing the size, shape, or number of elements of the antenna, or by using a reflector or a lens to direct the signal. Antenna gain is important for applications that require long-distance communication or precise targeting of the signal. However, high-gain antennas also have narrower beamwidths, which means they cover less area and are more sensitive to the orientation of the antenna. Therefore, low-gain antennas may be preferred for applications that require omnidirectional coverage or mobility of the antenna.

Gain = 4π(radiation intensity)/(total input (accepted) power)

The maximum return loss achieved is approximately -58.318 dB. For a standard antenna, the minimum return loss should be less than -10 dB. Consequently, in this proposed system, the return loss has been enhanced. This Proposed system has obtained Voltage Standing Wave Ratio (VSWR) of around 1. The standard antenna should have less than 2 VSWR. VSWR is also improved by maintaining it in equivalent to 1.

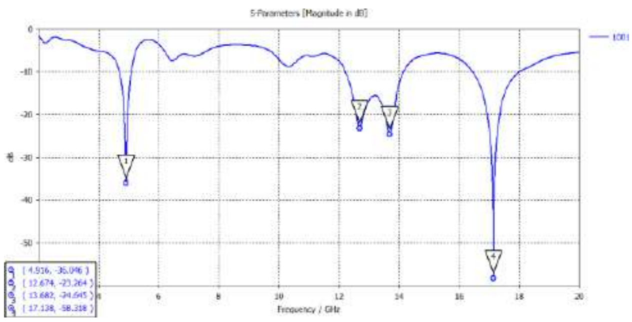

Fig. 5 Return Loss in 1001 Mode

In Fig. 5, The **maximum return loss** is **-58.318 dB** for the no. 4 frequency 17.138 GHz achieved in 1001 (i.e ON-OFF-OFF-ON) condition.

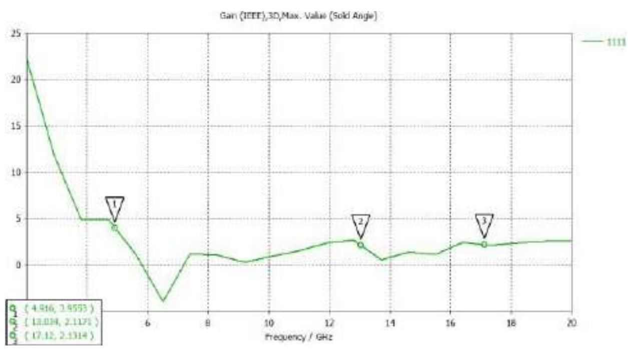

Fig. 6 Gain in 1111 Mode

In Fig. 6, **The maximum gain** is **3.955 dB** for the no.1 frequency 4.916 GHz is achieved in 1111 (i.e ON-ON-ON-ON) condition.

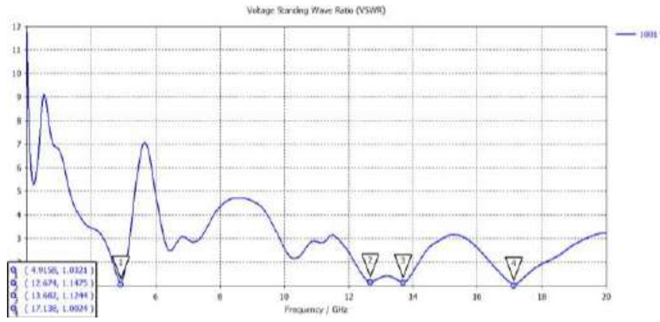

Fig. 7 VSWR in 1001 Mode

In Fig. 7, This design achieves **VSWR** with a remarkably low value of **1.002** for the no. 4 frequency 17.138 GHz in 1001 (i.e ON-OFF-OFF-ON) condition.

V CONCLUSION AND FUTURE WORK

In this Proposed system, a novel design for a microstrip patch antenna has been implemented. The modifications included altering the antenna's structure and introducing ground slots.

As a result, significant improvements were observed in return loss, gain, and VSWR. Additionally, the system incorporates four switches, with a PIN diode serving as the switch. The use of PIN diodes enhances performance due to their favourable properties. Notably, this design achieved a maximum return loss of -58 dB at a frequency of 17 GHz.

Furthermore, it operates effectively in the frequency range of 4-17 GHz. The proposed microstrip patch antenna design demonstrates promising enhancements and optimized performance across the specified frequency band.

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Alzheimer Disease Identification Using Neuro-Imaging and Deep Learning Strategies

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Abstract—**Alzheimer's Disease (AD) is a progressive neurodegenerative disorder that primarily affects cognitive functions, causing memory loss, impaired thinking, and behavioral changes. Early and accurate diagnosis of AD is crucial for effective intervention and treatment. Neuroimaging techniques, such as magnetic resonance imaging (MRI) and positron emission tomography (PET), have demonstrated potential in providing insights into the structural and functional alterations associated with AD. Leveraging the advancements in deep learning, this project focuses on developing a robust and accurate framework for the identification of Alzheimer's Disease using neuroimaging data. This project focuses on using deep learning such as Inception V3 and Alex Net techniques in conjunction with neuroimaging data to identify Alzheimer's Disease. The study utilizes a dataset containing Neuro-imaging scans from both AD patients and healthy individuals. Preprocessing enhances image quality, while feature extraction captures essential information. The project aims to offer an efficient tool for early Alzheimer's Disease Detection, contributing to improved patient care and disease understanding. The experimental results show that our Inception V3 achieved more better classification performance in terms of accuracy and F1-score, compared with the Alex Net method.**

Keywords--**Alzheimer's Disease, Neuro-Imaging, Deep Learning, Inception V3, Alex Net, Accuracy.**

I. INTRODUCTION

Alzheimer's disease (AD) is a crippling neurodegenerative condition marked by memory loss, progressive cognitive decline, and ultimately, the inability to function independently in day-to-day tasks. It is a major global public health concern, becoming more common as populations get older. In order to potentially halt the disease's progression, early recognition of AD is essential for starting the right therapies and treatments. A common non-invasive imaging technique in clinical practice to see the structural alterations in the brain linked to AD is magnetic resonance imaging (MRI). With the help of MRI scans, which offer comprehensive information about the anatomy of the brain, doctors and researchers can spot abnormalities and patterns of atrophy that point to neurodegeneration.

Convolutional neural networks (CNNs), a type of deep learning, have become a potent tool for medical image processing in recent years. CNNs are excellent for applications like image classification, segmentation, and detection because they can automatically learn hierarchical representations of data. By utilizing the copious amounts of MRI data, scientists have implemented CNNs to help with AD early diagnosis and detection.

Of the several CNN architectures created, Inception V3 and Alex Net are two that are commonly used and have unique features. Google developed the Inception V3 deep CNN architecture, which includes inception modules that enable multi-scale feature capture and effective utilization of computational resources. Conversely, one of the first CNN architectures to show the value of deep learning in image classification problems was Alex Net, which was first shown by Krizhevsky et al. Several convolutional and pooling layers precede fully linked layers in Alex Net, despite its simplicity in comparison to Inception V3.

The purpose of this study Is to examine how well the Alex Net and Inception V3 networks identify AD from MRI data. We aim to investigate the trade-offs between classification accuracy and model complexity by contrasting these two models. In particular, we speculate that Inception V3's deeper architecture would allow it to detect more subtle patterns of AD-related brain atrophy, outperforming Alex Net in the process.

We will start by preprocessing the MRI data in order to normalize intensity values, adjust for artifacts, and standardize image resolution in order to accomplish this goal. Next, we will use the convolutional layers of both Inception V3 and Alex Net to extract features from the pre-processed MRI images. After that, these characteristics will be given into fully connected layers for AD and non-AD categorization.

We will use metrics like recall, accuracy, sensitivity, and precision to assess the models' performance. To better grasp the real-world effects of using these models in clinical settings, we will also evaluate computational efficiency in terms of training time and inference speed.

The findings of this study will contribute to the growing body of literature on automated AD diagnosis using deep learning techniques. Moreover, the comparative analysis between Inception V3 and Alex Net will provide insights into the strengths and limitations of each architecture, informing future research directions in the development of more accurate and efficient AD diagnostic tools.

II. RELATED WORK

In this section, we briefly introduce previous studies on computer-aided AD diagnosis methods with S-MRI data and electroencephalogram (EEG) data. Then we respectively review the Support Vector Machine (SVM), 2D CNN, and 3D CNN-related works in medical imaging analysis.

A. Support Vector Machine

The diagnosis of Alzheimer's disease involves neurological examinations, among which one can mention the electroencephalogram (EEG). The waveforms collected by the EEG scalp electrodes are then analyzed by a specialist, to identify patterns that indicate the presence of dementia. Some studies show the use of Machine Learning (ML) techniques in extracting these patterns, providing therefore an aid to the specialist in this type of analysis. In this study, Support Vector Machines, an ML method based on Statistical Learning Theory, were used to induce a model that, from EEG waves gets an automatic diagnosis of Alzheimer's disease, becoming a tool that supports the diagnosis made by neurologists. The performance obtained from the analysis of EEG epochs was 79.9% accuracy and 83.2%sensitivity, whereas the analysis considering the diagnosis of each patient was obtained with 87.0% accuracy and 91.7% sensitivity.

B. 2D CNN And 3D CNN

In the previous work of this method, they tested a pattern classification system that combines sparse autoencoders and convolutional neural networks. We were primarily interested in assessing the accuracy of such an approach on a relatively large patient population, but we also wanted to compare the performance of 2D and 3D convolutions in a convolutional neural network architecture. Our experiments indicate that a 3D approach has the potential to capture local 3D patterns which may boost the classification performance, albeit only by a small margin. These investigations could be further improved in future studies by carrying out more exhaustive searches for the optimal hyper-parameters in both architectures. Moreover, the overall performance of these systems could be further improved. For instance, the convolutional layer used in our experiments has been pre-trained with an autoencoder, but not fine-tuned. There is evidence that fine-tuning may improve the performance at the cost of a much increased computational complexity at the training stage.

III. MATERIALS AND METHODS

A. Data Acquisition

Sixty-four hundred MRI training and testing pictures that depict four different forms of dementia (Figure 1) make up the dataset. These photos were taken from Kaggle, a well-liked platform for dataset sharing and data-driven research. Table 1 displays the total number of photos associated with each dementia. The MRI pictures have to be accessed and downloaded from Kaggle's repository in order to acquire the dataset. 6400 MRI pictures are included, which offers a significant amount of data for analysis and model training. This dataset makes it easier to conduct investigations on the diagnosis and categorization of dementia using MRI data. It is a useful resource for researchers and practitioners in the fields of neuroimaging and machine learning.

TABLE I. DATASET CLASSIFIED

FOUR CLASS	TOTAL COUNT
VERY MILD DEMENTED	2240
MILD DEMENTED	896
MODERATE DEMENTED	64
NON DEMENTED	3200

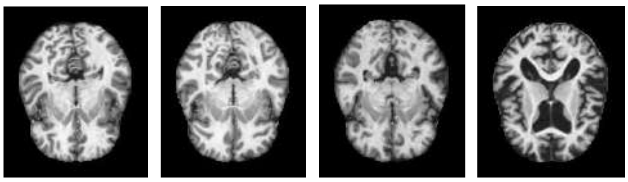

Fig. 1. Samples From Each Dementia

B. Data Augmentation

Data augmentation is a straightforward yet powerful technique used to enhance datasets by artificially expanding their size and diversity. In the context of MRI data for Alzheimer's Disease identification, simple data augmentation techniques involve applying basic transformations to the existing MRI images. This includes rotations, flips, translations, and changes in image brightness or contrast. For instance, rotating MRI images at different angles simulate variations in the orientation of the brain within the scanner, while flipping images horizontally or vertically introduces reflections, effectively doubling the dataset size. Translations can shift the position of the brain within the image, mimicking slight movements during scanning. Adjusting brightness and contrast levels can simulate differences in imaging conditions or scanner settings. These simple augmentations help expose the model to a wider range of variations in the input data, improving its ability to generalize and recognize patterns across different MRI scans. Overall, simple data augmentation serves as a valuable tool to boost the robustness and performance of machine learning models trained on MRI data for Alzheimer's Disease identification. Following data augmentation, the number of images will be the same for every dementia class.

C. Data Preprocessing

Our preprocessing pipeline involves several key steps to ensure the quality and suitability of the input data for subsequent analysis. Firstly, we perform cropping to focus on the region of interest within the MRI scans, specifically targeting the brain area while excluding unnecessary background information. This step helps reduce computational overhead and enhances the efficiency of subsequent processing steps. Following cropping, we apply normalization techniques to standardize the intensity values of the MRI images across different scans. Normalization helps mitigate the effects of variations in imaging parameters and scanner settings, ensuring consistency in the data representation. By scaling the intensity values to a common range, we facilitate comparability between images and improve the convergence of machine learning algorithms during training. Additionally, our preprocessing pipeline encompasses quality control measures to identify and discard any corrupted or unusable MRI scans. This involves a thorough examination of the data for artifacts, motion artifacts, and other anomalies that may affect the accuracy of subsequent analyses.

D. AlexNet Algorithm

Alex Net, a seminal convolutional neural network architecture (Figure 3), sparked a paradigm shift in computer vision with its victory in the ImageNet Large Scale Visual Recognition Challenge in 2012. Its architectural design is characterized by eight layers, consisting of five convolutional layers followed by three fully connected layers. The first convolutional layer processes the input image with a 96-filter bank of size 11x11 with a stride of 4 pixels, followed by a rectified linear unit (ReLU) activation function, enhancing the model's ability to capture non-linear relationships in the data. Subsequent convolutional layers employ similar strategies, reducing filter sizes and increasing the number of filters to capture increasingly complex features. Interspersed between the convolutional layers are max-pooling layers, which downsample feature maps to reduce computational complexity and spatial dimensions while retaining essential information.

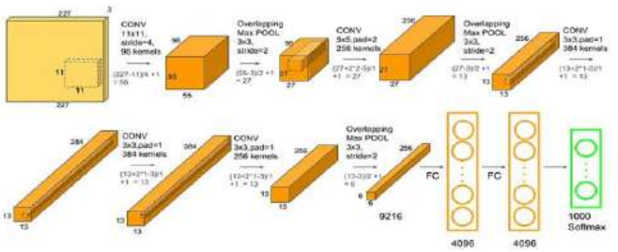

Fig. 2. Alexnet Architecture

One of AlexNet's key innovations is the incorporation of local response normalization (LRN) within its convolutional layers. LRN enhances the model's generalization capabilities by normalizing responses across adjacent channels, effectively promoting competition among neighboring features. Furthermore, AlexNet employs dropout layers in its fully connected layers to prevent overfitting by randomly dropping out neurons during training, thereby reducing the risk of co-adaptation among neurons. The architecture also benefits from GPU acceleration, leveraging parallel computing power to significantly accelerate training time compared to traditional CPU-based approaches. This efficient use of computational resources was instrumental in the success of Alex Net and contributed to its widespread adoption in subsequent research and applications.

In summary, AlexNet's architectural innovations, including its deep convolutional layers, ReLU activations, LRN, dropout regularization, and GPU acceleration, collectively contributed to its breakthrough performance and cemented its status as a landmark in the evolution of deep learning for computer vision tasks.

E. Inception V3 Algorithm

The Inception v3 architecture (Figure 2) is meticulously designed to address the challenges of feature extraction in deep learning models, particularly for image classification tasks. At the heart of the architecture lies the inception module, a pivotal component that revolutionizes the approach to feature representation. Each inception module comprises a series of parallel convolutional operations, including 1x1, 3x3, 5x5, and 7x7 convolutions, as well as max pooling operations. These parallel pathways are designed to capture features at different spatial scales and resolutions, allowing the network to extract rich and diverse information from input images. By incorporating multiple convolutional operations within a single module, the inception architecture promotes feature reuse and encourages the network to learn hierarchical representations of increasing complexity. Furthermore, the inception modules integrate bottleneck layers, which serve to reduce the computational burden of the network without sacrificing representational capacity. These bottleneck layers consist of 1x1 convolutions that project the input feature maps into a lower-dimensional space before applying more computationally expensive operations. This dimensionality reduction step helps streamline the computational flow through the network, enabling the construction of deeper and more expressive architectures.

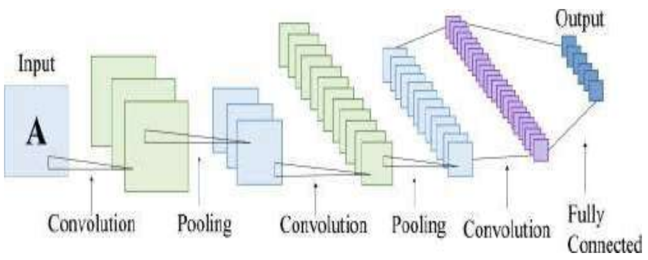

Fig. 3. Inception V3 Architecture

In addition to the inception modules, the Inception v3 architecture includes auxiliary classifiers, which are auxiliary branches connected to intermediate layers of the network. These auxiliary classifiers serve two main purposes: they provide additional supervision signals during training, facilitating more stable and efficient training convergence, and they serve as regularization mechanisms, helping to mitigate the risk of overfitting by encouraging the network to learn more robust and generalizable features.

Overall, the Inception v3 TPU training runs match accuracy curves produced by GPU jobs of similar configuration. The model has been successfully trained on v2-8, v2-128, and v2-512 configurations. The model has attained greater than 78.1% accuracy in about 170 epochs.

IV. DISCUSSION AND RESULTS

In comparing the architectures and results of Inception v3 and AlexNet, notable distinctions arise. Inception v3 boasts a deeper structure, featuring 48 layers, and introduces inception modules, enabling efficient feature extraction at multiple scales. This design facilitates superior performance on benchmark tasks like ImageNet classification, thanks to its ability to capture intricate patterns. Conversely, AlexNet, with its shallower eight-layer design, may struggle to represent fine-grained details effectively. While groundbreaking in its time, its reliance on fully connected layers and simpler architecture can limit its performance compared to more recent models like Inception v3. On Going the Training and Testing of the dataset under both the algorithms we get to know that From Table 2 & 3, The Inception v3 accuracy is higher when compared with Alex Net Accuracy.

TABLE II. REPORT OF ALEXNET

	PRECISION	RECALL	F1-SCORE	SUPPORT
MILD DEMENTED	0.90	0.98	0.94	182
MODERATE DEMENTED	1.00	0.99	1.00	162
NON DEMENTED	0.92	0.89	0.90	173
VERY MILD DEMENTED	0.92	0.87	0.90	181
ACCURACY			0.93	698
MACRO AVG	0.93	0.93	0.93	698
WEIGHTED AVG	0.93	0.93	0.93	698

TABLE III. REPORT OF INCEPTION V3

	PRECISION	RECALL	F1-SCORE	SUPPORT
MILD DEMENTED	0.78	0.74	0.76	182
MODERATE DEMENTED	1.00	1.00	1.00	162
NON DEMENTED	0.74	0.76	0.75	173
VERY MILD DEMENTED	0.64	0.65	0.64	181
ACCURACY			0.78	698
MACRO AVG	0.79	0,79	0.79	698
WEIGHTED AVG	0.78	0.78	0.78	698

Overall, while AlexNet pioneered the field, Inception v3's depth, efficiency, and performance advancements have solidified its position as a preferred choice for complex computer vision tasks. By analyzing the confusion matrix (Figure 4) of Alexnet and Inception V3, we get to know that a number of images are misclassified into another class.

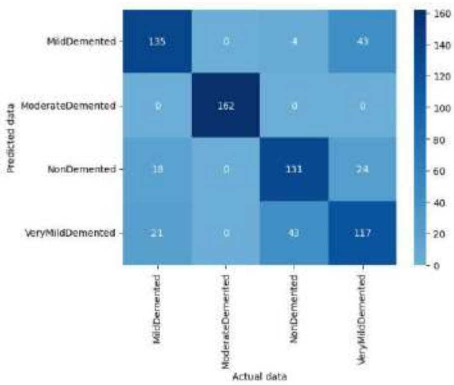

Fig. 4. Confusion Matrix Of Alexnet

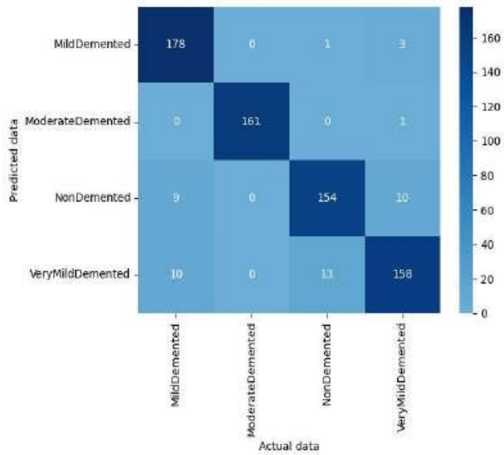

Fig. 5. Confusion Matrix Of Inception V3

V. Conclusion

In conclusion, while AlexNet marked a significant milestone in the development of convolutional neural network architectures for computer vision tasks, the emergence of Inception v3 represents a quantum leap forward in complexity, efficiency, and performance. Inception v3's deeper structure, incorporating innovative inception modules, has propelled it to the forefront of the field, surpassing AlexNet's pioneering yet comparatively simpler design. Its superior ability to capture multi-scale features and achieve remarkable accuracy rates on benchmark datasets underscores its dominance in contemporary computer vision applications. As the torchbearer of convolutional neural network evolution, Inception v3 stands as a testament to the relentless pursuit of excellence in deep learning architectures.

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Design And Implementation of An Improvised Pagoda Style Antenna for Drone Applications

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Abstract — UAV (Unmanned Aerial Vehicles)/Drones are being widely used and have multiple use cases, like Photography, Agriculture, mapping, Surveillance, Military application, etc. Currently while building custom drones, one of the major challenges is video reception from drone to ground station at frequency 5.8 GHz over long range. As these antennas need to be mounted on the drones, the weight and size of the antenna is a major restriction. This means antenna characteristics, need to be light weight and low cost. They need to exhibit omnidirectional radiation characteristics. Current antenna systems suffer from range issue for video reception. The proposed pagoda style antenna has been shown to increase the range by more than 20% while keeping the size, weight and cost to reasonably acceptable level.

Keywords— *Drones, UAV, Omnidirectional Antenna, Pagoda Style Antenna.*

I. INTRODUCTION

UAVs(Unmanned Aerial Vehicles)/Drones today strive for having low profile and light weight antenna on both the transmit and receive side, but still have a good range so that the UAVs can cover large distances. This presents a challenge in designing antennas for video reception, such that antenna size must be small and light. However the range that the UAV can travel needs to be large, that is several 100's of meters to a couple of kilometers.

The objective is to design a custom antenna for video transmission and reception at 5.8GHz, with range of at least 450 meters for the ominidirectional antenna. The main design goals are (1) Return loss less than -20 dB (2) Standing Wave Ratio close 1 (3) Omnidirectional radiation pattern. (4) Reasonably small size less than 15 cm. (5) Easy to manufacture with fine tolerances at low cost (6) Improving the range over a standard dipole.

In the field of UAV, Omnidirectional circularly polarized (CP) antennas have attracted more and more attention from experts and scholars due to their wide use in wireless communication, remote sensing and other telemetry applications. Omnidirectional antenna can radiate electromagnetic wave in any direction in a plane, which is suitable for multi-point simultaneous communication and communication in uncertain position during movement. The CP antennas can accept arbitrary polarized wave, reduce multi-path interference and have high polarization isolation [1]. Having both advantages of omnidirectional antenna and CP antenna, omnidirectional CP antenna can meet the requirements of accurate signal transmission of UAV systems. Hence they can be used, as an image transmission antenna, which can effectively reduce the signal polarization interference.

II. ANTENNA CONFIGURATION

Researches have proposed pagoda style antennas, instead of dipole for better range [2]. A pagoda structure is an Asian tiered tower with multiple eaves common to Thailand, Cambodia, Nepal, Vietnam, and other parts of Asia. Most pagodas were built to have a religious function, most often buddhist, and were often located in or near viharas.

Fig. 1 shows the configuration of omnidirectional CP pagoda antenna. It consists of three dielectric substrates with a thickness of 1mm, a radiant patch, a reference ground and a middle ring patch. The radiation patch and ground plane are located on the upper surface of the upper substrates and the middle substrates respectively, the material of which is FR-4 with the permittivity of 4.4 and the loss tangent of 0.002. The radiation patch and ground plane each contains three curve branches in opposite direction, which are commonly used to reduce the size of antenna. The coaxial cable is in direct contact with the radiation patch for feeding.

The antenna feed refers to the components of an antenna which feeds the radio waves to the rest of the antenna structure, or in receiving what antennas collect which are the incoming radio waves, convert them to electric currents and transmit them to the receiver. Microstrip line is one of the easier methods to fabricate as it is just a conducting strip connecting to the patch and therefore can be considered as an extension of patch. It is simple to model and easy to match by controlling the inset position. Since the current is low at the ends of a half-wave patch and increases in magnitude towards the centre, the input impedance (Z=V/I) could be reduced if the patch was fed closer to the center. Microstrip antennas can also be fed from underneath via a probe. The outer conductor of the coaxial cable is connected to the ground plane, and the centre conductor is extended up to the patch antenna.

However, this has a disadvantage of coaxial feed introducing an inductance into the feed that may need to be taken into account if the height gets large (an appreciable fraction of a wavelength).

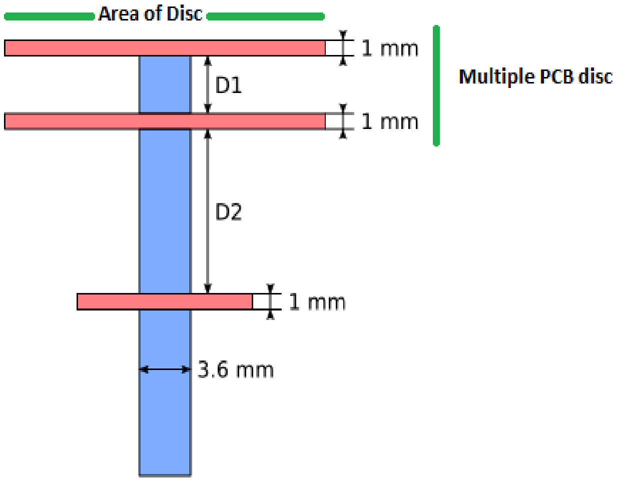

Fig. 1. Configuration of omnidirectional pagoda antenna

III. Design and Methodology

Fig. 2 shows the configuration of omnidirectional CP pagoda antenna. The inner conductor of coaxial cable is made of copper. In order to improve the bandwidth for better practicability, the antenna is loaded with the lower substrate with two ring patches on the upper surface and the lower surface respectively. The lower substrate with two ring patches acts as a choking coil, similar to a metal sleeve. Since, it can be coupled with the radiation patch to enhance the radiation intensity, the lower substrate broadens both impedance bandwidth and axial ratio bandwidth.

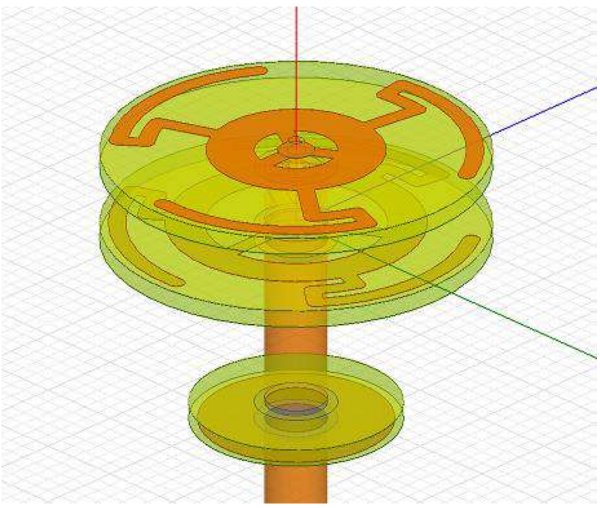

Fig. 2. Designed pagoda antenna

In this section, the working principle and parameter of the omnidirectional CP pagoda antenna are discussed. CP waves are composed of two orthogonal linearly polarized waves with a phase difference of 90°[3]. According to the duality principle, the electric field (□□) in the far field generated by the

$$\vec{E} = \hat{\theta} E_\theta + \hat{\phi} E_\phi . \quad (1)$$

magnetic currents on the pagoda antenna can be expressed as

It is found that when there are more branches, omnidirectivity of the antenna is better, and the operating frequency is reduced as the increase in the number of branches, which has the function of miniaturization. However, considering the size of the antenna, three branches are finally chosen. The three branch elements are arranged in sequence and fed by coaxial cables, forming a clockwise current loop. The end of each branch element is connected to the ground plane, which form a current path. According to the boundary condition, the clockwise current loop generates a vertical down magnetic pole □ = □□ × □, which forms a horizontal polarization component, the □ □ field. The radius of the current loop is R1 . The far field of the current loop □ □

$$E_\varphi = \frac{[I] R_1 \omega \mu_0}{2r} J_1(\beta R_1 \sin\theta) \hat{\varphi} . \quad (2)$$

Where [□] represents the magnitude of current on the loop, □ is the operating frequency, □0 is the free-space permeability, □1 is Bessel's first order function, □ is the propagation parameter of space and □ is the distance between the antenna and the measuring point. Omnidirection Vertical polarized waves are generated by coaxial cable. Its far field

$$E_\theta = j \frac{[I] H \omega \mu_0}{4\pi r} \sin\theta \ \hat{\theta} . \quad (3)$$

□□ can be expressed as

Based on (2) and (3), it is noted that as long as the current [I] through coaxial cable, curved branch, there will be a 90° phase difference between the vertical polarized component and the horizontal polarized component. The circularly polarized radiation pattern will be generated when the magnitude of □□ and □□ are adjusted to be equal. It can be found that the current passing through does not change its direction in one time. Therefore, two polarization components exist 90° phase difference to each other in the far field. Due to the compact structure of the antenna, two polarization components have the same amplitude and orthogonal to each other in space at the same time. Thus the omnidirectional circularly polarized pagoda antenna is realized. To optimize, the design simulations were conducted in Ansys HFSS[4]. The simulated results are presented below.

IV. Simulation Results

A. Return Loss

Return loss provides valuable insights into the matching quality, efficiency, bandwidth, and stability of antenna systems, making it a fundamental parameter in antenna design, characterization, and optimization. A high return loss indicates good performance and efficient power transfer, while a low return loss suggests potential issues with impedance matching, efficiency, and system performance. The omnidirectional pagoda was simulated for 5.8 GHz. The design requirement for return loss was less than -20 dB. As seen in Fig. 3, the simulated antenna shows a return loss of -26.35 dB at 5.845 GHz.

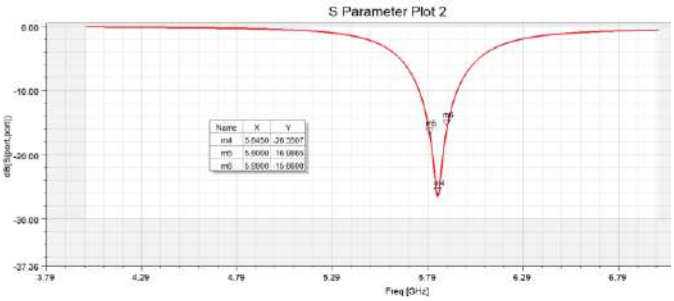

Fig. 3. Return Loss plot of simulated antenna

B. VSWR(Voltage Standing Wave Ratio)

VSWR in the antenna output indicates the level of impedance mismatch between the antenna and the transmission line, leading to power loss, radiation pattern distortion, signal degradation, and potential reliability issues in RF systems. Keeping VSWR within acceptable limits is essential for optimal performance and system integrity. The design requirement for VSWR was to be close to 1, and seen in Fig. 4 in the simulated results the VSWR is 1.39 at 5.845 GHz.

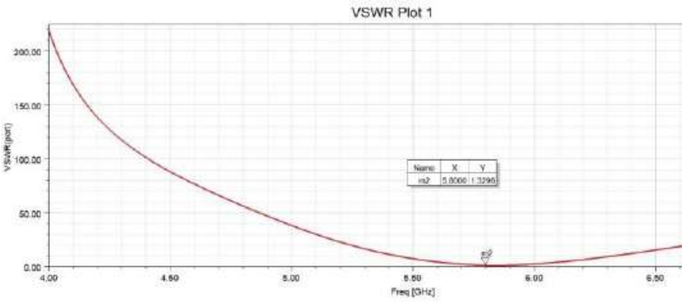

Fig. 4. VSWR plot of simulated antenna

C. Radiation Pattern

In a three-dimensional (3D) gain plot, the antenna gain is represented as a function of azimuth, elevation, and gain magnitude. It provides a more comprehensive visualization of the antenna's radiation pattern, allowing for better understanding of its directional characteristics. The design requirement was a ominidirectional pattern, and the simulated result is close to an ominidirectional pattern, as shown in Fig. 5.

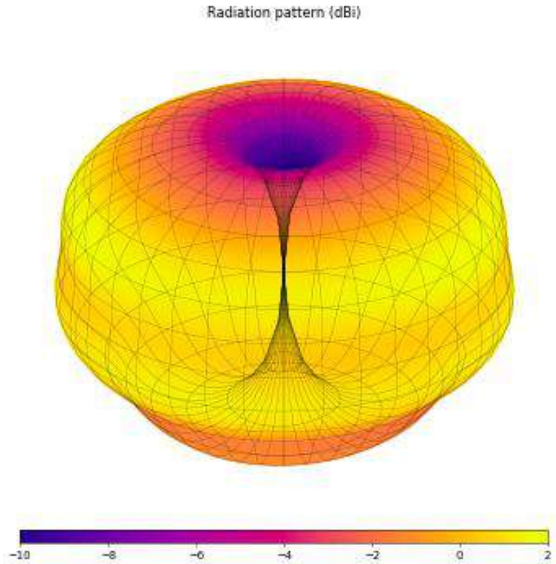

Fig. 5 Radiation plot of simulated antenna

V. Fabricated Antenna and Results

As per the design requirements the thickness of the FR4 material was chosen to be 1mm. The design was tuned for standard FR4 shift in the center frequency of the antenna. The fabricated PCBs are shown in Fig. 6.

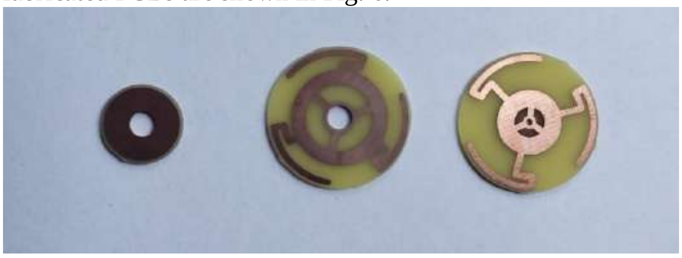

Fig. 6 Fabricated PCBs

To place/stack each of these PCBs on the coaxial cable, 3D design STL (Standard Tessellation Language) files were created using Autodesk Fusion 360, and were 3D printed using PLA (Polylatic Acid) filament to create the Jig to solder the PCBs to the Coaxial cable, as shown in Fig. 7.

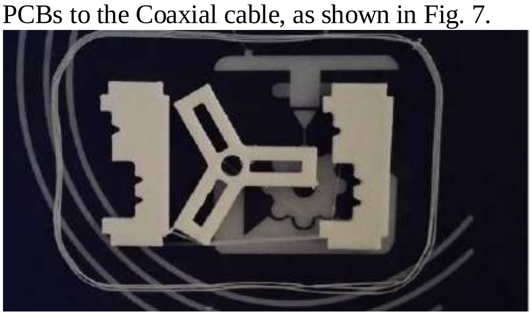

Fig. 7 3D printed parts for the Soldering Jig

Regular RG402 coax, with a 0.92 mm core, 3.0 mm dielectric, and 3.6 mm outer diameter is used as a feed. Regular solderable SMA connector is used to solder to the other end of the RG402 cable, here RP-SMA connector was used, as shown in Fig 8.

Fig. 8 Soldering using 3D printed Jig and SMA connector

The assmbeled antenna was mounted on the FPV(First Person View) monitor as shown in Fig 9.

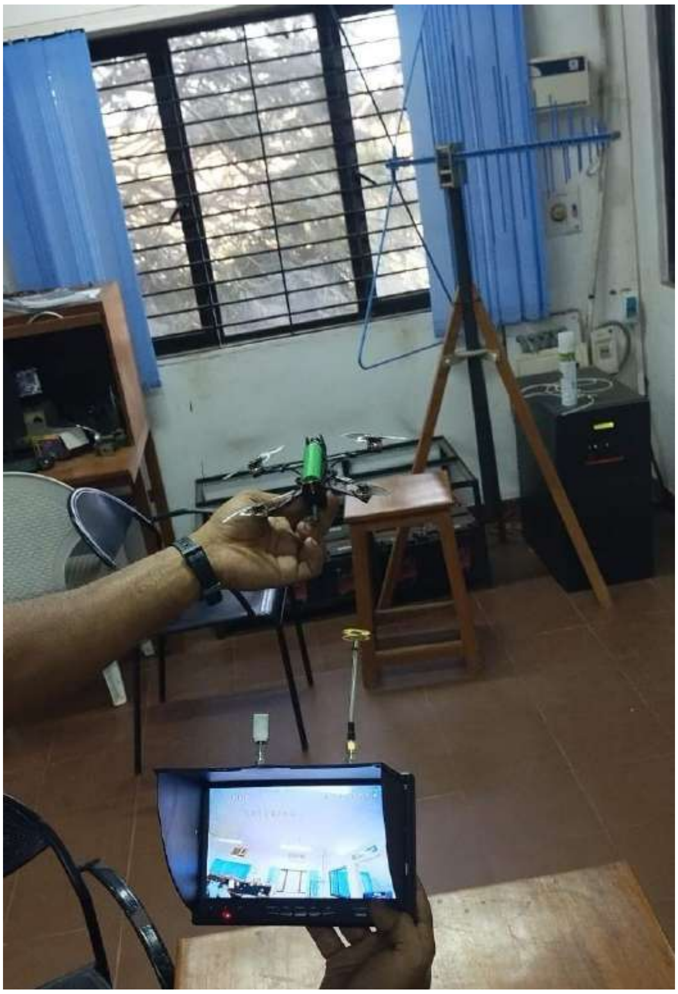

Fig 9: Assembly of Pagoda antenna for drone video reception.

Range test was performed using a quadcopter with dipole antenna connected to the video transmitter, and fabricated antenna connected to FPV monitor on one end and dummy 50 ohms load on other end.

Practical range test results
(1) Range of UAV from FPV monitor using standard dipole antenna = 310 m
(2) Range of UAV from FPV monitor using fabricated pagoda antenna = 380 m

DISCUSSIONS

As seen from the range test the pagoda antenna increase the range by more than 20%. This is a signficant increase for practical UAV applications.

The fabrication cost for prototype was found to be 30% higher, when compared to a dipole. Mass manufacturing can reduce this cost by another 10%. The trade-off of cost vs range shows that the pagoda antenna is a promissing canidate for long range UAV applications.

CONCLUSIONS

An ominidirectional circulaly polarized pagoda antenna was designed, simulated and fabricated for the desired specifications. The test results indicate that pagoda antenna is favarouble when compared to a standard dipole antenna.

ACKNOWLEDGMENT

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Smart Energy Monitoring for Efficient Monetization Using ESP32

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***Abstract*—Energytrack is a remote energy management system that aims to reduce physical boundaries in tracking and various parameters in a three-phase system.The system's basic components include a ZMPT101B voltage sensor, SCT-013-000 Current Sensor, Q3F-1Z Relay Module, etc.... The system can measure voltages, currents, power, frequency, and the phase sequence of each three-phase line.The total units of power consumed from all three lines are also calculated.The main aspect of the system that sets itself apart from the other management systems is the implementation of REMOTE MONITORING using the WiFi module of the ESP32 WROOM Module.Data from the sensors are sent to the ESP32 Microcontroller, Which uploads the data to the server.They can be viewed anywhere with the help of our dashboard.**

***Keywords*—Three Phase, Server, Phase Sequence, Relay System, Dashboard.**

I. INTRODUCTION

Electronic surveillance is an essential tool in today's security environment. Due to the increasing energy demand, this system becomes the basis for efficient resource management and optimization. By combining advanced sensors, and real-time monitoring, it can track and analyze energy consumption in various areas, from businesses to residential households. The system provides useful insights on usage patterns, peak demand periods, and potential areas for performance improvement, allowing users to make informed decisions to reduce waste and improve resource use. Additionally, the ability to detect deviations and deviations from expected usage levels allows for effective monitoring and resolution, reducing downtime and improving performance. At the plant, the system plays an important role in supporting compliance with regulatory standards and achieving safety goals by continuously monitoring emissions and environmental impact. In addition, the emergence of cloud computing and Internet of Things (IoT) technologies have increased scalability and availability, opening new avenues for remote monitoring and centralized management. As organizations and individuals realize the importance of energy conservation and security, the use of energy monitoring systems will become more important and focus on sustainable construction and environmentally friendly infrastructure. In essence, the deployment of these systems means a transition to a more efficient and effective energy ecosystem, where insights from insights lead to smarter use of resources and environmental management.

II. PROBLEM DEFINITION

A. *Introduction of The Relay System*

The Introduction of the Relay system (3x Q3F-1Z RELAY MODULE for each phase) is one of the unique features of the EnergyTrack System.It helps in cutting the power supply to the connected load when there is an increase in the voltage supply to the system.This is implemented to protect the load component connected to the system.A separate "IC ULN2003APG IC MODULE" controls the relay circuit.

B. *Implementation of Phase Sequence Detection*

Phase sequence detection is very necessary for three-phase loads such as three-phase motors etc.. A change in the sequence can be damaging to the load.For example, A three-phase motor functions in the opposite direction.In this system, there is an additional feature to detect changes in the phase sequence.

C. *Server and Dashboard Features*

The system also implements data uploads to the server with the use of the WiFi Module present in the ESP32 WROOM Microcontroller.The uploaded data can be viewed remotely with the help of an indigenous dashboard developed with SpringBoot.

III.IMPLEMENTATION

The ESP32 Enertrack energy monitoring system takes voltage from a three-phase line and a natural line.The three live lines are passed into the ZMPT101B voltage Sensor.The ZMPT101B is a small voltage sensor that can measure single-phase AC voltage.Three voltage sensors are connected to three-phase lines in series.Analog signal OUT from the three voltage sensors is provided to PINS 32,34 and 35 of the ESP module which has built-in analog to digital converters.ULN2003APG IC MODULE is used to control the relay system.The voltage cap is set at 250v.If the voltage from any line exceeds the limit, Relay comes into action and stops the power supply to the load to protect it.GPIO pins 21,22 and 23 are used to control the relay IC.Finally, the SCT-013-000 CURRENT SENSOR is clamped between the load and the system to measure the current drawn by the load in all three phases individually.Output from the current sensors is fed to the ADC pins 36,39 and 33 of the ESP module.

Data from the ESP is updated frequently on the server.We can view the specific data from each of the three lines in the dashboard.Some other features of the dashboard include a phase sequence pass/fail indicator, Power unit consumed display, date and time filters for narrowing the data down, etc... Even if there is a power outage, power units consumed can be retrieved back as it is stored in the EEPROM of the ESP32 module.

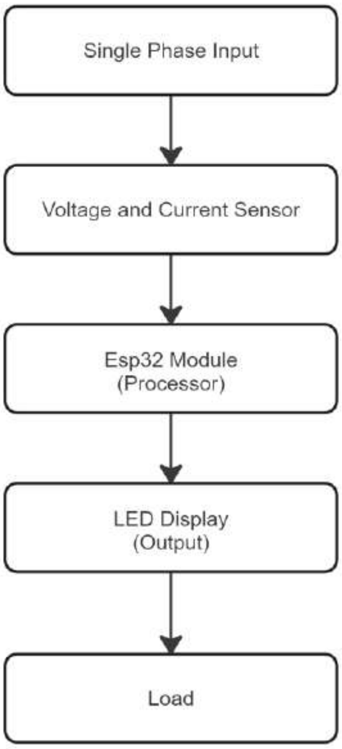

Fig 1 :Block Diagram Existing System

The proposed system has advanced IOT implementation and more features compared to the existing one. The proposed system is more efficient and quick. The proposed system is given below:

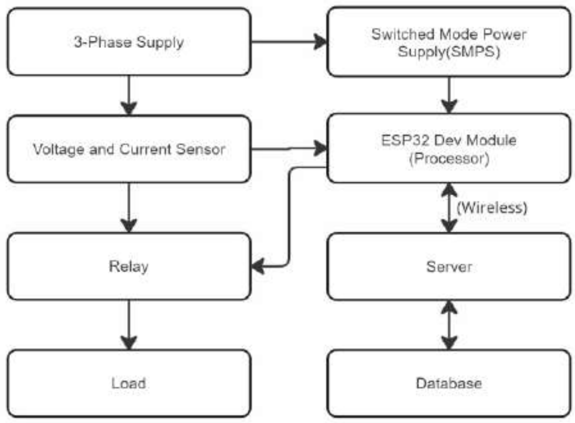

Fig 2 : Block Diagram Proposed System

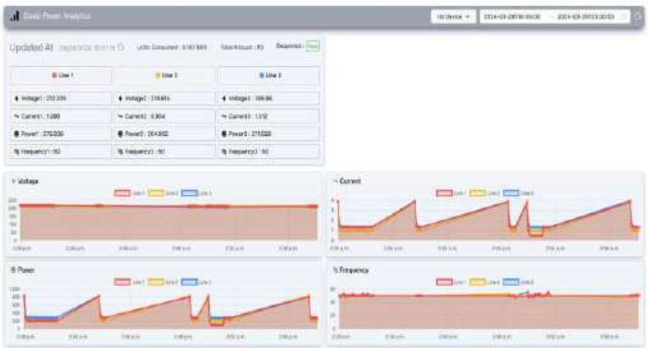

Figure 3 : Dashboard

IV. MODULE IMPLEMENTATION

1. ZMPT101B Voltage Sensor:

1.1 Vrms:

ZMPT101B is a stepdown transformer that was set in a reference voltage of 3.3V. The voltage supply is directly given to the device and its Vout is given to ESP32 in its ADC pin. The Vcc and ground for the device are given from the ESP32 itself.

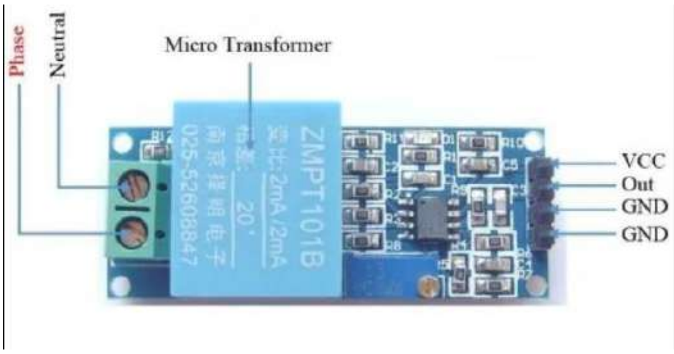

Figure 4 : Voltage Sensor(ZMPT101B)

To calculate the Vrms the sine wave output of the sensor is sampled(we used 20 loop count) and multiplied with the calibration factor(Sensitivity) of the sensor to produce the required Vrms value. the formula used while sampling is given below:

$$\text{ReadingVoltage} \mathrel{+}= \frac{\text{sqrt(Vsum / measurements\_count)}}{\text{ADC\_SCALE * VREF * sensitivity;}}$$

$$\text{Vrms} = \frac{\text{Reading Voltage}}{\text{Loopcount}}$$

1.2 Phase Sequence:

The same voltage sensor is also used to detect phase sequences for the three-phase AC voltage. The three phases are connected to three voltage sensors and have three ADC pins in ESP32. The sine wave of the three-phase voltage is obtained by using the function analog read (Pin_Number). The midpoint of a wave is captured and compared with the other wave at the same instance to find the phase sequence for a three-phase connection. If the Phases match, the sequence is said to be "in phase"

```
if((v1>=1.45 && v1<=1.60)&&(v1<v11)){
      if(v1<v3 && v1>v2){
     Serial.println("Sequence Correct")
     seq=true;
      return;
```

Comparison of voltage amplitudes at midpoint(1.65v) after offset.

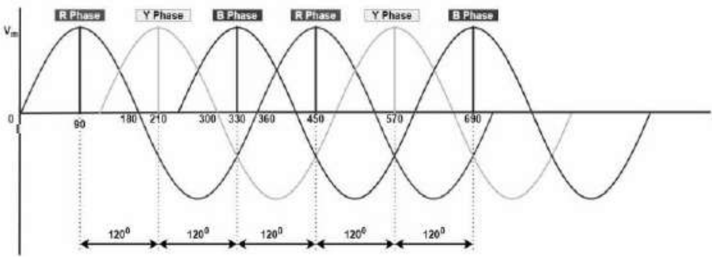

Figure 5 : Phase Sequence Representation

1.3 Frequency:

The frequency of the supply is also calculated with the help of the voltage sensor. This is done similarly to the sequence detection but here a timer model (millis()) is started when the midpoint is detected and stopped after a single wave. Then the value is reciprocated to obtain the Frequency of the supply.

```
if (v1 >= 1.45 && v1 <= 1.65)
      delay(3);
      volt1 = analogRead(pin);
      float v11 = (volt1 * 3.3) / 4096;

if ((v1 < v11) && graphStart && (millis() - timer) > 5)
       graphStart = false;
```

Timer start using millis() function, incremented to 5 avoid value detection on the same wave. Analog voltage v11 multiplied by 3.3 for the offset and converted according to 12-bit resolution.

2. SCT-013-000 Current Sensor:

2.1 Irms:

The SCT013 series are sensors of non-invasive, current transformers that measure the intensity of a current that crosses a conductor without needing to cut or modify the conductor itself.

Figure 6 : SCT-013-000 Current Sensor

We used voltage output because the connection is simpler. The connection used for the current sensor is given below.

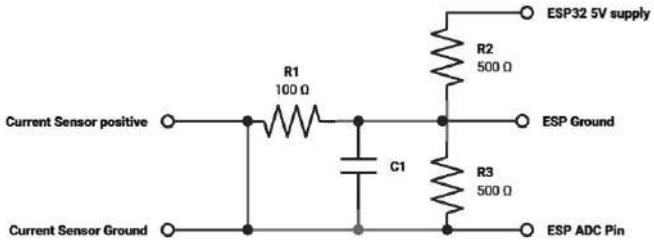

Figure 7 : Current Sensor Implementation Circuit

The Irms values from each phase are calculated by sampling the signal and calibrating it according to the ADC pin of ESP32 (Since ESP32 has 12-bit ADC pins, the value is divided by 4096).

$$\text{Offset} \mathrel{+}= \frac{\text{AnalogRead(Pin\_number)-OffsetI}}{4096}$$

$$\text{SumI} \mathrel{+}= \text{Offset}$$

$$\text{Irms} = \text{sqrt(sumI / Number\_of\_Samples)}$$

3. *Q3F-1Z Relay Module:*

The Q3F-1Z is a general-purpose power relay with a DC coil voltage of 12V 10A and five pins. It has a load capacity of 125V/250V AC, 30V/28V 10A, and 15A switching capability.

Figure 8 : Q3F-1Z Relay Module

The relay is used to shut down the load company whenever a voltage spike is detected in the supply. The relay is also combined with a ULN2003APG IC MODULE which is used to drive high current loads using digital logic circuits. The ESP32 digital out pin sends a digital signal to the ULN2003APG IC MODULE, opening the relay and shutting the power supply. This is done to protect the load from voltage spikes.

4. *Data Transaction:*

The data transmission mechanism from the ESP32 to the Spring Boot backend relies on crucial header files and straightforward code snippets. It starts with the inclusion of essential libraries such as WiFi.h, WebServer.h, HTTPClient.h, and ArduinoJson.h, enabling the ESP32 to establish a stable network connection and execute HTTP communication.

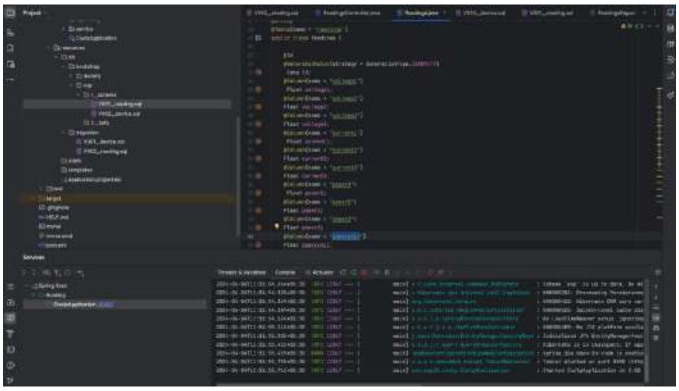

Figure 9 : Backend

This facilitates the transmission of data encapsulated in JSON format, containing vital parameters like voltage, current, power, and frequency readings for each phase, alongside a sequence indicator. This data is dispatched via an HTTP POST request to a specific endpoint on the Spring Boot backend, identified by a unique URL. Upon receipt, the backend swiftly acknowledges the payload, initiating necessary actions such as storage, analysis, or further processing. This cyclical process, operating at a frequency of every three seconds, ensures a continuous and seamless exchange of data, facilitating real-time monitoring and analysis of power consumption metrics across diverse applications and systems.

5. *Data Storage:*

Upon receiving the JSON payloads from the ESP32, the Spring Boot backend acknowledges the data. The backend then sends the data to a dedicated controller for processing. This controller parses the JSON payloads to extract relevant data fields like voltage, current, power, frequency readings, and sequence indicators.

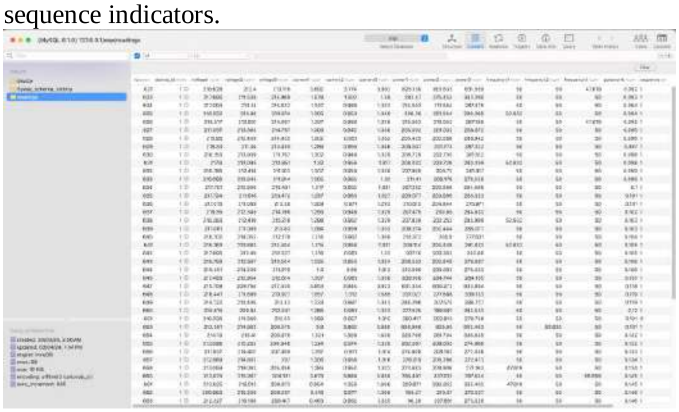

Figure 10 : Database

Using MySQL, the controller stores this data in designated tables in the database. With optimized database schemas and indexing, the backend ensures efficient storage and retrieval of data for analysis and visualization. This straightforward process enables real-time monitoring and analysis of power consumption metrics across various applications.

***6. Hosting*:**

To host the Springshutsn a local hotspot, first connect your machine to the hotspot's Wi-Fi network. Next, configure the backend application to bind to your machine's local IP address in the application.properties file.

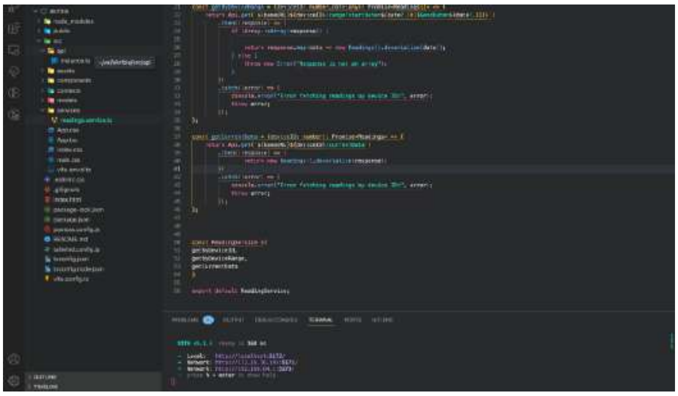

Figure 11 : Hosting

Then, run the application locally. Devices within the same hotspot can access the backend by navigating to your machine's IP address and port. This setup offers a convenient and efficient means for testing and development within a controlled environment, ensuring seamless connectivity for devices connected to the local network.

V APPLICATIONS

1. ***Usage in Commercial Buildings:***

Energy monitoring systems optimize energy consumption in offices, shops, and hotels, as well as our project in an industrial environment. They help businesses identify inefficiencies and reduce operating costs while supporting sustainability efforts.

2. ***Implementation in the Transport sector*:**

Energy monitoring is essential to manage fuel consumption and emissions in vehicles, similar to how our project monitors energy consumption in machinery. It helps transport companies optimize efficiency, reduce costs, and minimize environmental impact.

3. ***Implementation in Healthcare Facilities*:**

As in our project, energy monitoring systems in healthcare facilities ensure efficient energy use without compromising critical operations. They help hospitals and clinics manage energy use in facilities and equipment, ensuring patient care while saving costs.

4. ***Industrial efficiency*:**

Energy monitoring systems optimize energy use in factories and industrial environments, just like our project. They identify where energy is being wasted, helping industries reduce costs and improve their bottom line.

5. ***Usage in Smart Homes*:**

Similar to how our project increases energy efficiency in homes, residential energy monitoring systems allow homeowners to manage energy use in real-time, reduce bills, and promote sustainability.

6. ***Integration of renewable sources*:**

Our project is also in line with the integration of renewable energy sources. Energy monitoring helps balance the use of renewable resources such as solar or wind power and ensures efficient production and consumption for sustainable practices.

VI FEATURES

- The main data like the power unit consumed will not be lost at any cost, it will be stored in the EEPROM of esp32 and the server can retrieve it at any time.
- The phase sequence of the 3-phase system can be determined. It is very important from the industrial point of view since certain 3-phase motor require the correct sequence to operate at full efficiency.
- Voltage spikes can affect the electrical equipment, so the relay feature cuts off the power supply when a voltage spike is detected.
- Datas of previous power usage can be analyzed and can be accessed from the dashboard.

- Cost of electricity can also be seen and analyzed for power optimization and efficiency.
- Every data can be seen and analyzed from anywhere using the dashboard.
- Datas of past uses can be filtered according to the specific time and date required.Making data comparison easier

VII FUTURE SCOPE

1. *Remote Control Capability:*

By integrating an additional Wi-Fi module to serve as both server and client, the system gains remote control capability. This enhancement allows users to interact with the system using remote devices such as smartphones or tablets. Users can remotely monitor energy consumption, adjust settings, and receive notifications, enhancing convenience and flexibility in managing energy usage and system operation.

2. *Expanded Device Control:*

Integrating a serial to parallel converter enables the system to control multiple device relay systems effectively. This enhancement allows for the simultaneous activation or deactivation of multiple devices based on predetermined conditions or user commands. By expanding device control capabilities, the system becomes more versatile and adaptable to complex energy management scenarios, catering to diverse application requirements with greater efficiency and precision.

3. *Enhanced Scalability:*

Incorporating a modular architecture facilitates the scalability of the energy monitoring system. With this approach, additional sensors, actuators, or modules can be seamlessly integrated into the system to accommodate expanding energy monitoring needs or evolving requirements. This scalability ensures that the system remains adaptable to future growth and can easily scale up to meet the demands of larger installations or more complex environments.

4. *Customizable Alerts and Notifications:*

By implementing customizable alerting mechanisms, the energy monitoring system can provide tailored notifications to users based on specific criteria or events. Users can define thresholds for energy consumption, voltage fluctuations, or equipment malfunctions, triggering alerts via email, SMS, or mobile app notifications. This feature empowers users to stay informed about critical system events in real time, enabling proactive intervention and troubleshooting to minimize downtime and optimize energy efficiency.

5. *AI-Driven Insights and Optimization*:

Integrating artificial intelligence (AI) algorithms into the energy monitoring system enhances its capabilities for data analysis and optimization. AI algorithms can analyze historical energy consumption patterns, identify trends, and predict future energy demands with greater accuracy. By leveraging machine learning techniques, the system can automatically optimize energy usage based on dynamic factors such as weather conditions, occupancy patterns, and production schedules. This AI-driven approach enables the system to continuously learn and adapt, maximizing energy efficiency and cost savings while minimizing environmental impact over time.

VIII ACKNOWLEDGMENT

We would like to express my deepest gratitude to Sri Venkateswara College of Engineering for providing me with the resources and support necessary to complete this project. We are also extremely grateful to our mentors, **Mr. M K Varadarajan** (Assistant Professor, Department of ECE), and **Ms. K S Subhashini** (Assistant Professor, Department of ECE), for their invaluable guidance, feedback, and encouragement throughout this process. Their expertise and insight were instrumental in shaping the direction of this project and refining its execution. Thank you for sharing your time, knowledge, and expertise with us. Your contributions have been immeasurable and will always be remembered.

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Robust Plastic Debris Detection in Maritime Environments Using Convolutional Neural Network (CNN)

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***Abstract*— The increasing risk of marine plastic pollution presents major obstacles to the health of Earth's ecology and oceanic ecosystems. This urgent issue is addressed by our unique Convolutional Neural Network (CNN) architecture, which effectively finds plastic waste in images. Our model, which makes use of convolutional layers and data augmentation approaches, shows promise in distinguishing between plastic debris and clean ocean surfaces. CNN architecture provides a lightweight alternative to conventional object detection models, improving scalability and resource efficiency. The model performs well at identifying plastic garbage in a range of orientations and scales because of its deep learning capabilities with an accuracy of 93%. For real- time monitoring and mitigation, future studies might look into incorporating more environmental parameters and working with marine conservation groups. Further streamlining implementation through the optimization of computing resources and model efficiency can support the management of marine ecosystems sustainably.**

Keywords - Deep Learning, Image Processing, Water Pollution, Neural Network.

I. Introduction

Marine plastic pollution poses a significant and escalating threat to oceanic and marine ecosystems. Each year, approximately 12.7 million metric tons of plastic find their way into the ocean, contributing to an estimated 5.25 trillion plastic particles currently floating in the open sea, with a combined weight of about 269,000 tons [1][2]. This widespread issue extends beyond national borders and is reminiscent of other global challenges such as greenhouse gas emissions and ozone depletion [1]. The persistent nature of plastic compounds worsens the situation, as they can remain in the marine environment for centuries to millennia. [3]. Both microplastics (particles under 5mm) and macroplastics (particles exceeding 5mm) significantly impact marine ecosystems, as evidenced by numerous incidents of marine species becoming entangled in and ingesting plastic debris [1][4]. The economic impact is substantial, with an estimated annual cost of $13 billion US [5]. Addressing this challenge requires utilizing open-source Earth observation data to accurately detect floating plastic, despite facing ongoing challenges.

In this paper, we propose a method to address the problem of plastic detection by using convolutional neural networks (CNNs) to classify images. Novel approaches to environmental monitoring and conservation [6] have been made possible by the growth of image-based data and the developments in deep learning methods. Although object detection is commonly used in research to detect plastic, we have chosen to use image classification, which has multiple advantages which include ease of integration, robustness to occlusions, simplicity, efficiency, and interpretability. Our approach, which makes use of these advancements, focuses on classifying photos into two groups: "plastic" and "non-plastic".

Our methodology seeks to significantly improve the accuracy and efficiency of plastic object separation from its environment by analyzing the images and patterns present in images. Furthermore, our method contributes to preventive measures in waste management, and pollution control by identification and classification of plastic materials.

II. Literature Survey

The majority of plastic pollution in marine ecosystems comes from land-based sources and travels through rivers and waterways to the oceans. To address this challenge, Wolf (2020) presented a novel machine learning method [7], which is built on convolutional neural networks (CNNs) and intended to identify and measure plastic debris that washes up on the beach and floats on the water. The two main parts of the system are a plastic litter quantifier (PLQ-CNN) and a plastic litter detector (PLD-CNN), which were trained using high-resolution aerial imagery from Cambodia. PLD-CNN classified targets as water, sand, grass, or plastic litter with an accuracy of 83%.

Abdellah El Zaar (2022) proposed a methodology in the domain of computer vision aimed at identifying plastic waste within images. The approach [8] leverages convolutional neural networks (CNNs). By employing transfer learning techniques, the proposed model utilizes either a support vector machine (SVM) classifier or fine-tuning the CNN model to serve as a feature extractor. Subsequently, the extracted features are employed for classification purposes using the CNN model. This method discerns plastic textures and objects depicted in images, thereby facilitating waste management efforts and mitigating the proliferation of plastic pollution in aquatic environments.

Deep learning techniques are used by Bing Xue (2021) to provide an achievable solution to the problem of locating and eliminating deep-sea garbage. The research [9] creates a large dataset designed for deep-sea debris identification that includes seven different kinds of debris: plastic, glass, metal, cloth, rubber, natural debris, and fishing nets and rope. The suggested method comprises evaluating eight advanced detection models in addition to building the ResNet50- YOLOV3 deep-sea litter detection network. The model’s performance is extensively tested via exhaustive experimentation, demonstrating its noteworthy effectiveness in quickly and precisely identifying deep-sea garbage.

Jack McShane (2022) studies the potential of Deep Learning and Computer Vision technology in addressing the problem of river garbage. This study [10] assesses the performance of two CNN models on a dataset containing garbage with different pre-processing levels: VGG-16 and DenseNet-201.To evaluate the effect of four dataset changes on detection accuracy, ranging from minimum pre- processing to significant augmentation, the study systematically analyses the data. This study aims to determine the best CNN model for detecting river waste through this work, as well as look into how pre-processing methods affect model performance.

III. Methodology

In this section, we provide a detailed breakdown of the methods utilized to detect marine plastic pollution using the Convolution Neural Network (CNN). We outline the dataset description, preprocessing steps, model architecture, and training/testing procedures. Through a systematic approach, we aim to ensure the reliability and reproducibility of our research findings.

A. Dataset Description

The image dataset utilized for marine plastic detection comprises 2150 images capturing both underwater and surface scenarios. These images have been meticulously chosen to represent a variety of environmental settings, including surface and underwater views. To distinguish between clean surroundings and instances of plastic pollution, the dataset is methodically divided into train and test sets with organized labeling. The train set includes 880 images of clean underwater and surface environments and 840 images of scenarios involving plastic contamination. Similarly, the test set includes 220 images of clean underwater and surface environments and 210 images of environments with plastic contamination. To offer a thorough depiction of ocean ecosystems, these images were sourced from various publicly available online sources.

B. Preprocessing steps

To optimize the training conditions and enhance the deep learning model's performance, several preprocessing steps were executed on the image data:

a) Image Loading and Resizing:

The images were loaded using OpenCV (cv2) and resized to a standard size of 224x224 pixels. Resizing the images ensures uniformity in input dimensions and reduces computational complexity during training.

b) Data Augmentation:

Using the TensorFlow Keras library's ImageDataGenerator class, data augmentation techniques were used to improve the training dataset's robustness and diversity. Augmentation techniques include:

- *Rotation Range*:
  Rotation, applied in a range of ±30 degrees, created differences in object orientations, allowing the model to absorb information from more viewpoints.
- *Width and Height Shift Range*:
  The augmentation of width and height included randomly repositioning objects within images by a maximum of 10% in each dimension. This variant replicated modifications in object placement, augmenting the dataset and improving the model's capacity to identify objects in various spatial configurations.
- *Zoom Range*:
  With a zoom range of ±20%, the model was able to learn from objects that varied in size and distance.
- *Horizontal Flipping*:
  The model was able to learn from both the original and horizontally flipped representations of objects, increasing its resilience to orientation fluctuations. Horizontal flipping augmentation was carried out with a probability of 50%, producing mirrored versions of images.

This technique increases the dataset's exposure to a wider range of scenarios and changes, which improves the model's generalization. Data augmentation makes deep learning model training more successful by reducing overfitting.

c) Normalization:

The image pixel values were normalized to range between [0, 1]. By standardizing the pixel values across all images, normalization assists in the stability and effectiveness of the training process.

d) Data Splitting:

The dataset was divided into two separate subsets: a training set (X_train) containing 90% of the data and a testing set (X_test) containing the remaining 10%. This splitting method ensures that the model learns from a wide range of photos capturing various scenarios linked to marine pollution and enables extensive model training on a significant percentage of the dataset. Meanwhile, the separate testing set, consisting of unseen data, facilitates unbiased evaluation of the trained model's performance, enabling assessment of its ability to generalize to new, previously unseen images.

These preprocessing steps ensure that the image data is ready for deep learning model training. While normalization guarantees uniform input scaling, augmentation techniques increase dataset diversity. All of these preprocessing stages work together to enhance our model's generalization and performance.

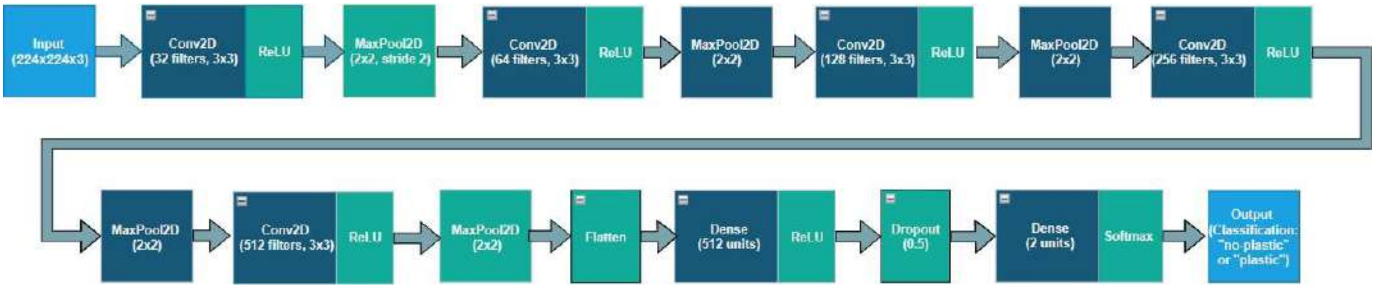


Figure 1. Our CNN Model Architecture

C. *Model Architecture*

Utilizing an architecture specifically created for picture classification tasks, our model makes use of a Convolutional Neural Network (CNN). An image or other grid-like data can be processed using Convolutional Neural Network (CNN).

It is made up of several layers, such as fully connected, pooling, and convolutional layers as seen in Figure 1. Convolutional layers of a CNN convolve learnable filters with the input data to extract different features from the input images. These filters capture patterns and characteristics at various spatial positions as they move over the input image. The feature maps are then downsampled by the pooling layers, which keep crucial information intact while decreasing the spatial dimensions of the maps. To provide predictions, the fully linked layers finally collect the acquired characteristics.

In our model, the CNN architecture employs multiple convolutional layers followed by pooling layers to extract hierarchical representations of the input images, enabling the detection of plastic pollution.

a) Input layer:

The input layer functions as the model's entry point, taking in input images in the form of (224, 224, 3), which stands for 224 pixels in height and width as well as three RGB color channels (Red, Green, and Blue).

b) Conv2D layers:

The fundamental building block of a convolutional neural network (CNN) is the Conv2D layer. It extracts different features from the input images by performing the convolution operation on them.

The output of a Conv2D layer is obtained by convolving a set of learnable filters, also known as kernels, with the input image vector. The output of each filter's element-wise multiplications as it passes through the input image is added to produce a feature map. Several Conv2D layer parameters that we employed in our model include

- *Filters*:

The depth of the output feature maps, which represent various learned patterns or features, is determined by the number of filters. The network can learn more intricate and varied properties from the input photos by applying more filters, which may enhance the network's capacity to identify the images effectively. In our model, 32 filters are used in the first layer, and that number gradually rises to 512 in subsequent layers.

- *Kernel size*:

Many factors, including the size of the input images, the complexity of the dataset, and the required amount of feature extraction, influence the choice of kernel size. Smaller kernel sizes (such as 3x3) are frequently employed since they enable the system to pick up more subtle edges and details in the images. Larger kernel sizes, however, can be appropriate for identifying more intricate patterns or characteristics in the data. The Conv2D layers in our particular model have a kernel size of (3, 3), which is a popular choice for many picture classification tasks because it finds a balance between computing efficiency and capturing small details.

- *Padding*:

Padding involves adding additional rows and columns of zeros around the input image before applying the convolution operation. The Conv2D layers in our model use the "same" padding. Regardless of the size of the convolutional filters or the strides used in the convolution operation, "same" padding applies to the convolution operation such that the output feature maps have the same height and width as the input pictures. This guarantees that the model can efficiently learn features from the whole input image and helps prevent information loss at the image's edges.

- *Activation function (ReLU):*

Neural networks use activation functions to add non-linearity to the output of convolutional and dense layers. This allows the network to recognize intricate patterns and correlations in the input. We primarily employ the Rectified Linear Unit (ReLU) activation function in our model.

ReLU is one of the most often utilized activation functions in deep learning models, because of its efficiency and ease of use. It preserves positive values in the input tensor while replacing any negative values with zero. Mathematically, ReLU is defined as:

$$f(x)=max(0,x)$$

where x represents the input to the activation function, and f(x) represents the output.

ReLU activation functions are applied after each convolutional layer in our model to provide non-linearity and improve the network's ability to extract discriminative features from the input images. As a result, the network is better equipped to identify patterns linked to marine plastic pollution and classify photos pertaining to plastic and non-plastic materials.

With the help of the Conv2D layer, the network can learn hierarchical representations of the input data, storing higher-level features (like shapes and objects) in deeper layers and lower-level features (like edges and textures) in earlier layers.

c) MaxPooling layers:

MaxPooling layers are arranged after each convolutional layer in our CNN model architecture in an organized way to enable hierarchical feature extraction and dimensionality reduction. To be more specific, a MaxPooling layer is used to downsample the feature maps produced by the convolution process after each Conv2D layer.

To select the greatest value within each window, the MaxPooling layers employ a pooling window, usually 2 × 2. This window moves incrementally across the feature maps. This approach's efficiency in reducing the spatial dimensions of the feature maps depends on the size and stride of the pooling window.

d) Flatten layer:

In our CNN architecture, the flatten layer plays a critical function by converting the multi-dimensional output from the convolutional and pooling layers above into a one-dimensional vector. This conversion is necessary to link the output of the convolutional layers to the fully connected layers, which need one- dimensional input.

Mathematically, the Flatten operation can be represented as follows:

$$Input = (N, H, W, C)$$

Where:

- N represents the batch size,
- H and W denote the height and width of the feature maps, respectively,
- C represents the number of channels or feature maps.

After flattening, the input shape is transformed to:

$$Output = (N, H \times W \times C)$$

Here, the height, width, and channel dimensions are flattened into a single dimension, resulting in a one-dimensional vector ready to be fed into the fully connected layers. Our CNN model design involves the Flatten layer as a transitional layer between the convolutional layers, responsible for extracting hierarchical features from the input images, and the fully connected layers, which classify the images based on these characteristics.

e) Dense layers:

The convolutional layers' flattened output must be processed by the Dense layers, also referred to as fully connected layers, in order to extract high-level features and generate predictions. We use two Dense layers at the conclusion of the model in our CNN design.

Each of the 512 units that make up the first Dense layer is linked to each activation in the flattened feature vector. The layer can recognize complex correlations and patterns in the retrieved features because of its dense connectivity. Applying the Rectified Linear Unit (ReLU) activation function to this layer's output helps the model learn complex representations efficiently.

Mathematically, the output of the first Dense layer can be represented as follows:

$$Output=ReLU\ (Input \times Weights + Bias)$$

In this case, the input is the feature vector that has been flattened, weights stand in for the learnable parameters connected to each link, and bias represents the bias term. To ensure that negative values are replaced with zero while positive values are preserved, the ReLU activation function is applied element-by-element to the linear combination of inputs and weights.

Before the output layer, the second dense layer functions as the penultimate layer. The purpose of this dense layer is to refine the features that were retrieved from the earlier layers and get them ready for the classification task at hand. Depending on the intended model capacity and problem complexity, the number of units in the second dense layer is usually configurable. In this instance, we have decided to include two units—one for each class—in the output layer for binary classification (plastic or non-plastic marine debris).

f) Output layer:

We employ the softmax activation function at the output layer, which is frequently utilized in multi-class classification applications. Based on the raw output scores of the model, the softmax function determines the probability of each class (plastic or non-plastic), making sure that the total of the predicted probabilities equals one.

Mathematically, the softmax function for each class j is defined as follows,

$$P(y = j|\mathbf{x}) = \frac{e^{z_j}}{\sum_{k=1}^{K} e^{z_k}}$$

Where:

- P(y=j | x) represents the probability that the input sample x belongs to class *j*.

- e^{z_j} is the exponential of the raw output score for class *j*.
- K is the total number of classes.

Higher probability indicates stronger confidence in the related class (plastic or non-plastic), and the softmax function makes sure that the predicted probabilities are normalized and fall within the range [0, 1]. This allows us to interpret the output of the model as the probability distribution over the classes, enabling us to make informed decisions based on our model's predictions.

D. Training, Validation, and Testing process:

The training, validation, and testing stages of our methodology are essential to the creation and evaluation of our deep learning model for the detection of marine plastic.

a) Loss function:

We use the binary cross-entropy loss function to train our binary classification model. The difference between the actual ground truth labels and the expected outputs is quantified by this loss function.

b) Optimization Algorithm:

We use the Adam optimizer to optimize the model's parameters during training. Adam allows for faster convergence and more stable training by dynamically adjusting the learning rate for each parameter. The advantages of RMSProp and AdaGrad are combined in this adaptive learning rate optimization approach.

c) Evaluation Metrics:

We use a variety of assessment indicators to keep an eye on the model's performance during training and validation. They include the F1-score, recall, accuracy, and precision. These metrics provide information on several elements of the model's performance, including overall predictive power, balance between precision and recall, and accuracy in classifying positive and negative data.

IV. Experimental results

To fully evaluate our model's efficacy in identifying marine plastic pollution, we measured its performance using several important criteria. These metrics are: precision, which shows the percentage of correctly identified positive predictions among all positive predictions made by the model; recall, which measures the model's ability to identify positive instances of plastic pollution among all actual positive instances; accuracy, which assesses the overall correctness of the model's predictions; and F1-score, which is a harmonic mean of precision and recall that offers a balanced assessment of the model's performance.

The accuracy graph of our model (Figure 2.a) shows a steady rise across epochs in both the training and validation stages. This increasing trend suggests that the model is generalizing well to previously unknown validation data and learning from the training set of data. With increasing accuracy, the model learns to accurately classify photos as either plastic pollution-free or plastic pollution-containing.

Concurrently, for both training and validation sets, the loss curve (Figure 2.b) shows a downward trend throughout epochs. The model's performance displays to be increasing as seen by this declining trend, which gradually reduces mistakes and differences between expected and actual results. Reduced loss values show that the model is successfully improving its parameters to better suit the data and is convergent towards an ideal solution.

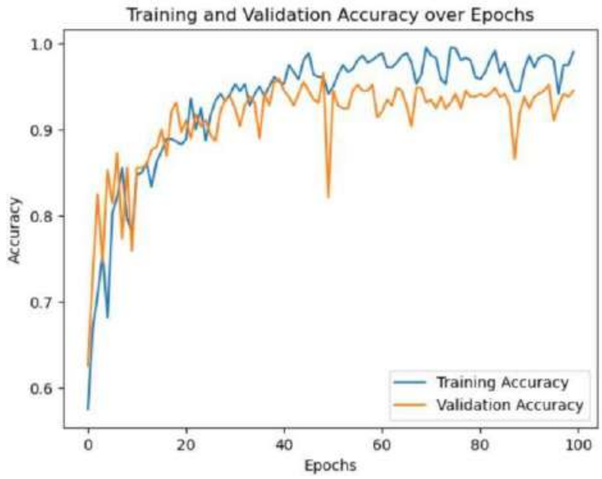


Figure 2.a Accuracy Curve

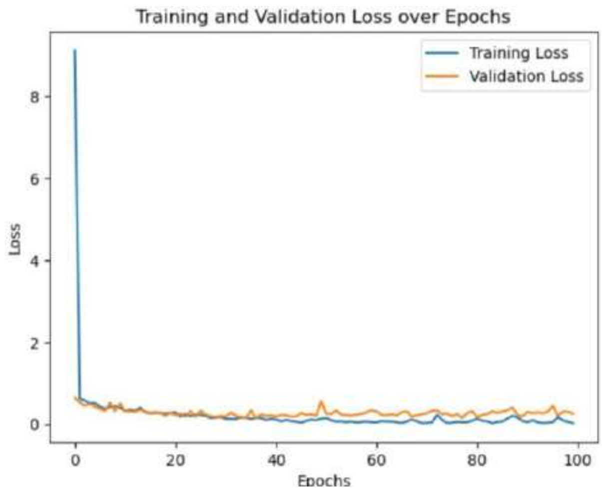
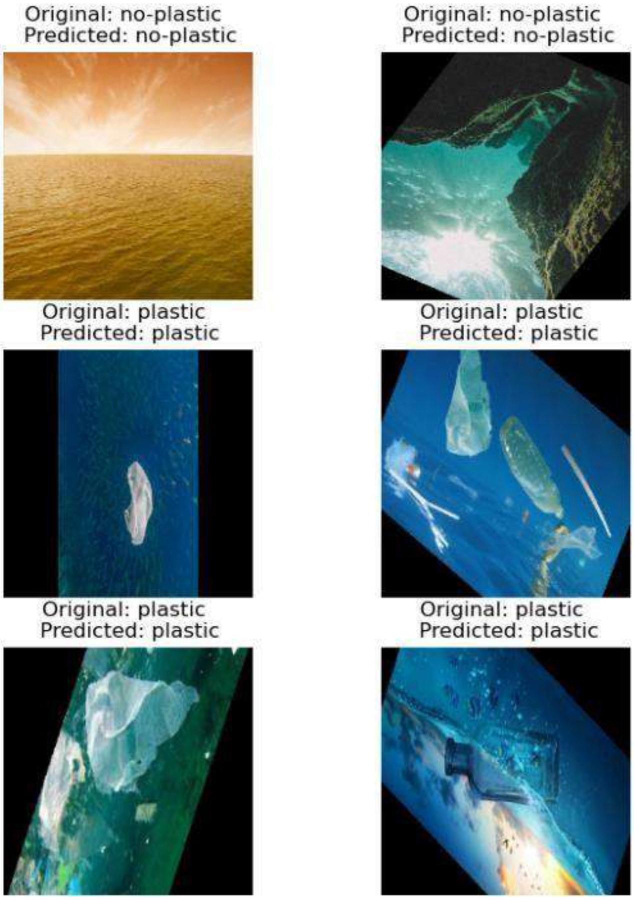


Figure 2.b Loss Curve

Metric	Value
Accuracy	0.93
Precision	0.93
Recall	0.93
F1 Score	0.93

The model's performance on the training and validation sets is revealed by these metrics. With few false positives and false negatives, the model is successfully detecting plastic pollution in marine images, as evidenced by its high accuracy, precision, recall, and F1-score. These results demonstrate the robustness and reliability of our model for real-world applications in marine pollution detection. Nevertheless, additional testing on other datasets and real-world situations is required to evaluate its generalizability and resilience.

Below is a sample output showcasing the model's predictions on a subset of test images:



This represents a selection of test photos and the model-generated predicted labels for each image. It illustrates how well the model can distinguish between images that are classified as plastic and those that are not. For reference, the true labels are shown, emphasizing the cases in which the model classified the images correctly or wrongly. Using a small selection of test images, this sample output provides a qualitative evaluation of the model's performance. An expanded assessment on a more extensive dataset would offer a more thorough comprehension of the model's performance in practical situations.

V. Discussion

The experimental evaluation of the deep learning model for marine plastic detection yielded encouraging results, with all performance indicators consistently reaching a value of 0.93. This implies that the model can accurately detect marine pollution in a range of environmental conditions, including scenarios that occur on the surface and underwater.

Moreover, the model's resilience and strong capacity to extrapolate to previously untested data are demonstrated by its constant performance across several criteria. This is essential for real-world applications, as the model might come across a wide range of difficult environmental circumstances.

Even though the model has been successful overall, there are still certain shortcomings and room for development. The use of static images, which might not adequately convey the dynamic character of maritime settings, is one drawback.

Furthermore, the way the model performs may differ based on variables like water clarity, sunlight, and the kinds of plastic waste that are there. Future studies could investigate the integration of temporal data from sources like video footage or time-series satellite photos to overcome these restrictions. Further improving the model architecture's performance and adaptability to various environmental situations may involve adding domain- specific characteristics.

Overall, the experimental results demonstrate the potential of deep learning techniques for marine plastic detection and highlight opportunities for further refinement and optimization in future studies.

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A Novel Prosthetic Hand Controller For Amputees Using Emg Signals

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Abstract--- The proposed work depicts the design and development of a prosthetic hand controller using EMG (Electromyogram) signals from amputees. In the case of amputees we can use this model to recover their actions of their impaired hand . The device mainly consists of an Arduino UNO microcontroller, Servo Motors (MG995), EMG amplifier Module and a 3D modelled Prosthetic hand which is made up of Polylactic acid material. This model's design is scalable, resizable and has minimal controlling strategies for all the five fingers to open-close, pick-place, and to get back to ideal position. This human hand replication can help the amputees to perform their regular activities and to work under harmful situations such as radioactive and bio hazardous. It is inexpensive user-oriented biorobotic arm can significantly improve the quality of life of amputees, in a better affordable way.

Keywords— Arduino UNO, Prosthetic-Hand, Replication System, Servo motors, Polylactic acid, EMG Signals.

INTRODUCTION

The term "prosthetic" originates from Greek, meaning "to add to," referring to artificial body parts like limbs or hearts. Loss of the upper limb can significantly impact daily activities, consisting of the hand, forearm, and arm, requiring coordinated movement facilitated by the nervous and musculoskeletal systems. Various joints, including shoulder, elbow, wrist, and finger joints, are crucial for performing tasks with precision. Artificial hands must closely mimic natural control features for effective use in daily life, but replicating the complexity of biological hand control is challenging. With the rise of consumer-level 3D printers, 3D printed prosthetics offer affordable alternatives to traditional, expensive prosthetics, accessible through open-source platforms like Thingiverse. These advancements allow for cost-effective and personalized prosthetic solutions, revolutionizing accessibility and affordability in prosthetic technology.

I. LITERATURE SURVEY

Anh Quang Tran et al., (2023) developed a simple, cost-effective prosthetic hand directly controlled by electromyography (EMG) signals acquired from the body. This promising result opens up opportunities for fabricating low-cost bionic hands ourselves to meet the needs of Vietnamese amputees.

Qi Luo et al., (2023) proposed to use human neuromuscular control principles to attain human-like compliance in prosthetic hands, aiming to enhance functionality. The effects of feedforward electromyography (EMG) decoding and proprioception on a biomimetic controller are explored.

Farshad Khadivar et al., (2022) shared control strategy for enhancing hand prosthesis functionality, integrating robotic hand force control and EMG decoding, was introduced to overcome dexterity limitations.

Zongtian Yin et al., (2022) Miniaturized ultrasound device Integrated intRo a prosthetic hand socket was developed for detecting muscle deformations. The potential for effective human-machine interface (HMI) systems in prosthetic hand control was demonstrated by the study.

Usman Khan et al., (2022) focused on the development of a manually operated robotic hand using an Arduino board and servo motors, with an emphasis on simplicity and versatility. It is designed to assist the disabled in daily activities and applicable in various fields due to its affordability and accessible components.

Boucetta Lakhdar Nadjib et al., (2021) described in the paper utilizes deep learning and surface electromyography (sEMG) signals to recognize hand movements for prosthetic hand control.

Mercy Paul Selvan et al., (2021) aimed at empowering amputees in their daily activities. The profound impact of limb loss on self-perception and mental health is addressed by offering functionality at a low cost. While not the most aesthetically advanced, quality is provided without breaking the bank.

Reza Bagherian Azhiri et al., (2021) described the real-time control of prosthetic hands using Electromyography (EMG) signals has become a focus of research. They addressed challenges in achieving accurate and fast EMG signal analysis

Wei Li et al., (2021) discussed the importance of natural control for improving the quality of life for amputees through prosthetic hands, with an emphasis on surface electromyography (sEMG) as a key signal for predicting upper limb motor intention.

Marcos Daniel Bloedow et al.,(2021) described a real-time prosthetic hand control system, featuring an integrated architecture with EMG acquisition devices, a real-time classifier platform, slip detection sensors, and an open-source prosthesis.

Minjie Chen et al., (2020) introduced a robotic arm control method based on forearm surface electromyography signals (sEMG), driven by the growing demand for high-quality prosthetics among the disabled, stemming from both advancements in control technology and rising living standards.

II. METHODOLOGY

In order in developing a robotic arm controlled by EMG signals incorporates essential components including the 3D printed prosthetic arm for physical structure and advanced functionalities, an EMG muscle sensor with three electrodes for measuring and amplifying muscle activity, MG995 servo motors for finger movement precision, and an Arduino Nano board as the central control unit processing EMG signals to command the prosthetic arm. Together, these components form a cohesive system that translates EMG signals into precise movements, offering individuals with limb amputations a functional and responsive prosthetic arm solution for improved independence and quality of life.

The figure 1 shows the block diagram of the methodology. Once we have done with this signal acquisition part, the next step is to process the raw EMG signal to get clear results at the end. The stages of EMG signal processing consist of pre-amplification, rectification, smoothening, and post-amplification Figure 2 shows the flow chart of a process. The Arduino UNO works as the brain of the system that commands the prosthetic hand attached with servo motor.

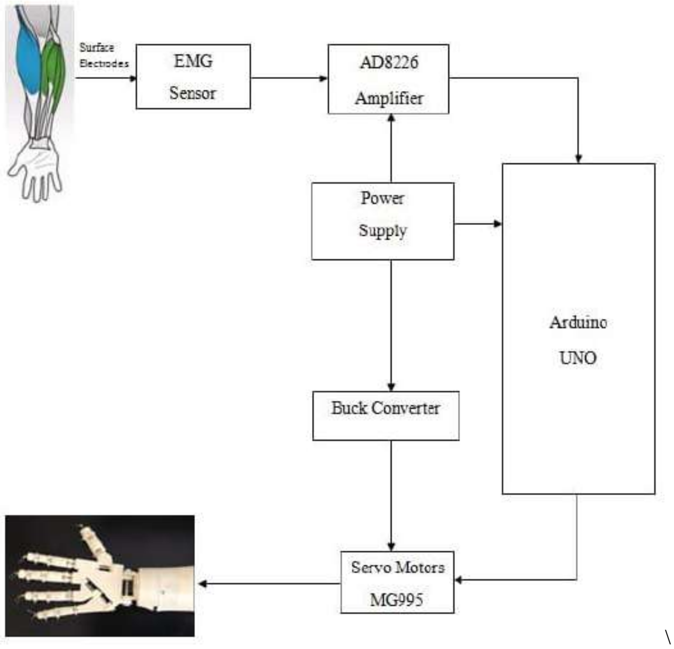

Fig.1: Block Diagram of the system

it to perform the desired action. Figure 2 shows the flow chart of a process. The Arduino UNO works as the brain of the system that commands the prosthetic hand attached with it, to perform the desired actions. The code is then uploaded on the Arduino Nano, which is connected to a monitor. The Arduino Nano is connected with the external prosthetic hand through the servo motor. As the code runs, the servo moves the prosthetic hand to produce the desired movements, with the help of EMG signal values acquired from the body, during flexion and extension process.

EMG signals are captured directly from muscles**.** When a person intends to move their fingers, the underlying muscles generate electrical activity. Electrodes placed on the skin detect these signals, which represent muscle contractions and relaxations. The acquired EMG signals are often weak and need amplification**.** This step boosts their strength, making them more discernible for subsequent analysis. Amplification ensures that even subtle muscle activity can be reliably detected. The amplified EMG data is interpreted by an Arduino microcontroller. This compact electronic device acts as the brain of the system. It analyzes the EMG signals, extracting meaningful information about muscle activation patterns.

Based on the interpreted EMG signals, the servo motors receive instructions. These motors are like the mechanical muscles of the system. When the microcontroller detects specific EMG patterns (such as a clenched fist), it sends commands to the servo motors. The coordinated action of servo motors results in precise finger movements. For example, if the user intends to close their hand, the microcontroller triggers the appropriate servo motors to rotate, mimicking the natural motion of fingers.

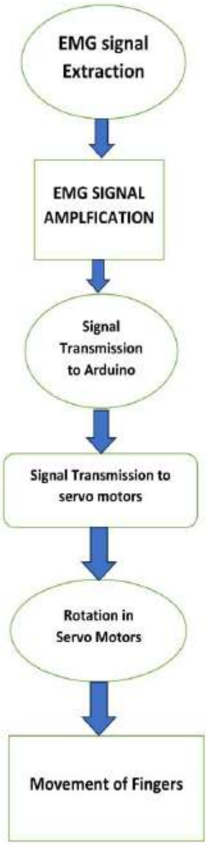

Fig.2: Flow chart of process

This process finds practical applications in prosthetic limbs and robotic hands. By translating EMG signals into motor actions, it enables more natural and functional limb behaviour. Users with limb disabilities can control prosthetic fingers using their residual muscle activity. By directly capturing EMG signals from muscles, this approach enables precise and natural finger movements. Users can control prosthetic limbs or robotic hands with greater accuracy, mimicking the way their own muscles would move. The system processes EMG signals in real time, allowing immediate adjustments based on user intent. When a person thinks about moving their fingers, the system responds swiftly, enhancing usability and functionality. Unlike invasive methods (such as implanting electrodes inside muscles), this flowchart relies on surface electrodes placed on the skin. It avoids surgical procedures, making it more accessible and less risky for users.

The system can adapt to different users' muscle patterns. Whether someone has partial limb function or varying muscle strengths, the EMG-based control accommodates individual differences. Users don't need to consciously think about each finger movement. The flowchart translates their natural muscle activity into motor commands, reducing cognitive effort. For amputees, this technology seamlessly integrates with prosthetic limbs. It allows intuitive control, making daily tasks (like grasping objects) more efficient. The system serves as a foundation for ongoing research and development in the field of prosthetics, robotics, and assistive devices. Innovations can build upon this framework to enhance functionality further

3D prosthetic hand: A 3D printed hand is a prosthetic limb which is made up of 3D printed technology that is controlled by the system. It is designed to perform various tasks, such as moving objects or performing actions in a specific sequence. At the end, the control signals are sending to the prosthetic to control the arm's movements.

Surface Electrodes: Surface electrodes are used to capture EMG signals from the forearm muscles. These electrodes are attached to the skin surface overlying the muscle using an adhesive gel or tape. The electrodes pick up the electrical activity generated by muscle contraction and send the signals to the AD8226 amplifier.

AD8226 Amplifier: The AD8226 amplifier is a device that amplifies the EMG signals picked up by the surface electrodes. The amplified signals are then sent to the microcontroller for further processing. Figure 3 shows the circuit diagram of EMG amplifier.

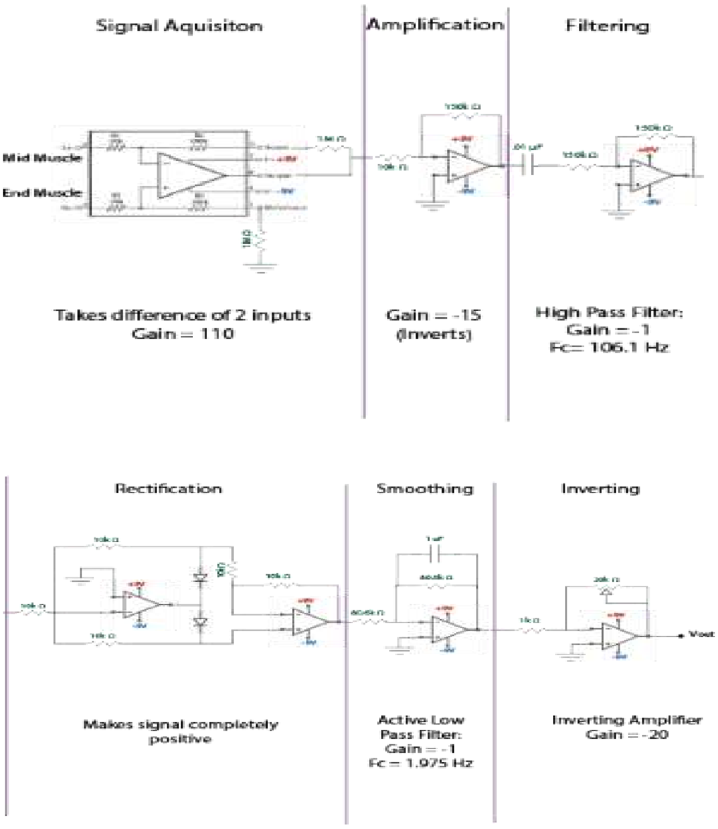

Fig.3: Circuit Diagram of EMG amplifier

Arduino Nano: The Arduino is the brain of the system. It receives the amplified EMG signals from the EMG amplifier and processes them using an Embedded C. The Arduino sends commands to the robotic arm based on the output of the Arduino IDE.

User Interface: The user interface allows the user to interact with the system. In this Study, the user interface EMG sensor capturing muscle signals from the user's body and the Arduino Nano processing these signals to command the movements of the prosthetic hand.

Buck Converter: A buck converter is a DC-to-DC converter which decreases voltage, while increasing current, from its input (supply) to its output (load). For the proposed model we use LM2596 DC-to-DC buck converter to increase the current value to load the serve motors from the power supply.

Power Supply: The system requires a power supply to operate. The power supply can be battery and external power source like power adapter upto 12V.

Servo Motor: Servo motors are the small mechanical motors that take an input from the Arduino and move based on that input. In it we used MG995 servo motor. We used this servo motor to build the fingers of arm to open and close the robotic arm. Figure 4 shows the parts of the servo motor.

Fig.4: Parts of Servo motor

III. HARDWARE

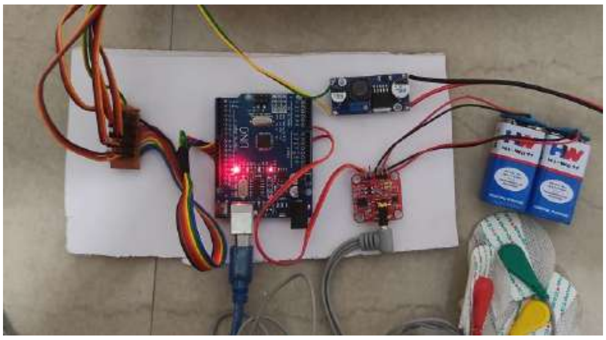

Fig.5: Hardware Components

Both the hardware and software tools communicate with one another, in order to make the correct decision whether to move the arm or not, based upon the intention of the subject involved in the process. Figure 5 shows the connection of the hardware components. The project works with an Arduino code that functions whenever an EMG signal arrives. The code has a threshold value that distinguishes between the different EMG values obtained with which the arm is able to produce flexion and extension movements accordingly. Initially, the EMG signal has to be acquired from biceps. For this purpose, we are using surface electrodes. Three electrodes are involved in this process. The working electrodes are placed on the mid-muscle and end muscle regions of the biceps respectively. The reference electrode is placed near the bony surface area of the elbow. Proper positioning of electrodes is necessary for the operation. At the same time, the electrodes that we have chosen should be capable of picking up the desired EMG signals more effectively.

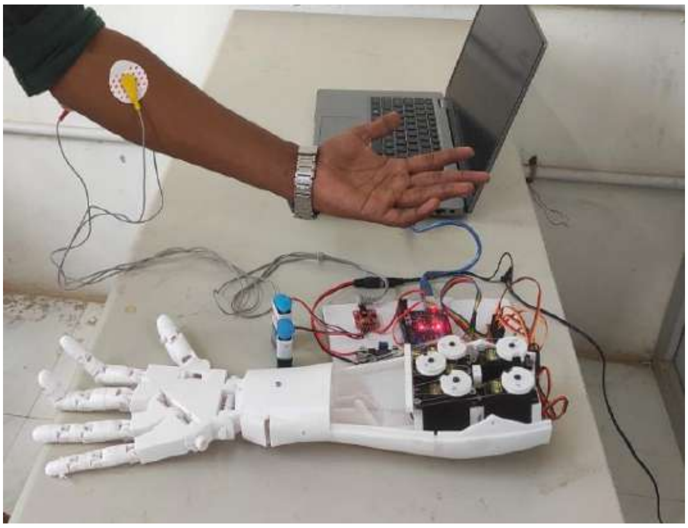

Fig.6: Final Hardware Output

Figure 6 shows the final hardware model of 3D printed prosthetic hand controlled by EMG signals for the amputees.

IV. RESULT AND DISCUSSION

The prosthetic hand controlled by EMG signals, enabling individual with limb amputations to operate the prosthetic hand effectively. By integrating components like 3D printed hand, EMG muscle sensor, MG995 servo motors, and Arduino Nano board, the system precise translation of EMG signals into physical movements. Through stages of EMG signal processing and the implementation of threshold values in the Arduino code, the prosthetic hand could accurately respond to the user's muscle activity, facilitating flexion and extension movements.

V. CONCLUSION

The project demonstrates a significant advancement in assistive technology for limb amputations by integrating components like a 3D printed prosthetic arm, EMG muscle sensor, MG995 servo motors, and Arduino Nano board. This allows for precise movement of the prosthetic arm based on the user's muscle activity. The innovative solution enhances the quality of life and independence of individuals with limb differences, providing a functional and accessible means of interacting with their environment. The project envisions a future where prosthetics are not just replacements but enhancements of human capability.

VI. FUTURE ADVANCEMENT

The project's future scope lies in further advancements such as enhancing EMG signal processing for more precise control, exploring advanced materials for improved durability and aesthetics, integrating additional sensors for richer data and better user interaction, implementing machine learning for personalized functionality, adding wireless communication for convenience, developing user-friendly interfaces, incorporating biomechanical feedback for safer interactions, and conducting clinical trials for refinement. Through these avenues, the project can continue to push the boundaries of prosthetic technology, offering enhanced functionality and usability by improving the overall quality of life for amputees.

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Simulation of Flower Shaped Antenna for X-band Applications

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Abstract*—This paper presents the design and simulation of a flower shaped antenna for X-band applications. The proposed antenna design is inspired by the natural shape of flowers, which has been found to have advantages in terms of electromagnetic performance. The antenna is designed to operate at a frequency range of 8 GHz-12 GHz, which covers the X-band spectrum used in various wireless communication systems such as satellite communications, radar systems, and wireless local area networks. The design process involves modeling the antenna using a microstrip patch antenna and optimizing its dimensions to achieve the desired frequency response. The antenna is then simulated using CST Studio Suite, to evaluate its performance in terms of radiation patterns, gain, directivity, and efficiency. The results show that the flower shaped antenna exhibits improved performance compared to traditional rectangular microstrip patch antennas, including higher gain and directivity, and wider bandwidth. The paper also discusses the possible applications of the proposed antenna design in X-band systems, including Satellite communications, Radar systems, and Wireless local area networks. The authors conclude that the flower shaped antenna offers a promising alternative to traditional antenna designs, providing better performance and versatility for a variety of applications.

Keywords*—Flower Shaped Antenna, Microstrip patch antenna,wireless communication, CST Studio suite, X-band Applications.

I. INTRODUCTION

Wireless communication systems have become an integral part of modern technology, enabling seamless communication and data transfer across various applications. One of the key components of these systems is the antenna, which plays a crucial role in transmitting and receiving signals. With the increasing demand for high-speed data transmission and broadband connectivity, there is a growing need for antennas that can operate efficiently in the X-band frequency range (8-12 GHz). Traditionally, rectangular microstrip patch antennas have been widely used for X-band applications due to their simplicity and ease of fabrication. However, these antennas often suffer from limited gain and directivity, which can result in reduced signal strength and interference. To address this limitation, researchers have been exploring innovative antenna designs that can enhance the performance of X-band antennas.

This paper presents the design and simulation of a flower shaped antenna for X-band applications using microstrip patch antenna. The proposed antenna design combines the advantages of traditional microstrip patch antennas with the benefits of flower shaped structures, offering a promising solution for high-performance X-band antennas. The paper provides a detailed analysis of the antenna's performance through simulations, highlighting its potential for use in various wireless communication systems.

II. DESIGN OF PROPOSED MICROSTRIP PATCH ANTENNA

Due to their low profile, simplicity in production, and design flexibility, micro-strip patch antenna is frequently employed in multiple communication systems which are wireless. The following steps are involved in antenna design, Choosing the operating frequency: The antenna's operating frequency is chosen depending on the requirements of the application. The substrate material must to be exceptionally thermally stable, have a low dielectric constant, and have a small loss tangent. Substratum materials like FR4, Rogers, and Duroid are frequently employed. Thus, the preliminary values of the patch of the antenna length PL and width PW can be determined from these equations and later optimized.

Step-1: To calculate width 'W' using the Equation (1)

$$W = \frac{Vo}{2fr}\sqrt{\frac{2}{\varepsilon r + 1}} \qquad --(1)$$

Step-2 : Calculate the effective dielectric constant using Equation (2)

$$\varepsilon_{\text{eff}} = \frac{\varepsilon r+1}{2} + \frac{\varepsilon r-1}{2}\left[1 + 12\frac{h}{W}\right]^{-0.5} \quad --(2)$$

Step-3 : Calculate ΔL using Equation (3).

$$\frac{\Delta L}{h} = 0.412\,\frac{(\varepsilon_{\text{eff}} + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_{\text{eff}} - 0.258)\left(\frac{W}{h} + 0.8\right)} \quad --(3)$$

Step-4: calculate length of the patch using Equation (4). v0 is speed of light in free space

$$L = \frac{v_o}{2fr\sqrt{\varepsilon eff}} - 2\Delta L \quad --(4)$$

FR - 4 was used to design the substrate, which has a relative permittivity of 4.4. The patch is a thin copper metallic layer (annealed). Copper makes comprises the ground plane, which is constructed on the substrate's back.The basic Structure of the flower shaped antenna was shown in the below Fig-1.

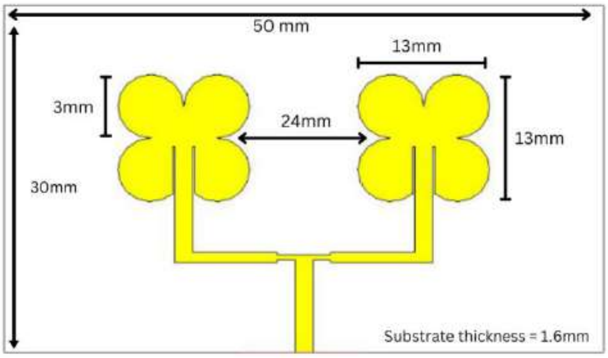

Fig.1 Schematic view of Antenna.

The values of substrate length, thickness, width, length, and width of patch, rectangular shape slot width, slot length, feed line length, and width can be observed in table1

Table 1: Dimensions

Parameters	Dimension(mm)
SL	50
SW	30
h	1.6
PL	13
PW	13
PH	0.036
R	3
d	24

Where,

- SL -- Substrate Length
- SW --Substrate Width
- h -- Substrate Thickness
- PL -- patch length
- PW -- patch width
- PH -- patch height
- R -- radius of the circle
- d -- distance between the patch antenna's

III. Simulation, Results and Discussion

The end results of antenna such as directivity, gain, return loss , VSWR, radiation pattern, bandwidth are analyzed respectively using CST software

The frequency obtained from the flower-shaped antenna is 8.756GHz. The return loss plot for the proposed antenna is shown in the Fig. 2.

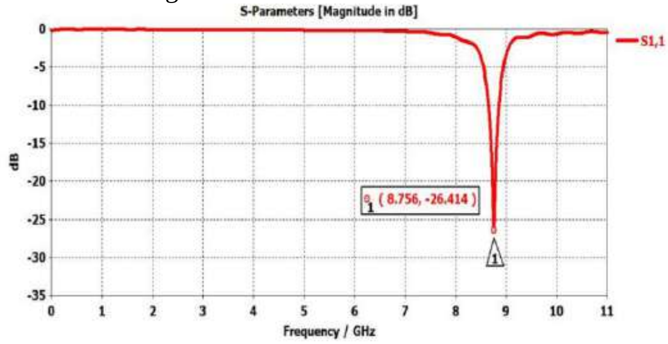

Fig. 2.S-parameter plot of the proposed antenna

. The VSWR Plot of the proposed antenna is shown in the Fig.3.

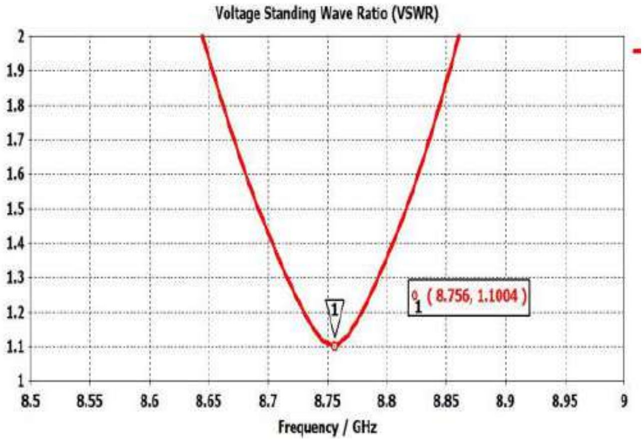

Fig.3. VSWR plot for the proposed antenna

The Polar Plots of the proposed antenna under the conditions phi=0 and phi=90 and theta=90 is shown in Fig.4,Fig.5,Fig 6

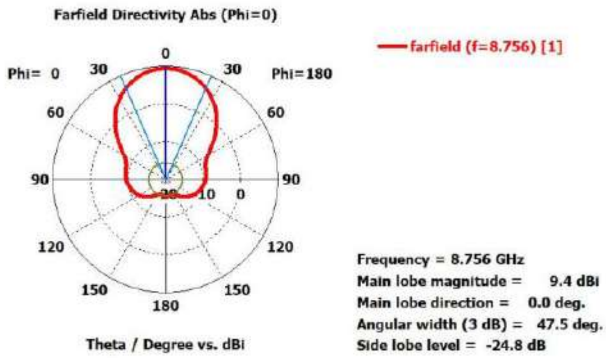

Fig.4 .The Polar Plot under the condition phi=0°

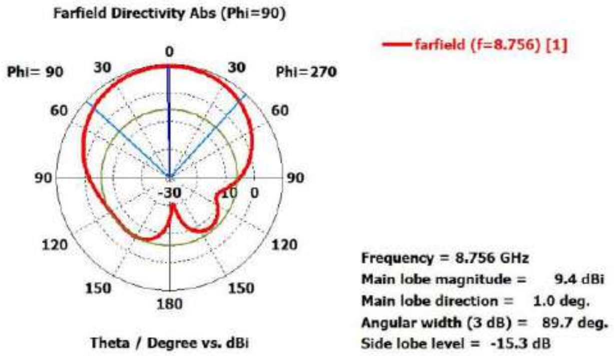

Fig.5 .The Polar Plot under the condition phi=90°

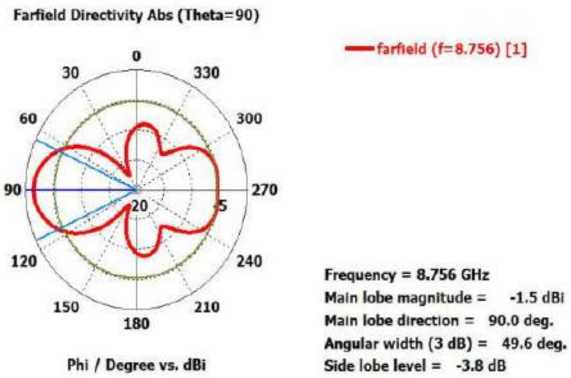

Fig.6 .The Polar plot under the condition theta=90°

The Directivity and Gain of the proposed antenna in 3D is shown in Fig. 7 and The Directivity Versus Gain plot of the proposed antenna is shown in the Fig. 8.

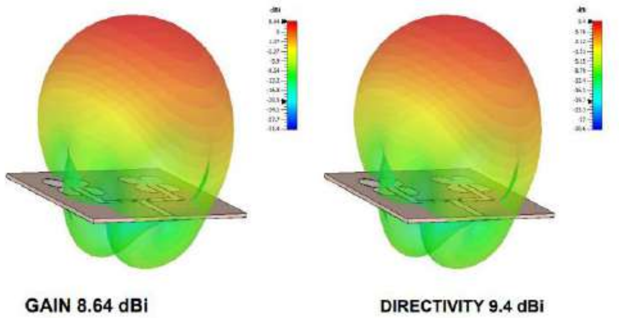

Fig.7. 3D Plot of The Directivity and Gain of the proposed antenna

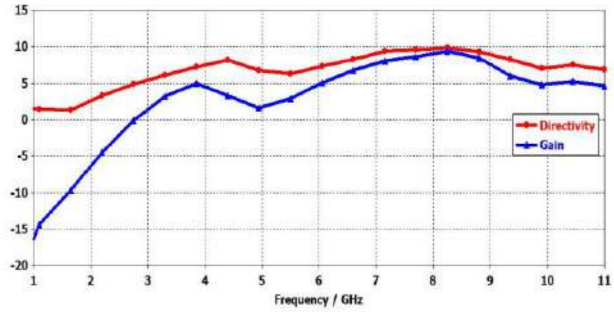

Fig.8. The Directivity Versus Gain plot of the proposed antenna

The Electric and Magnetic Field Polarization Plot of the proposed antenna in 3D is shown in Fig.9.

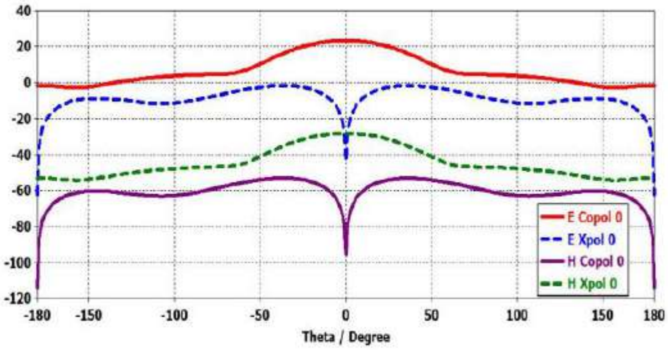

Fig.9 .The Electric Field and Magnetic Field Plot of the proposed antenna a E-plane, b H-plane under the ondition phi=0^0

The Radiation Efficiency of the proposed antenna is shown in Fig.10.

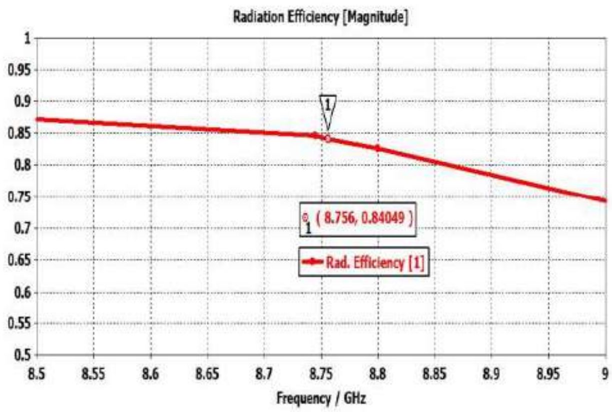

Fig.10. Radiation Efficiency for the proposed antenna

The proposed antenna is operating in the frequency in 8.756 GHz on X-bands. The X-band frequency range has may applications such as Radar Systems, Satellite Communication, Wireless Communication, Remote Sensing, Aerospace and

Defense, Automotive Radar, Radio Astronomy, Medical Imaging

IV. CONCLUSION

Through meticulous design and simulation processes, we have successfully achieved an operating frequency of 8.756 GHz, using the CST studio suite. The results obtained signify the potential of the proposed antenna design to contribute to a wide range of applications in X-band frequencies, including radar systems, satellite communication, wireless communication, and remote sensing. Its versatility and performance make it a promising candidate for integration into advanced communication systems, aerospace platforms, automotive radar, radio astronomy instruments, and medical imaging devices.

The Future work for the flower-shaped antenna designed for X-band applications includes exploration of techniques to enhance bandwidth, integration into practical systems, investigation of advanced materials and fabrication techniques, development of multi-band and reconfigurable capabilities, and trials for real-world assessment, all aimed at advancing antenna design for enhanced performance and applicability in telecommunications, aerospace, and defense industries.

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Oil Spill And Solid Waste Collector Robot

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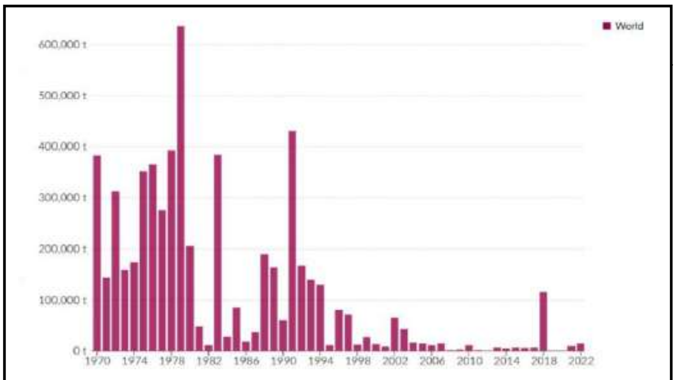
Abstract— The Oil spill and Solid waste collector robot utilizes solar power to absorb oil and collect solid waste in water bodies. It employs buoyant PVC pipes and professional welding for durability, while sensors transmit weight data to cloud platforms for real-time monitoring. Operating sustainably, it reduces environmental impact while maximizing efficiency. This innovative solution represents a significant advancement in environmental remediation technology, proactively addressing the harmful effects of oil spills and solid waste pollution in aquatic ecosystems.

Keywords – Solid waste, Solar power, PVC pipes

I. INTRODUCTION

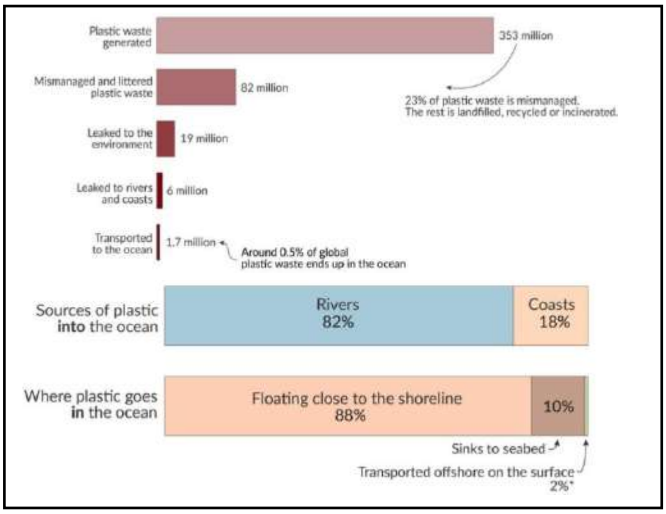
A. The solar-powered robot [7] presents a groundbreaking solution to the environmental challenges posed by oil spills and solid waste pollution in water bodies. Designed with state-of-the-art skimming techniques and powered by renewable solar energy, it effectively absorbs oil and navigates across aquatic environments for thorough cleanup operations. Its construction, featuring buoyant PVC pipes and robust welding, guarantees durability and resilience in adverse conditions. Moreover, equipped with advanced sensors, the robot collects real-time data on collected waste materials, empowering decision-makers with actionable insights for efficient cleanup strategies. By integrating cutting-edge technology with environmental consciousness, this project epitomizes a proactive and sustainable approach to environmental remediation. It heralds a promising future where innovative solutions play a pivotal role in safeguarding our water ecosystems and preserving them for generations to come

*1) **ADVERSE EFFECT OF OIL SPILL**: Oil spills in water bodies devastate marine ecosystems, disrupting the food chain, harming marine life, and posing risks to human health. Economic repercussions affect industries reliant on healthy marine environments, with cleanup costs borne by governments and taxpayers. Long-term environmental consequences perpetuate ecosystem imbalances, demanding concerted efforts for prevention and mitigation.*



Global quantity of oil spilled from tankers, 1970 to 2022

often shouldered by governments and taxpayers. Long-term consequences persist, with oil residues threatening wildlife and human health for years. Addressing oil spill challenges requires collaborative efforts to prevent, mitigate, and promote sustainable practices, safeguarding marine ecosystems and dependent communities.



*3) **SKIMMING TECHNIQUE** :Oil skimming utilizes specialized equipment to swiftly remove oil spills from water surfaces by exploiting density and surface tension disparities. Techniques involve rotating drums, belts, and weir skimmers to collect and contain oil for disposal. While offering rapid cleanup, skimming's efficacy hinges on oil type, viscosity, and environmental factors. Coordination with other cleanup methods such as dispersants and mechanical recovery ensures comprehensive oil spill response, minimizing environmental harm and protecting coastal ecosystems and communities.[1][2][3]*

*4) **CONVEYER BELT MECHANISM** : The conveyor belt mechanism efficiently collects solid waste from water bodies using floating platforms equipped with conveyor belts. These belts continuously gather debris and plastics, transporting them to a central collection point for disposal or recycling. Offering systematic waste removal with minimal manual intervention, the mechanism can be customized for various water bodies. Integration with sorting and recycling facilities maximizes material recovery while minimizing environmental impact, providing a sustainable solution to combat solid waste pollution.[6]*

II. LITERATURE SURVEY

A. Introduction:

Oil spills present formidable challenges to marine ecosystems worldwide, necessitating effective response strategies. Among these, oil skimming stands out as a prominent method for surface oil removal. This review provides insights into the historical evolution of skimming techniques, recent advancements, and global efforts in combating oil spills, including pertinent case studies from India and other nations.

1) History of Skimming in the Sea:

The practice of oil skimming has undergone significant evolution over the past century in response to escalating oil spill incidents. Initially, manual methods such as absorbents were employed, but the increasing scale of spills demanded more efficient approaches. Mechanical skimmers like drum and belt skimmers emerged, enhancing oil recovery capabilities.

2) Global Trends in Oil Skimming:

Oil skimming has become integral to oil spill response strategies worldwide. Countries worldwide, including the United States, Europe, and Asia, invest in skimming equipment, training, and research to bolster response capabilities. Specialized vessels and equipment are deployed in regions like the Gulf of Mexico and the North Sea, where offshore drilling activities pose heightened spill risks.

3) Oil Skimming in India:

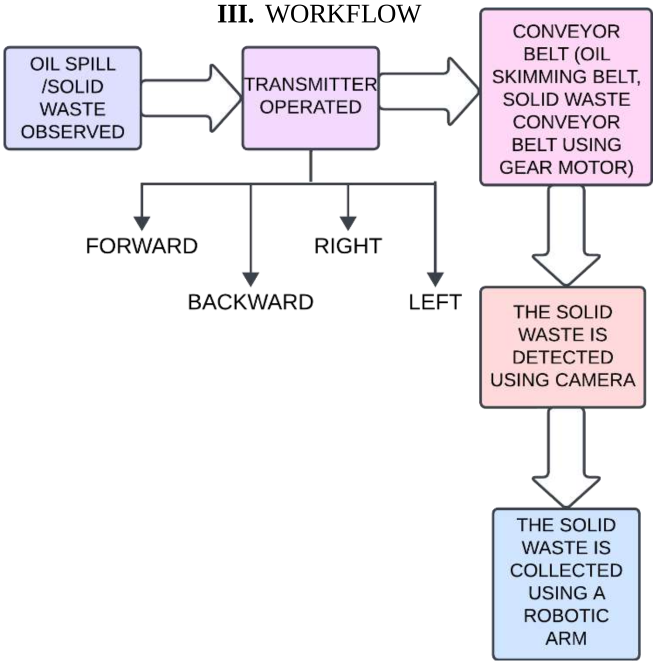
India, with its extensive coastline, confronts oil spill challenges, exemplified by incidents like the 2010 Mumbai oil spill. The Indian Coast Guard and other stakeholders actively engage in skimming efforts, underscoring the nation's commitment to mitigating oil pollution and enhancing preparedness.

Case Studies:

Case studies like the 2010 Mumbai oil spill and the Deepwater Horizon incident in the Gulf of Mexico highlight the efficacy and challenges of oil skimming in response efforts, emphasizing the need for continuous innovation and coordinated responses to protect marine environments.

Oil skimming plays a pivotal role in mitigating oil spill impacts globally. Advancements in skimming technologies, coupled with robust preparedness measures, are essential for effective response and marine resource protection. Learning from past experiences, nations like India can bolster their spill response capacities and safeguard marine ecosystems for future generations.

III. WORKFLOW



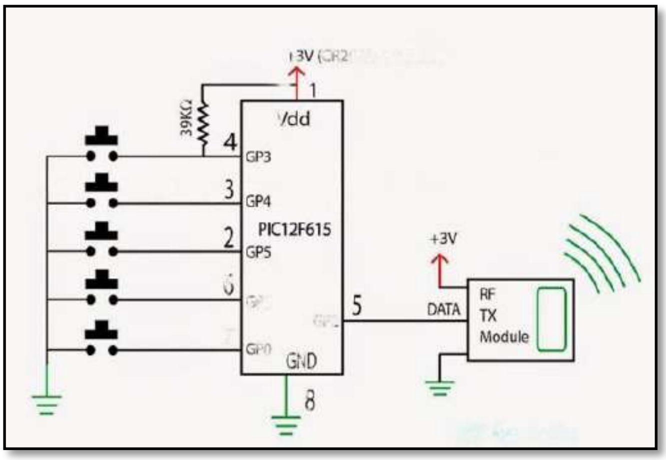
IV. OBJECTIVE

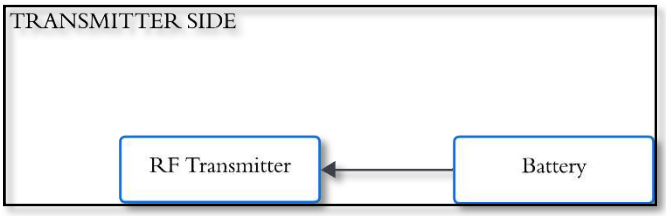
S. No.	Objectives
1.	Scalable
2.	Versatile
3.	Fast
4.	Accurate
6.	Cheap
7.	Assembly
8.	Implementation

V. DESIGN CONSIDERATION

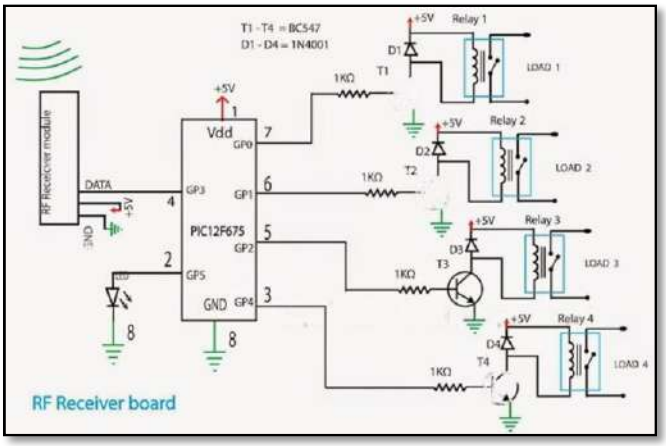
S. No.	Name	Tool/Method /Qty
1.	Type	Floating robot
2.	Stability	Dynamic
3.	Weight	30kg

4.	Centre of Mass	Controlled by tx and rx
5.	Feedback	Closed feedback
6.	Motor Torque	Stall torque Min: 10Kg-cm Max: 20Kg-cm
7.	Battery Specification	12V 7A
8.	Expected Operating time	6hrs Peak capacity
9.	No of motors	2
10.	Motor type	Metal Gear Servo
11.	Motor constraint	Angle of Rotation: 0-180 degree
12.	Motor min operating voltage	4.4 V
13.	Motor Max operating voltage	5V
14.	Motor Burn voltage	8.4 V
15.	Motor Burn current	2200 mAh
16.	Prototyping	Rapid prototyping
17.	Material	1. Aluminum Alloy 2mm Plate/Sheet- 100x100x2mm 2. iron 3. PVC

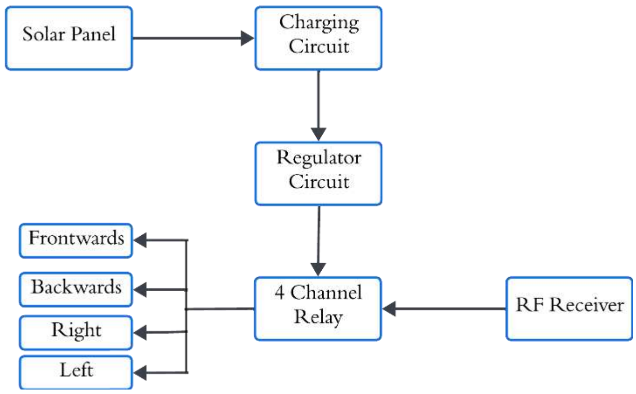




CIRCUIT DIAGRAM OF THE TRANSMITTER



RECEIVER SIDE

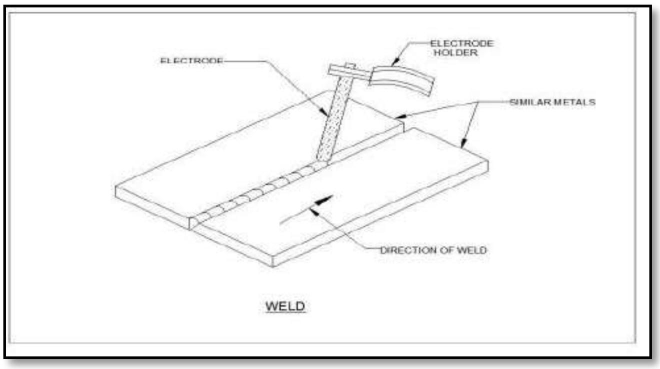


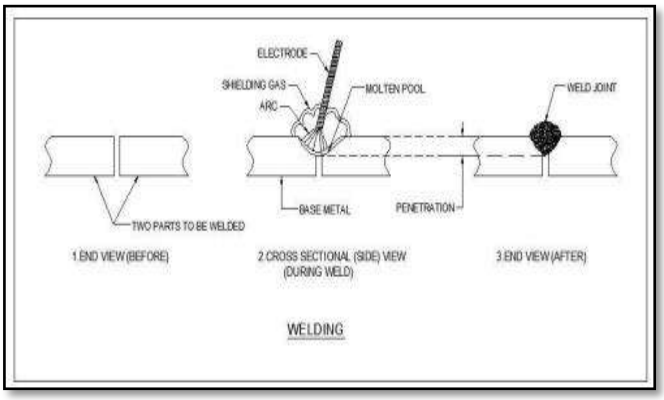
CIRCUIT DIAGRAM OF THE RECEIVER

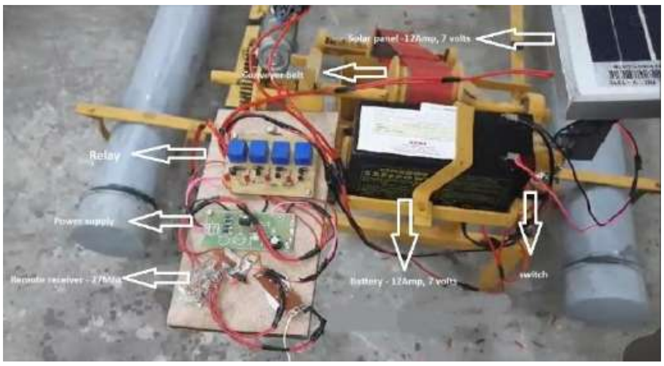
VI. MECHANICAL FABRICATION

A. WELDING

Welding, a vital fabrication process, joins materials like metals or thermoplastics through fusion, using heat, pressure, or both. Its significance spans construction, manufacturing, automotive, aerospace, and shipbuilding. The process involves material preparation, method selection, heat application, possible filler addition, and cooling. Various techniques like arc, gas, resistance, and laser welding suit diverse materials and applications. Welding ensures strong, durable joints, versatility, and production scalability. However, challenges like defects (porosity, cracks, distortion) necessitate careful management. Overall, welding is indispensable for modern manufacturing and construction, fostering innovation and progress.[5]







CIRCUIT FOR THE RECIEVER AND THE PROPELLER MODULE

B. SOLDERING

Soldering joins metal components using a lower melting point filler metal, or solder, without melting the base metals. It finds applications in electronics, plumbing, and jewelry making due to its precise, low-temperature bonding. Heating the solder melts it onto the joint, creating a strong connection. Flux is used to clean surfaces and prevent oxidation. While soldering offers ease and versatility, it has weaker joint strength and is sensitive to high temperatures, requiring proper technique and materials for quality results.[4]

VII. COMPONENTS AND DESCRIPTION

The major parts that are effectively employed in the design and the fabrication of the oil skimmer are described below:

- Battery,
- Bearing With Bearing Cap,
- Spur gear,
- Motor,
- Frame,
- Solar panel,
- Control unit.

Sl. No.	PARTS	Qty.	Material
1	D.C Motor	1	DC
2	High Speed motor with wings	2	P.M.D.C
3	Solar Panel	1	10V
4	Bearing	1	6202
5	RF circuit board	1	Electronic
6	PVC pipe	4 Feet	4 inch
7	Frame stand	1	M.S
8	Battery	1	Lead Acid
9	Belt	1	Nylon
10	Column Support	1	M.S

VIII. ADVANTAGES ,DISADVANTAGES AND APPLICATIONS

A. ADVANTAGES:

- Small and compact
- Inexpensive
- Scalable
- Self-organizing
- Automation compatibility
- Corral, absorb and process
- Uses renewable source-solar energy

B. DISADVANTAGES:

- Initial cost is high
- Difficulty of Maintenance

C. APPLICATIONS :

- Enhanced Environmental Protection: The oil spill and solid waste collector robot offers a proactive solution for environmental protection by efficiently collecting oil spills and solid waste from water bodies, preserving aquatic ecosystems and marine life.

- Efficient Oil Spill Response: With swift detection and collection capabilities, the robot enables rapid response to oil spills, minimizing contamination spread and ecological damage, particularly in coastal areas.

- Cost-effective Cleanup Operations: The autonomous robot reduces reliance on manual labor and expensive cleanup equipment, offering a cost-effective solution for pollution management compared to traditional methods.

- Real-time Monitoring and Data Analysis: Equipped with sensors, the robot provides real-time monitoring of water quality and pollution levels, enabling authorities to assess risks and implement targeted remediation efforts.

- Versatile Deployment: Its modular design allows deployment in various water bodies, ensuring adaptability to different terrains and pollution challenges.

- Public Awareness and Education: The robot's deployment raises public awareness about environmental conservation, inspiring community engagement and stewardship.

- Long-term Sustainability: By mitigating pollution impacts, the robot contributes to long-term environmental sustainability, ensuring cleaner water bodies for future generations.

IX. FUTURE SCOPE

- Advancements in design and capabilities: Further research can lead to improvements in the robot's design, enhancing its maneuverability and efficiency in collecting oil spills and solid waste.
- Integration of AI and machine learning: Incorporating artificial intelligence algorithms can enhance the robot's autonomy and decision-making abilities, enabling it to adapt to changing environmental conditions.
- Collaboration with stakeholders: Partnerships with environmental organizations and regulatory bodies can facilitate widespread adoption and deployment of the robot for proactive pollution management.
- Global deployment: With refinements and advancements, the robot can be deployed on a global scale to address environmental challenges in various water bodies and coastal regions.
- Continuous innovation: Ongoing innovation and development efforts will ensure that the robot remains at the forefront of environmental remediation technology, offering effective solutions to combat pollution.

ACKNOWLEDGMENT

We extend our heartfelt gratitude to Dr. S. Ganesh Vaidyanathan, Ph.D., Principal of Sri Venkateswara College of Engineering, for his unwavering inspiration. Special thanks to Dr. G A Sathish Kumar, M.E., Ph.D., Head of the Department of Electronics and Communication Engineering, for his invaluable guidance and support. We also acknowledge Ms. T.J. Jeyaprabha, M.E., and our project coordinators, Ms. K.S. Subhashini, M.E., and Mr. S. P. Sivagnana Subramanian, M.E., for their relentless encouragement and assistance throughout our project journey.

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[2] Subrajit Bhattacharya, Hordur Heidarsson, Gaurav Sukhatme, Vijay Kumar, "Cooperative Control of Autonomous Surface Vehicles For Oil Skimming And Cleanup", IEEE International Conference on Robotics and Automation,2011.

Explores cooperative control approaches for autonomous surface vehicles assigned to oil skimming and cleanup duties. It is probable that the paper examines novel techniques for orchestrating these vehicles to respond efficiently and effectively to oil spill events in marine settings. This study advances the realm of robotic systems for environmental cleanup and underscores the promise of autonomous technologies in tackling significant issues like oil pollution.

[3] Suraj Nair, Kajol Kamble, Sayali Shewale, Sanjay Lohar, “Design And Fabrication of Disc Type Oil Skimmer”, IJSART International Journal for Science and Advance Research in Technology, Vol.3, April 2017

Investigates the design and construction of a disc-type oil skimmer, featured in the IJSART International Journal for Science and Advanced Research in Technology. This research likely outlines the methodology and engineering considerations involved in developing an efficient disc-type oil skimming device for environmental applications. It contributes to the discourse on innovative solutions for combating oil pollution in aquatic environments.

[4] K. L. Chia, B. L. Choo, S. J. Lee, C. T. S. Luang, M. S. Tan and T. Truman, "Robotic soldering of lead free alloys", ***2018 Pan Pacific Microelectronics Symposium (Pan Pacific)*****, pp. 1-10, 5–8 Feb. 2018.**

This research investigates robotic soldering with lead-free alloys, presenting advancements in soldering technology at the 2018 Pan Pacific Microelectronics Symposium. It contributes to the development of precise and efficient soldering processes, especially concerning environmentally friendly lead-free alloys.

[5] Gabbriel Nicolae Popa, Iosif Popa and Sorin Ioan Deaconu, "Coated electrode manual-metal Arc Welding with high frequency welding inverter power sources", 6th International conference on electromechanical and power systems, Oct. 2007.

The study explores coated electrode manual-metal arc welding utilizing high-frequency welding inverter power sources. Presented at the 6th International Conference on Electromechanical and Power Systems in October 2007, it delves into advancements in welding technology and power sources for improved welding efficiency.

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The research focuses on modeling and optimizing the energy efficiency of belt conveyors. Published in the journal Applied Energy in 2011, the study provides valuable insights into enhancing the performance and sustainability of conveyor systems in various industries.

[7] M. Zeman, "Introduction to Photovoltaic Solar Energy: Chapter 1. Introduction to Solar Electricity" in Solar Cells, Delft University of Technology, 2003.

The publication introduces the fundamentals of photovoltaic solar energy, specifically focusing on solar electricity. Produced as part of the Solar Cells course at Delft University of Technology in 2003, this chapter serves as a foundational resource for understanding solar power generation.

Tendon Driven Continuum Robot (TDCR) For Exploration and Rescue in Dynamic Environments

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Abstract— The goal of this project is to create and deploy a new type of robot called a Tendon-Driven Continuum Robot (TDCR), which is specifically designed for operations involving exploration and rescue in hazardous and dynamic situations. Compared to conventional rigid-bodied robots, continuum robots—which draw inspiration from natural forms like human tendon elephant trunks and octopus arms—offer notable flexibility advantages. This TDCR design's use of tendon-driven systems gives it fine control over its movements, improving its dexterity and agility as it navigates challenging environments. This study also highlights the TDCR's ability to independently navigate and adapt to changing environments by integrating obstacle- detecting sensors. Through the use of sensors, the robot can collect environmental data in real time, recognize barriers, and plot the best possible routes for effective exploration or rescue operations. To sum up, the Tendon Driven Continuum Robot (TDCR) is a noteworthy development in robotics technology for use in demanding and dynamic situations for exploration and rescue missions.

Keywords— Tendon-driven, Continuum, Embedded, Antagonistic tendon, pulley system, Exploration and rescue.

1. INTRODUCTION

Tendon-driven continuum robots (TDCRs) are an intriguing category of robotic manipulators characterized by their exceptionally dexterous hands and soft, slender bodies. They do not have solid joints like traditional rigid-link robots do; instead, they flex continuously by manipulating internal cables or tendons. They have significant advantages due to their distinctive design, which makes them suitable for a wide range of applications in different sectors. Inspired by natural features such as octopus arms, elephant trunks, and human finger tendons, TDCRs provide superior dexterity and flexibility over rigid-bodied robots. Tendon-driven mechanisms are used by TDCRs to provide precise movement control and the ability to navigate challenging settings. When obstacle-detecting sensors are integrated with TDCRs, autonomous navigation and environment adaption are made possible. Tendon-driven continuum robots (TDCRs) are an intriguing category of robotic manipulators characterized by their exceptionally dexterous hands and soft, slender bodies. They don't have solid joints like traditional rigid-link robots do; instead, they flex continuously by manipulating internal cables or tendons. They have significant advantages due to their distinctive design, which makes them suitable for a wide range of applications in different sectors. Inspired by natural features such as octopus arms, elephant trunks, and human finger tendons, TDCRs provide superior dexterity and flexibility over rigid-bodied robots.

Tendon-driven mechanisms are used by TDCRs to provide precise movement control and the ability to navigate challenging settings. When obstacle-detecting sensors are integrated with TDCRs, autonomous navigation and environment adaption are made possible.

1.1 Embedded System

A computer processor, computer memory, and input/output peripherals with a specific purpose integrated into a larger mechanical or electronic system make up an embedded system. It is integrated into a full device, frequently with mechanical and electrical/electronic hardware. Microcontrollers, or microprocessors with integrated memory and peripheral interfaces, are the foundation of many modern embedded systems; however, regular microprocessors, which rely on external chips for memory and peripheral interface circuits, are also frequently used, particularly in more complicated systems. The current technological landscape is greatly shaped by embedded systems, which allow for a broad range of applications across industries.

Engineers and developers must possess a fundamental understanding of embedded systems, encompassing hardware components, communication protocols, power management, and security, to effectively design and implement dependable embedded solutions. Embedded systems will develop further as technology does, spurring creativity and enabling the subsequent wave of intelligent systems and gadgets. Architectures for Hardware: Advanced systems use Real-Time Operating Systems (RTOS) for multitasking and intricate peripheral management, going beyond simple microcontrollers. Demanding programs can process data in parallel thanks to multi-core computers. Real-Time Programming: Tight timing limitations are a common problem for embedded devices. Time-tracking strategies like as scheduling algorithms and interrupt handling make ensuring that jobs are finished on time. Low-Power Architectural Methods: An integral part of many embedded systems is battery life. Clock gating and low-power sleep modes are examples of power-saving technologies used in advanced designs to reduce energy usage.

2. LITERATURE REVIEW

A study examined collapsed houses after an earthquake using a special robot camera (ASC) that can move on its own. The ASC safely entered the houses and captured images, helping researchers assess the damage. The paper details the findings and areas for improvement to the ASC for future disaster zones. It also describes a test field to evaluate the robot's capabilities[1].

New soft robots grow like vines! By inflating a special chamber at the tip, they can lengthen quickly and steer themselves using built-in sensors. This lets them navigate tight spaces and even form 3D shapes as they grow. These robots move as fast as some animals and robots, and their stretchy bodies are even more impressive than plant cells. This paves the way for robots that can explore and build using growth instead

3. EXISTING PROBLEM

The main issue facing search and rescue is that robot stiffness prevents it from searching in complex terrain. These settings, which include crumbling structures, uneven debris, and deep trees, are frequently chaotic. Stiff robots have an easier time navigating confined spaces and becoming trapped in garbage. This postpones the search for survivors who may be holed up in those difficult-to-reach places. These barriers can readily impede a robot with an inflexible design. It may find it difficult to maneuver through confined passages, become caught in the debris, or struggle to ascend over uneven terrain. This inflexibility severely hinders the search, causing vital rescue operations to be delayed and possibly decreasing the likelihood of discovering individuals who are stranded in difficult-to-reach locations.

4. BLOCK DIAGRAM OF TDCR STRUCTURE

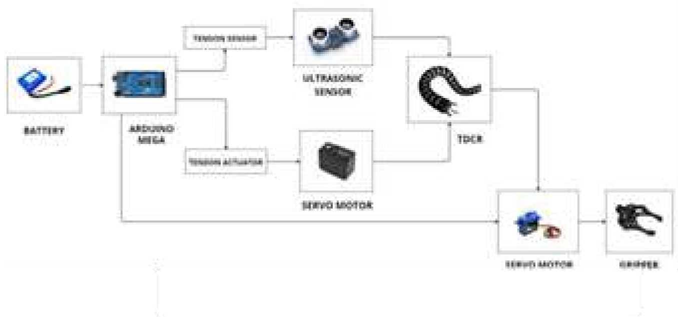

Fig: 4.1 BLOCK DIGRAM OF THE TDCR

4.1 ARDUINO MEGA (ATmega 2560)

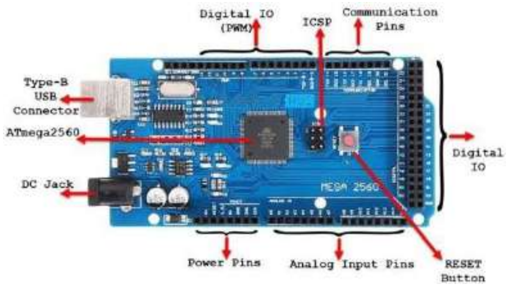

Fig:4.2 ARDUINO MEGA BOARD

A microcontroller board called the Arduino Mega ATmega2560 is intended for applications requiring a large number of inputs and outputs. It works similarly to a tiny computer that you may program to operate devices. Fast processing is handled by the ATmega2560 chip at its core. The Mega 2560 features 16 Analog pins for reading variable. voltages from sensors like light sensors, and 54 digital pins for turning on and off devices like LEDs or motors. It has four internal serial ports that it can use to communicate with other devices. Using the board is simple. Just use a USB cable to connect it to your computer, then use the Arduino IDE software to produce code, or sketches, that instructs the board what to do. To get you started, a plethora of online projects and tools are accessible. Powerful and adaptable, the Arduino Mega 2560 is an excellent board for both small and large projects. A large number of pins on the Arduino Mega ATmega2560 allow you to attach a variety of components to your project. The following summarizes its pin capabilities:

Digital Pins (54): These resemble light switches. To control digital devices such as motors, LEDs, or digital sensors, you can configure them to emit a low (0V) or high (5V) signal.

PWM (Pulse Width Modulation) capable pins (15): A portion of digital pins with the ability to produce varying voltages. This makes it possible to control motor speed, dim LEDs, and produce intricate sound effects.

Analog Input Pins (16): These pins can read voltage signals from analog sensors, such as light, temperature, and microphone sensors. Your code may respond to environmental changes since the voltage value matches the sensor's readout

4.2 SERVO MOTOR

A well-liked servo motor with a reputation for longevity and good torque is the MG996R. For many robotics and automation applications where exact control and movement are required, it's an excellent option.

Specifications of the MG996R servo motor:
Operating Voltage: 4.8V to 6V (typically 5V)
Stall Torque:
9.4 kg-cm (at 4.8V)
11 kg-cm (at 6V)
Operating Speed:
0.17 sec/60° (at 4.8V)
0.14 sec/60° (at 6V) Operating Angle: 360 degrees
Gear Type: Metal
Weight: 55g
Dimensions: 40.7 x 19.7 x 42.9 mm Control **System**: Analog (PWM) Wire Length: 30cm
Connector: 3-pin JST servo connector

Fig:4.3 SERVO MOTOR

Key features of the MG996R servo motor:

High torque: Because of its strong torque output, the MG996R is a good choice for exerting considerable force or moving heavier objects.

Metal gear: Compared to plastic gears, metal gears are less prone to wear and tear and have greater durability.

Double ball bearing design: This design makes operation smoother by increasing stability and lowering friction.

Wide operating voltage range: The MG996R offers you versatility in terms of power supply choices because it can run on a voltage range of 4.8V to 6V.

Standard 3-pin JST connector: As a result, the majority of servo controllers and receivers are compatible with the MG996R.

4.3 ULTRASONIC SENSOR

An ultrasonic sensor is a device that senses the presence and proximity of things using sound waves. It quantifies the amount of time it takes for high-frequency sound waves to return after they bounce off things.

DISTANCE = (SPEED X TIME AKEN) / 2

There are several uses for ultrasonic sensors, such as:

- Parking assist systems in cars
- Robotics
- Object detection
- Level measurement

Fig:4.4 ULTRASONIC SENSOR

4.3.1 *Working of the ultrasonic sensor***:**

The sensor generates a sound wave with a high frequency.
The sound wave moves through the atmosphere before colliding with an object.
The sound wave returns to the sensor after bouncing off the item.
The duration taken by the sensor to detect the return of the sound wave.
The sensor determines the distance to the item by measuring the speed of sound.

4.4 TDCR (TENDON DRIVEN CONTINUUM ROBOT)

Exposing Tendon-Driven Continuum Robots' (TDCRs) Dexterity

Imagine a robot arm with a fluid, snake-like bend instead of stiff joints. TDCRs, or tendon-driven continuum robots, are essentially like this. a novel class of robots modeled after the nimblest creatures in the natural world. Let's take a closer look at TDCRs and discover more about their intriguing potential, distinctive design, and operational philosophy.

Fig:4.5 TENDON

The Tendon Network (The Strings of Control):

Tendons are a network of tiny wires that weave their way along the backbone of the continuum. These tendons transfer forces to govern the robot's bending, functioning as its muscles. Tendons function similarly to when you pull a rope to bend a garden hose. Sections of the robot bend in the correct direction by motors pushing on these tendons that are strategically routed along the backbone.

The Power Behind the Bend:

TDCRs usually use extrinsic actuation, which means that the motors that govern their motion are situated outside of the robot's body. This maintains the robot's compact and lightweight construction. The tendons are attached to the motors, which control the robot's bending behavior by applying or relieving strain on these cables.

4.5 GRIPPER OF THE TDCR

A robotic arm can grab and move things with the help of a gripper, which is a device attached to the end of the arm. They serve as the robot's "hand," enabling it to engage in a range of interactions with the outside environment. Although there are numerous gripper designs, we employ angular grippers.

Robotic grippers that use servo motors to regulate the gripping motion are known as angular grippers with servos. The torque ratings of the servo motors that are used will determine the precise capabilities of an angular gripper that uses servos. How a gripper finger is designed affects what kinds of objects it can hold. For improved grabbing, certain grippers, for instance, might include grippy surfaces on their fingers. The servo movements of the gripper are frequently programmed and controlled using control boards such as Arduino.

Fig:4.6 GRIPPER

4.5.1 Working of the gripper:

Normally, an angular gripper consists of two or three fingers fixed on a rotating base around a central axis.

A servo motor is attached to each finger.

To grasp objects, the gripper fingers can be opened and closed by adjusting the position of the servo motors.

4.5.2 Advantages:

Versatility: Because their fingers rotate, angular grippers' fingers can conform to items of different sizes and shapes more easily than parallel jaw grippers.

Controllability: Servo motors provide sensitive object handling by providing exact control over the gripping force and finger placements.

Simplicity: Since the concept is straightforward and simple to execute, it can be used for instructional robotics projects or hobbyist projects.

Cost-effective: In general, servos are less expensive than more intricate gripper systems.

4.5.3 ***Disadvantages*:**

Limited Grip Strength: When compared to the hydraulic or pneumatic actuators used in industrial grippers, servos usually have less torque. Their capacity to handle big objects is so limited.

Bulkier Design: When compared to certain other designs, the gripper may become bulkier due to the inclusion of servo motors.

Control Complexity: Although servos provide accurate control, programming the movements of servos for intricate grasping tasks may necessitate some familiarity with robotics and control systems.

4.6 POWER SUPPLY

USB cable: The easiest and best option is this one. An ordinary USB A to B cable can be used to power the Arduino Mega straight from the USB port on your computer. The Arduino needs 5V, which is provided by the USB connection.

Wall adapter: An appropriate option for powering your Arduino without a computer is a regulated 5V wall adapter. To be sure an adapter can supply adequate power for your project, look for one with a center-positive plug (tip positive, barrel negative) and a current rating of at least 500m (milliamps). They are widely accessible and frequently used to charge phones and other electronics.

Important: Steer clear of utilizing a standard 9V wall adaptor. Higher voltages may cause damage to the Arduino Mega since it is only intended to accept 5V of input.

5. PROPOSED WORK: Tendon Driven

Continuum Robot (TDCR) for SEARCH AND RESCUE

5.1 Introduction:

With a tendon-like structure akin to human fingers, the Tendon-Driven Continuum Robot (TDCR) is a cutting-edge robotics design that allows for dexterity and complex maneuvers in confined places. Servo motors are used by the TDCR for actuation. Smooth motion is made possible by the tendons of the TDCR, which makes it easy to handle

challenging activities and maneuvering through intricate settings. It is made up of a sensor, motors, grippers, flexible wires, a triangle coupler, a shaft, pulleys, gear belts, and other small parts. As the "brain" of the robot, the TDCR actuator regulates each segment's actuation by intended movements.

5.2 Proposed Solution:

To solve the above-mentioned problem this project aims at the flexible movement of the robot, where the solution is inspired by the human body part "Tendon". This tendon movement ensures the robot’s flexible and agile motion to find the needed.

5.3 *Proposed TDCR Design:*

Bioinspired Tendon-Driven Continuum Robot (TDCR) Design

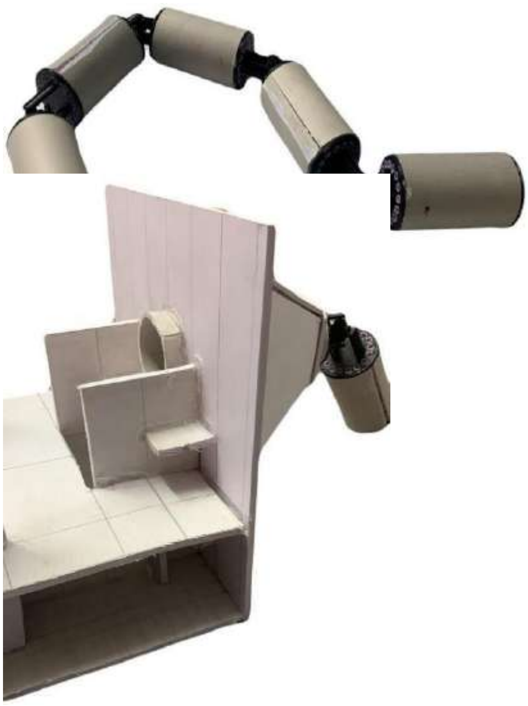

Fig:5.1 PROPOSED TENDON OF TENDON

The flexibility and dexterity of the human finger serve as the model for our suggested TDCR design. It makes use of a tendon-like structure made up of several separately produced and 3D-printed parts. These sections are then painstakingly joined to create a continuous backbone that mimics the complex architecture of a tendon.

With a maximum torque of 2.05 Nm, each segment's dual servo motor actuation provides an astounding 270 degrees of rotation. This robust actuation system acts as the primary control unit, precisely coordinating each segment's movement in response to commands that are sent either in real-time or in advance.

Smoothly merging with the actuator unit, the TDCR structure forms a strategic triangle coupler that facilitates the efficient and stable transfer of forces.

Fig:5.3 TENDON AND TRIANGULAR COUPLER

The segments can hold the required parts and tendon channels by designing them with 3D printing
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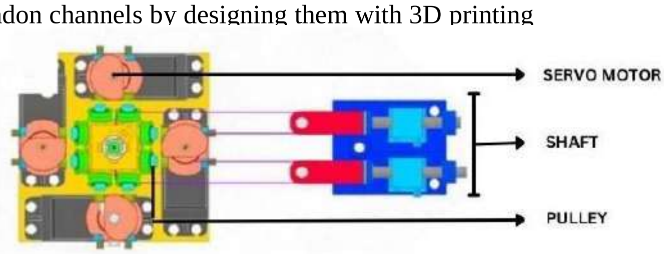


Fig:5.2 ANTAGONISTIC TENDON

like thin cables or wires. Each string or cable should have one end secured to the tendon. Using pulleys or other comparable devices, firmly fasten the tendons to the actuators to guarantee dependable and smooth movement.

Fig:5.4 TRIANGULAR COUPLER

Two servo motors are utilized for each segment of the robot in this TDCR project, which uses servo motors as actuators to move the robot.

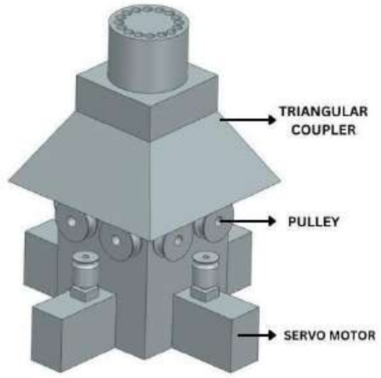


Fig:5.5 3D MODEL ACTUATOR

Moreover, the design integrates an ultrasonic sensor to improve its flexibility in changing surroundings. This sensor continuously scans its surroundings for potential obstructions, serving as the robot's eyes. Subsequently, the gathered information is transmitted to the control system, enabling instantaneous modifications to the robot's path, guaranteeing secure and effective maneuvering in restricted areas.

5.4 **Control Strategy Of the proposed system:**

5.4.1 *Precise Control for Agile Maneuvers*

Individual Segment Actuation: High-precision servo motors are used by the TDCR to regulate every individual section. Because of this fine control, movements can be accurate and well-coordinated, simulating the flexibility of a human finger.

Simple Programming & Flexibility: The simple method of pulse width modulation (PWM) control is used for servo motors. This makes the TDCR accessible to a wide range of skill levels by facilitating simple programming through user-friendly platforms such as the Arduino IDE or Visual Studio Code.

Arduino MEGA(The Control Hub): The Arduino MEGA microcontroller powers the robot's control system. This robust board provides the memory and processing capability required to run control programs and handle in-the-moment movement modifications.

Scalable Control Complexity: Various degrees of complexity can be accommodated by tailoring the control method. Servo motor control is the main means of operation for the TDCR. On the other hand, jobs requiring environmental awareness and real-time modifications can be done with sensor integration and feedback loops for more advanced features.

Ultrasonic Obstacle Detection: The robot's eyes are an ultrasonic sensor, which continuously scans its environment.

The control system may instantly modify the robot's movement trajectory thanks to this real-time obstacle recognition, guaranteeing effective and safe navigation in changing situations.

5.5 Simulation and Analysis:

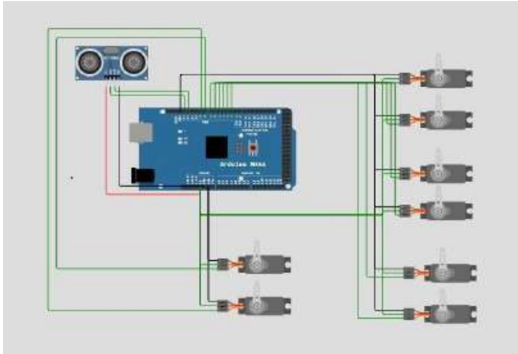


Fig:5.6 WOKWI SIMULATION MODEL

WOKWI simulation software is used by the TDCR project to test the robot's capabilities and simulate its behavior. WOKWI offers an online simulator for Internet of Things (IoT) and electronics projects, enabling researchers to virtually test and evaluate the operation of the TDCR. Researchers can detect potential flaws or improvements before putting them in the real robot by using the WOKWI simulation to visualize the movement and behavior of the robot. Virtual logic analysis, which interfaces with the Arduino IDE and Visual Studio Code to facilitate a seamless workflow, is also used in the TDCR project. Through efficient and precise control of the robot's movements, this study aids in the debugging and optimization of the TDCR's control system code.

6. BUILDING THE STRUCTURE OF THE TDCR

The structure of the TDCR contains two parts:

- Tendon
- Actuator Mechanism

6.1 *TENDON*

Tendons are important components of this continuum robot; they are modeled after tendons seen in human fingers, elephant trunks, and octopus arms, which provide notable flexibility benefits over more conventional rigid-bodied robots. This TDCR design's use of tendon-driven systems gives it fine control over its movements, improving its dexterity and agility as it navigates challenging environments. Tendons are constructed from segment-like components joined by universal joints. The TDCR moves in accordance with the movement of cables or strings.

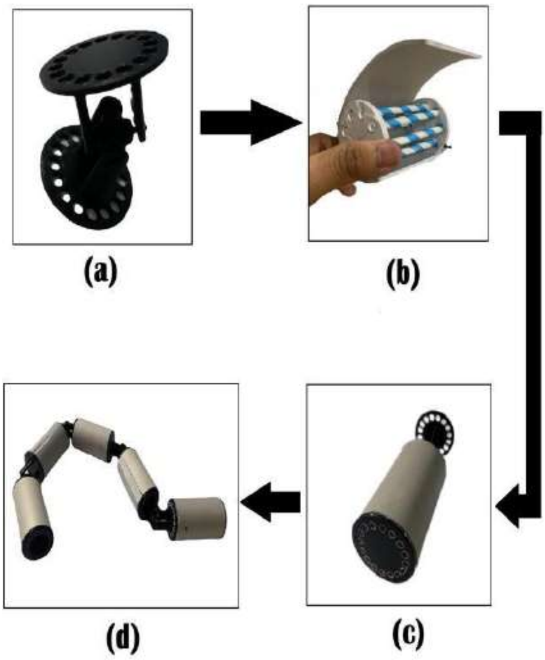


Fig:6.1 PROCESS OF BUILDING TENDON

The 3D-printed universal joint was designed and printed.
Inside view of the segment which is made up of foam board with 16 narrow string paths.
The Segment that is attached to the universal joint.
Five segments that are joined serially to resemble a tendon- like structure

Fig:6.2 CONNECTING TENDON WITH TRIANGULAR COUPLER

The arrangement of the strings between the segments.
Anchor point of the strings at the end of each segment.
Initial structure of TDCR.
Triangular coupler where the tendon structure and the actuator converge.

6.1.1 ANTAGONISTIC TENDON PAIR

An antagonistic tendon pair controls the bending and extension of a robot employing a pair of tendons that are routed down its backbone, usually on opposite sides. The agonist and antagonist are the names given to the two types of tendon. The robot bends when one tendon contracts, but it may move in a controlled manner when the antagonist's tendon relaxes. On the other hand, by opposing the force of the contracting tendon, the antagonist tendon contracts and straightens the robot. Operators can modify the stiffness of the robot and hence its uses by varying the tension in the tendon pairs. Achieving dexterous and adaptive movement requires this.

6.2 ACTUATOR MECHANISM

The actuator mechanism is the brains behind the flexibility and maneuverability of a tendon-driven continuum robot in intricate settings. These are the motors or other systems that regulate the tendon's tension. They can be rotary actuators (winding/unwinding a spool) or linear actuators (pulling/pushing in a straight line). Pneumatic pistons, hydraulic cylinders, and electric motors are examples of common types. These are the motors or other systems that regulate the tendon's tension.

There are a couple of mechanisms for using a single servo motor to control two antagonistic tendons. Here are two common approaches:

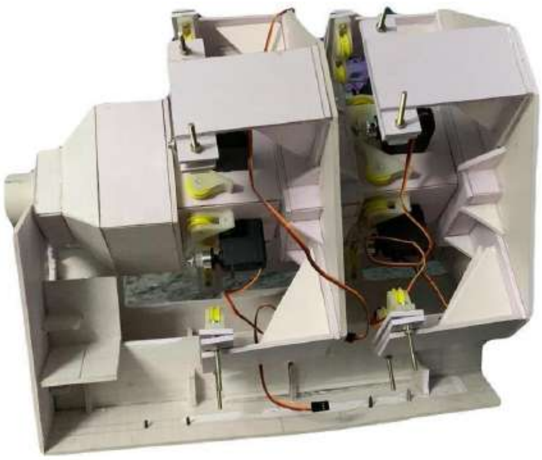
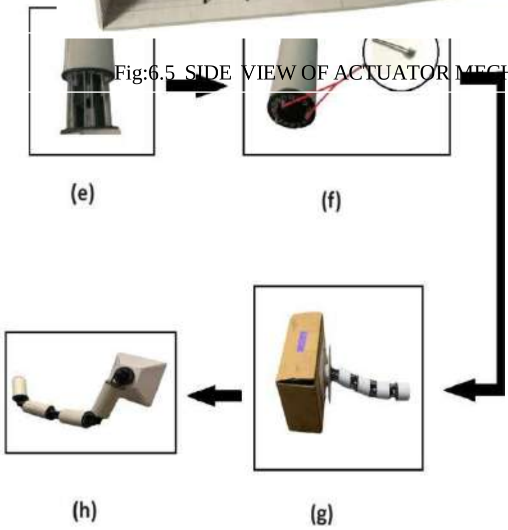


Fig:6.5 SIDE VIEW OF ACTUATOR MECHANISM



6.2.1 Pulley System

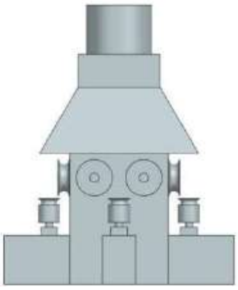


Fig:6.3 PULLEY SYSTEM

It's an often employed technique. Consider a solitary servo motor that is attached to a shaft. There are two fixed pulleys on this shaft, one on each side. After attaching to the bone or link you wish to move, each tendon goes around the pulley that is assigned to it.

Movement: One tendon, referred to as the agonist, is wound by the motor's clockwise rotation, while the other, referred to as the antagonist, is unwound. Tugging the bone or link in a single direction, tightens the agonist tendon. On the other hand, movement in the opposite direction results from a counter- clockwise rotation that tightens the antagonist.

6.2.2 Worm Gear Mechanism

Fig:6.4 WORM GEAR MECHANISM

This method accomplishes the antagonistic action by use of a unique gear arrangement. A worm gear is connected to the shaft of the servo motor. The worm gear meshes with a different gear rack that has teeth running the length of it. Each tendon is fastened to a single-gear rack end.

Movement: The worm gear moves the gear rack back and forth as the motor rotates. Depending on which way the rotation is made, this movement contracts one tendon while loosening the other.

Pulse width modulation (PWM) is used to program the servo motors, and platforms like the Arduino IDE and Visual Studio Code make controlling them simple.

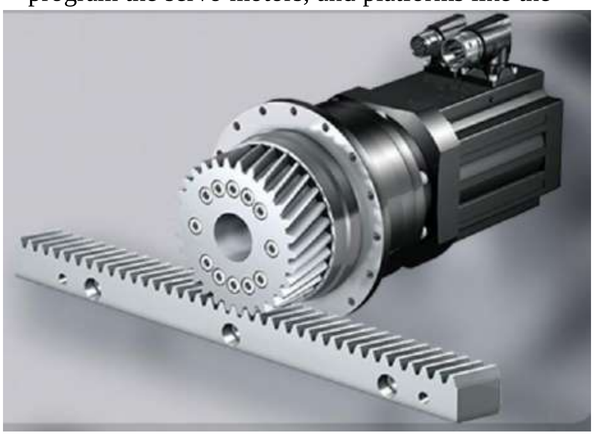


Fig:6.6 FRONT VIEW OF ACTUATOR MECHANISM

The gripper at the edge of the TDCR structure is additionally moved using a servo motor.

7. WORKING OF THE TDCR

The robot is made up of several serially connected segments; the segments themselves don't have to be flexible; the joints must. To allow for bending and movement, an actuation mechanism with servo motors is housed in each segment. Tendons are thin, highly-strengthened cables that run inside the body of the robot. An Arduino UNO is used in a control system, and its programming serves as the robot's brain, coordinating segment actuation by intended movements. Creating a TDCR is a multi-step process. Initially, each segment is developed or 3D printed taking into account variables like weight, strength, and tendon channels. Next, each segment's selected actuation mechanism is installed, guaranteeing a secure attachment to the tendons. These tendons are fastened to the robot's base on one end and to different locations throughout its body on the other. The pulleys at the robot's base link the tendons to the servo motors. The tendons can be pulled or released to cause the robot's body to bend and deform in particular ways by carefully manipulating the winches. Lastly, the actuators, as well as any extra sensors or tools the robot may need, are connected to the integrated control system.

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7.1 Actuation and Control:

7.1.1 Segment Movement:

For actuation, each segment has two servo motors. The control system sets the position of each segment by adjusting the pulse width modulation (PWM) supplied to the servo motors. This makes it possible to precisely regulate how each segment bends and, eventually, how the robot moves as a whole.

7.1.2 Control System:

We use the Arduino Mega, a microcontroller board renowned for its processing power and ease of use, to operate these unusual robots. The commands are converted into exact tendon motions by the Arduino Mega. To specify the robot's desired turns, we can use a C-based programming language to program the Arduino. The required modifications for every tendon are then computed by the algorithm. creating the Arduino IDE software, which will serve as the brains of the robot and coordinate segment actuation in response to sensor input and desired movements. attaching the actuators, sensors, and grippers needed for search and rescue missions to the control system.

7.2 Adaptability and Navigation:

7.2.1 *Ultrasonic Sensor:*

An ultrasonic sensor built into the TDCR serves as a sensory organ. This sensor can perceive barriers in its environment because it continuously produces and detects ultrasonic vibrations.

7.2.2 Real-time Adjustments:

The ultrasonic sensor provides data to the control system. The control system can modify the scheduled movement of the robot segments in real-time based on the obstacles that are detected. This lets the robot avoid collisions and maneuver through tight locations.

8. PARTS OF TENDON STRUCTURE

8.1 SEGMENTS

The robot is made up of multiple, individual segments connected in series. These segments can be rigid or have some level of flexibility depending on the design. Each segment houses the actuation mechanism and other necessary components.

Fig:8.1 SEGMENT

8.2 ROBOTIC JOINT

The tendon is composed of many 3D-printed universal robotic joints that enable each segment to have an x-axis axis of rotation that rotates 360 degrees.

Fig:8.2 ROBOTIC JOINT

8.3 CABLES

These connect to the actuation mechanism in each segment as they pass through the body of the robot. The robot can move and maneuver because we can control the amount of bend in each segment by varying the tension of the tendon cable. To maintain stability while operating, the TDCR robots frequently need an anchor point. At both ends, the tendons are firmly fixed. Typically, one end of the cable is fastened to the robot's base, while the other end is connected to different parts of the body of the robot.

Fig:8.3 CABLE

8.4 TRIANGULAR COUPLER

The prism-like device that connects the actuation mechanism and the tendon structure is known as a triangular coupler. It serves as a bridge to establish a physical connection between the tendon and the actuators.

Fig:8.4 TRIANGULAR COUPLER

8.5 SHAFTS

There are two servo motors in it, one on each side. This is mostly used to modify the cables' stiffness as they pass through the pulleys. Two wires from the same axis are coupled to the servo motor via a gear belt and a shaft.

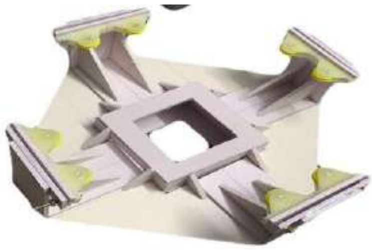

Fig:8.5 SHAFT

9. **OUTPUT AND RESULTS**

Inspired by the human finger, the TDCR performs exceptionally well in confined areas. With the help of servo motors, its parts can bend and reach precisely. Its eyes are an ultrasonic sensor that provides real-time obstacle detection. Because of its flexibility, the TDCR can move through debris and collapsed structures during search and rescue operations to identify survivors. Because of its agility and adaptability, this bioinspired design is a useful tool for preserving lives in tight spaces and dangerous situations.

Fig:9.1 ACTUATOR MECHANISM WITH TENDON

10. **INVOLVEMENT IN SEARCH AND RESCUE**

These robots are quite good in small areas. Their supple bodies, guided by tendons and internal wires, allow them to move larger Robots cannot navigate confined spaces and difficult terrain. An ultrasonic sensor is positioned at the end of the tendon structure to detect obstructions. To avoid hitting the obstacles, the robot turns around when the sensor finds them. This movement is feasible because of the TDCR's adaptable construction. A structure resembling a gripper is positioned as an end device to aid in the target's rescue.

11. DISCUSSION AND FUTURE RESEARCH

The future of tendon-driven continuum robots, or TDCRs, promises to be exciting. While biocompatible materials will pave the way for new developments in medicine, advances in material science promise stronger, more adaptable backbones. More accurate manipulation and possibly even human-robot cooperation will result from enhanced control systems with enhanced sensing and machine-learning capabilities. Miniaturized TDCRs for fine jobs and specialized robots for underwater research are what we may anticipate.

Their capabilities will be further enhanced by modular designs and controllable stiffness. Biomimetic designs, which draw inspiration from nature, have the potential to unleash unprecedented levels of flexibility and agility. TDCRs have the potential to transform a wide range of industries in the future, including industrial automation, scientific research, and surgery. Machine learning-enabled TDCRs will transform search and rescue. Imagine disaster-zone-navigating robots with flexible backbones. Safe searches in small spaces are made possible by biocompatible materials. The focus is on machine learning, which maps the surroundings by evaluating sensor data, adjusts navigation to avoid obstructions, and can even recognize victims through dust and debris. When combined with cutting-edge control systems, these sentient robots have enormous potential to become indispensable search and rescue comrades, perhaps saving countless lives.

CONCLUSION

Tendon-driven mechanism that mimics the human finger's remarkable dexterity, the Tendon-Driven Continuum Robot (TDCR) ushers in a new era of search and rescue operations in unpredictable and dangerous environments. Unlike traditional, rigid-bodied robots that struggle in tight spaces, the TDCR is specifically designed for navigating hazardous terrain. This novel design gives the robot unparalleled flexibility and agility—imagine a robot that can bend, twist, and contort its body—the TDCR does this with precise control over each segment, making it easy to navigate through collapsed buildings, dense foliage, or narrow tunnels. The TDCR is capable of much more than just moving. It functions as its intelligent scout, constantly surveying its surroundings and collecting environmental data in real time thanks to its obstacle-detecting sensors. This enables the robot to move about and adjust to dynamic circumstances. Imagine a robot with the ability to "see" possible dangers in its route in addition to being able to move past trash. The TDCR maximizes search and rescue operations by detecting obstructions and modifying its motions accordingly, guaranteeing both effectiveness and safety.

Search and rescue teams benefit practically from the innovative design of the TDCR. Its capacity to enter tight areas that conventional robots were previously unable to access greatly raises the likelihood of finding survivors. Faster environmental assessments and more focused rescue operations are made possible by real-time data from obstacle- detecting sensors. Robotics has advanced significantly with the development of the TDCR. It provides a ray of hope in the face of calamity thanks to its agility, adaptability, and sophisticated navigational capabilities, making it an indispensable tool for search and rescue teams.

ACKNOWLEDGEMENT

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Proactive Security: Integrated Surveillance and Intrusion Detection

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***Abstract*—In today's security landscape, ensuring critical areas' safety is paramount. This involves not only identifying potential threats but also responding swiftly to protect individuals and assets. Traditional surveillance methods often prove inadequate against the tactics employed by intruders, highlighting the necessity for advanced solutions like the Intrusion Detection System (IDS) [1]. Unlike passive surveillance approaches, an IDS actively monitors designated areas, leveraging state-of-the-art [2] technology to detect and alert against unauthorized activities in real-time promptly. This paper examines the pivotal role of IDS in enhancing security measures, outlining its core components such as high-fidelity IP-based cameras, edge computing units [3], alert mechanisms [4], and cloud storage. Through comprehensive analysis, the paper aims to illustrate how targeted IDS implementations bolster security protocols and uphold the integrity of critical zones.**

***Index Terms*—Intrusion Detection System, proactive surveillance, critical area protection, and real-time alerts.**

I. Introduction

In today's increasingly insecure world, safeguarding critical areas demands more than just passive observation; it requires a proactive approach to swiftly confront emerging threats and safeguard lives and valuables. Traditional methods of perimeter security, such as guards and fences, are no longer sufficient in thwarting the ever-evolving tactics of intruders. This growing challenge has led to a pressing need for advanced solutions like the IDS to stay ahead of the curve. Picture this: you're tasked with protecting a fortress. Rather than relying solely on static surveillance, an IDS functions like a team of vigilant sentinels patrolling the ramparts, constantly on the lookout for any signs of trouble. Upon detecting anything suspicious, such as an attempted breach, it immediately triggers alerts to the rest of the security team. This rapid response is vital for halting intruders in their tracks and safeguarding the fortress's treasures. However, an IDS doesn't merely observe; it learns. Through the analysis of past incidents and ongoing monitoring for new threats, it continuously improves its ability to identify potential dangers. Essentially, it operates as a round-the-clock security expert, always ready to spring into action at a moment's notice. Yet, the utility of an IDS extends beyond apprehending wrongdoers. It also serves to avert accidents and disasters. For instance, by detecting anomalies like fires or leaks, it can promptly alert relevant personnel, allowing them to take preemptive measures before situations escalate. In essence, an IDS acts as a guardian angel for security. Its proactive surveillance capabilities, powered by cutting-edge technologies like high-fidelity IP-based cameras, edge computing devices, alert mechanisms, and cloud storage, form a robust defense infrastructure. By promptly identifying and responding to threats, an IDS empowers security personnel to mitigate risks and protect critical infrastructure and public safety.

This paper endeavors to delve into the pivotal role of IDS in enhancing security protocols for critical areas, elucidating its operational principles, core components, and associated benefits. Through a thorough examination of IDS capabilities and real-world case studies demonstrating its efficacy in diverse security scenarios, this research seeks to underscore the importance of proactive surveillance in today's dynamic security landscape. Ultimately, the adoption of IDS technology represents a proactive stride towards fortifying security measures and safeguarding against emerging threats.

II. Components of the Integrated System

The integrated system comprises high-quality IP-based cameras, edge computing devices, alert mechanisms, and cloud storage.

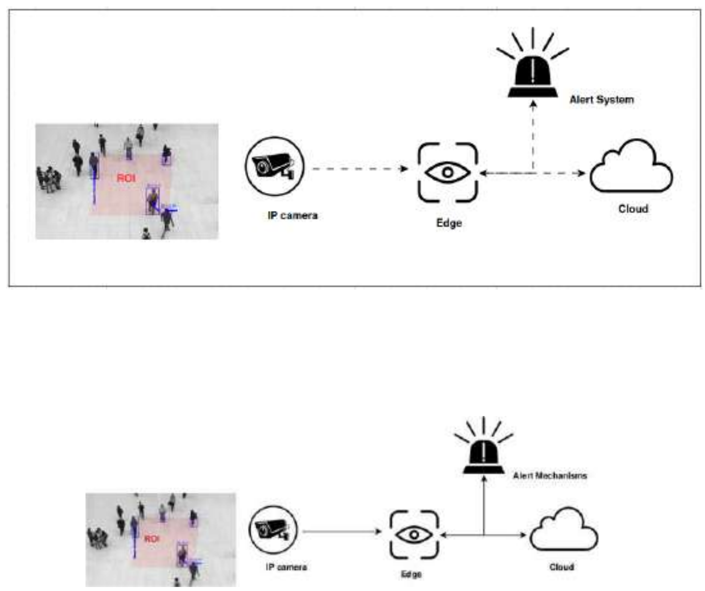

Fig. 1. Integrated System

A. High-Quality IP-Based Camera

The TP-LINK Tapo 4MP 2K QHD (2560x1440) CCTV Security Wi-Fi Smart Camera delivers clear and detailed surveillance footage, critical for effective threat detection. Configuration involves adjusting settings like resolution, frame rate, compression format, and network configurations tailored to the IP-based camera. Additionally, optimizing features such as motion sensing, low-light vision, and user access management enhance the camera's performance and bolster its security capabilities [5].*Edge Computing and Storage Integration*

The integration of edge computing devices with IP camera capabilities ensures precise intrusion detection even in challenging low-light or adverse weather conditions. The system includes onboard storage, featuring a 1TB HDD for local data storage and an FTP server for alarms and alert snapshots. This seamless fusion of edge computing and storage enhances system efficiency and reliability, enabling swift and effective responses to security threats [6].

B. Alert Mechanisms

Alert mechanisms are crucial in triggering immediate responses upon detecting potential security threats. When an intrusion is detected, alerts are promptly generated to notify relevant stakeholders or security personnel. Saivarun et al. introduced an IoT-based solution for monitoring industrial environments and detecting gas leakages, utilizing IoT technology for data analytics on sensor readings and prompt alerting of officials in case of intrusion, thereby preventing potential incidents [7].

C. Cloud Storage

Cloud storage is essential for securely managing and accessing data, especially in IoT applications. Pierleoni et al. conducted a comprehensive comparison of cloud platforms, including AWS, GCP, and Azure, focusing on their IoT services. Their study assists developers in selecting the most suitable platform based on architecture and performance [8]. AWS S3 is particularly notable among cloud storage solutions, renowned for its scalability, reliability, and robust security measures.

Maintaining a continuous flow for Intrusion Detection Systems involves regular updates, performance monitoring, log analysis, training, incident response planning, integration with other security measures, and regular testing. These practices ensure the IDS remains effective in detecting and responding to security threats on time.

III. System Architecture

The system architecture encompasses various essential components, each playing a vital role in the overall functionality of the surveillance and intrusion detection system.

The Configuration Manager serves as the system's initial interface, tasked with reading and managing the configuration file defining the Region of Interest (ROI) for the camera. This data is then utilized by the Camera Module, which is responsible for physically capturing video footage, and the Video Stream, continuously transmitting the captured data. At the system's core lies the IDS Model, a pre-defined algorithm analyzing video frames to detect potential intrusions. Upon detecting an intrusion, the Alarm System promptly alerts relevant personnel, while information about the intrusion is stored in the Information Storage component for future analysis. Regarding data flow, configuration data initially moves from the Configuration Manager to the Camera Module during system initialization. Subsequently, the continuous flow of video

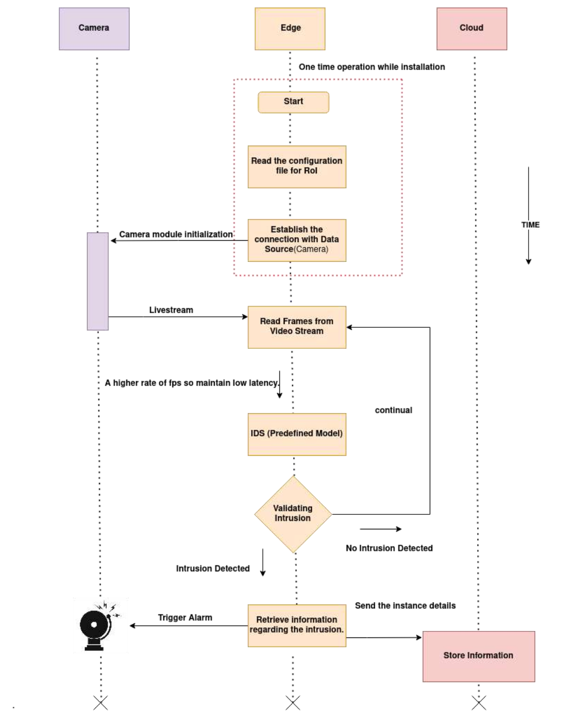

Fig. 2. System Architecture

frames from the Video Stream are directed to the IDS Model for analysis. The IDS Model then sends intrusion detection results back to the main process loop, initiating further actions based on the outcome. The system's control flow operates in a perpetual loop, continuously reading and processing video frames. If no intrusion is detected, the loop proceeds uninterrupted. However, upon identifying an intrusion, the Alarm System activates, and additional steps, such as storing supplementary information or communicating with external systems, may be initiated. It's crucial to acknowledge that the system's specific implementation details may vary based on complexity, emphasizing the importance of implementing adequate security measures to safeguard sensitive data and communication channels. Furthermore, system scalability and flexibility are essential considerations, allowing for seamless integration with existing infrastructure and accommodating future expansion or upgrades. Additionally, continuous monitoring and maintenance are imperative to ensure optimal system performance and responsiveness to evolving security threats. Regular audits and assessments can help identify potential vulnerabilities and ensure compliance with industry standards and regulations, enhancing overall system reliability and effectiveness. Regarding the image classification model, the system employs YOLOv8, a state-of-the-art model known for its accuracy and efficiency in real-time object detection tasks [9]. YOLOv8 utilizes a deep neural network architecture to detect and classify objects within images, making it well-suited for surveillance and intrusion detection applications.

IV. ADVANTAGES AND BENEFITS

The Detection system offers a myriad of advantages and benefits, making it a formidable asset in modern security infrastructure.

A. Enhanced Surveillance Coverage

The utilization of high-quality IP-based cameras and infrared sensors ensures comprehensive surveillance coverage, minimizing blind spots and providing a detailed view of the monitored area. This enhanced coverage significantly improves the system's ability to detect and respond to security threats effectively.

B. Real-Time Threat Identification

One of the system's standout features is its real-time object detection and intrusion alerting capabilities. By leveraging advanced algorithms and edge computing technology, the system can promptly identify and alert security personnel to potential security breaches as they occur. This swift detection enables rapid response actions, mitigating the impact of security incidents.

C. Secure Data Management

Cloud storage integration plays a crucial role in ensuring the secure management and backup of surveillance data. By storing data in the cloud, the system guards against data loss or tampering, providing robust data security and integrity. Additionally, cloud storage facilitates easy accessibility to surveillance data from anywhere, enhancing operational efficiency and facilitating retrospective analysis.

D. Scalability and Accessibility

The system's distributed architecture and cloud integration offer scalability and accessibility, allowing for seamless expansion and remote access. This scalability enables the system to adapt to changing security requirements and accommodate future growth without compromising performance or reliability. Moreover, remote accessibility enables authorized personnel to monitor and manage the system from anywhere, enhancing operational flexibility and responsiveness.

E. Proactive Security Measures

By leveraging proactive surveillance techniques and real-time alerting mechanisms, the integrated system empowers security personnel to take preemptive action against potential security threats. This proactive approach helps prevent security incidents before they escalate, safeguarding critical assets and ensuring the safety of individuals within the protected area. The integrated system's array of advantages and benefits, including enhanced surveillance coverage, real-time threat identification, secure data management, scalability, accessibility, and proactive security measures, collectively contribute to its effectiveness in bolstering security protocols and upholding the integrity of critical zones.

V. CASE STUDIES AND USE CASES

Real-world case studies offer concrete illustrations of how the integrated security system significantly improves security across various scenarios. With its diverse applications, the system provides advanced surveillance, threat detection, and response capabilities. Here are several noteworthy use cases showcasing the system's effectiveness in bolstering security measures across critical infrastructure, urban settings, border surveillance, corporate campuses, retail outlets, and public events.

TABLE I
REAL-WORLD USE CASES OF THE INTRUSION DETECTION SYSTEM

Use Case	**Description**
Application in Critical Infrastructure	Deployment in critical infrastructure like power plants or transportation hubs to safeguard vital assets [10]. Enhances security measures and ensures uninterrupted operations in critical facilities.
Urban Security	Plays a crucial role in enhancing public safety and reducing crime rates in urban environments [11]. Monitors public spaces, streets, and transportation systems to deter criminal activities and provide law enforcement agencies with valuable insights.
Border Surveillance	Scenarios involve efficiently monitoring and securing international borders to prevent unauthorized crossings [12]. By harnessing advanced camera sensor technologies and intelligent analytics, these systems enable swift detection and response to border breaches, bolstering national security measures.
Corporate Campus Security	Implements comprehensive surveillance and access control measures in corporate campuses to safeguard employees, assets, and sensitive information. Enhances security protocols and enables rapid response to security incidents within the campus premises.
Retail Store Loss Prevention	Utilizes video analytics and real-time alerting mechanisms to prevent theft and shoplifting incidents in retail stores. Enhances security measures and provides actionable insights for store management to optimize operations and enhance customer experience.
Public Event Security	Ensures the safety and security of attendees at public events such as concerts, festivals, or sporting events. Implements crowd monitoring and threat detection measures to mitigate risks and maintain order during large gatherings.
School Campus Safety	Enhances security measures in educational institutions by monitoring campus premises and detecting unauthorized access or suspicious activities. Improves student and staff safety and enables swift responses to security incidents.
Healthcare Facility Security	Secures healthcare facilities by monitoring sensitive areas, such as patient wards and medication storage areas, to prevent unauthorized access and ensure patient safety. Implements access control measures and real-time alerts for security breaches.
Airport Security	Enhances security at airports by monitoring passenger flows, luggage handling areas, and restricted zones to detect and prevent security threats such as smuggling or unauthorized access to aircraft. Implements advanced surveillance and threat detection technologies [13].

VI. Future Directions

With the continuous evolution of machine learning and deep learning techniques, the future of IoT security, particularly in the realm of IDS, holds significant promise. One notable avenue of exploration involves integrating reinforcement learn- ing algorithms into IDS, enabling adaptive and self-learning systems capable of identifying emerging threats in real time [14]. Additionally, the exploration of blockchain technology to enhance the security and integrity of IDS data and transactions offers considerable potential [15]. Moreover, the advancement of distributed IDS architectures, leveraging edge computing and federated learning methodologies, presents an effective solution to address scalability and privacy concerns in large-scale IoT deployments [16]. Furthermore, ongoing research endeavors focusing on anomaly detection and behavioral analysis, employing innovative neural network architectures and ensemble learning methods, are poised to further elevate the accuracy and robustness of IDS in dynamic IoT environments. In summary, interdisciplinary collaborations and sustained research efforts are essential for fully harnessing the capabilities of AI-driven IDS in safeguarding IoT networks. As we progress towards this future, the integration of advanced technologies and methodologies will undoubtedly shape the landscape of IoT security, ensuring robust protection against emerging threats.

VII. CONCLUSION

To encapsulate, the IDS is a pivotal asset in fortifying security measures and safeguarding critical areas. By seamlessly integrating cutting-edge surveillance technologies and proactive monitoring strategies, the IDS empowers security personnel with real-time threat identification and response capabilities, bolstering security protocols across diverse environments. As technological advancements continue, the IDS evolves to redefine security operations, offering unparalleled protection against evolving threats. In a world fraught with multifaceted security challenges, the IDS emerges as a beacon of resilience, offering proactive surveillance capabilities to swiftly respond to emerging threats. By harnessing high-fidelity IP-based cameras, edge computing units, alert mechanisms, and cloud storage, the IDS creates a robust security infrastructure. It remains vigilant and adaptive to evolving threats through continuous refinement and adaptation, positioning it as a cornerstone of modern security infrastructure. Looking ahead, advancements in artificial intelligence and data analytics hold promise for further enhancing IDS efficacy. The integration of reinforcement learning algorithms and distributed architectures heralds a new era of decentralized security solutions. In conclusion, the IDS represents a paradigm shift in security operations, redefining security preparedness. As we navigate modern security challenges, it stands as a beacon of resilience, offering unparalleled and paralleled protection in an uncertain world.

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Advanced Steering Mechanism Using Electronic Control Unit

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Abstract - The project focuses on implementing advanced steering mechanism using an Electronic control unit (ECU). This project replaces traditional hydraulic power steering system using an electric motor for better performance and comfort. The system enhances fuel efficiency by operating only when assistance is required, reducing energy consumption compared to other steering alternatives. Additionally, this system provides greater flexibility in tuning steering feel and responsiveness, contributing to improved vehicle handling and maneuverability. In real time, sensors are used to amplify the signal given in the steering column and the ECU calculates the optimal steering support required and sends this information to the electric motor and necessary actions take place in motor for the vehicle to turn. Implementation of this system can bring self-driving cars and driving becomes more comfortable and easier.

Keywords: Electric power steering (EPS), steering torque, torque sensor, electronic control unit (ECU), rotation in electric motor

I. INTRODUCTION

The primary purpose of the steering system is to allow the driver to guide the vehicle. Steering systems have evolved from traditional manual steering gear or hydraulic power assisted systems, to electrical power steering (EPS) systems. As the move towards lower emission vehicles continues, these EPS systems offer weight saving advantages over traditional hydraulic systems, helping to reduce the overall vehicle weight and subsequently improve handling and efficiency. Electric power steering works by using an electric motor to assist the driver in turning the steering wheel. The motor is typically mounted on the steering column or the steering rack and is controlled by a computerized system. This electric motor controls and assists the vehicle steering and provides an optimal and enjoying steering feel.

EPS uses Sensors detect the position and torque of the steering column, and a computer module applies assistive torque via the motor, which connects to either the steering gear or steering column. This allows varying amounts of assistance to be applied depending on driving conditions. Even in the event of component failure that fails to provide assistance, a mechanical linkage such as a rack and pinion serves as a back-up in a manner similar to that of hydraulic systems.

One of the key advantages of electric power steering is its ability to provide variable levels of assistance depending on driving conditions. For example, at higher speeds, less assistance may be needed, while more assistance may be provided during low-speed maneuvers or parking. Compared to traditional hydraulic power steering systems, electric power steering is generally more fuel-efficient because the electric motor only consumes power when assistance is required. This can result in improved fuel economy and reduced emissions. Also, Electric power steering systems typically require less maintenance than hydraulic systems since they have fewer moving parts and do not rely on hydraulic fluid. Additionally, EPS systems are generally more reliable and less prone to leaks or failures.

Electric vs hydraulic power steering:

Hydraulic power steering system is a closed loop system that uses pressurized hydraulic fluids for changing the wheel angle of front wheels based on steering angle.

Hydraulic systems provide a direct connection to the steering system, driver feedback and overall handling experience is good but it is prone to leaking, consumes a large amount of power, involves time to time replacement of the hydraulic fluid, greater in weight compared to EPS and also the system is slightly complex. Also, hydraulic power steering system are generally less efficient compared to electric power steering system as they continuously draw power from the engine to operate the hydraulic pump, even when steering assistance is not needed. Whereas, in case of electric power steering draw power from the vehicle's electrical system when steering assistance is required which contributes to improved fuel efficiency.

Figure 1. Electric vs hydraulic power steering

II. STRUCTURE OF EPS

The Electric Power Steering (EPS) consists of sequence of five phases, with each phase passing its outcomes on to the following in pipeline fashion without the feedback loop. The EPS stages are shown in fig#. The EPS consists the following phases: Steering wheel, Torque sensor, Electronic Control Unit, DC Motor, Rack and pinion.

EPS loads a rotational torque applied to the steering wheel as the input to the sensor. The information of how much torque is applied reaches the core of the ECU and it instructs the DC motor on how much to power assist the motor should give to the rack and pinion. The wheels connected to the rack and pinion rotate in accordance with the rotation of the steering rack.

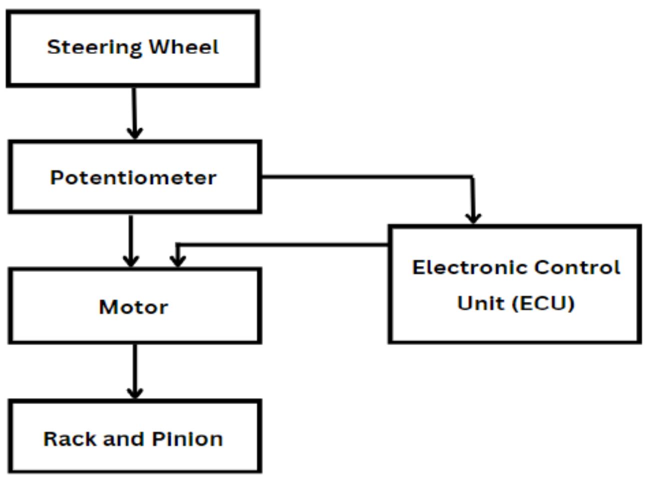

Fig 2. Block diagram of EPS

To understand the concept, advantages and challenges of the EPS, we device a prototype of the concept using RC toy car setup and use the following devices.

1] Potentiometer - The potentiometer is a voltage divider generally use for measuring electric potential(voltage). In our device, the potentiometer acts as the torque sensor sensing the rotation of the steering wheel and passing on the information to the ECU.
2] Arduino Uno - Arduino Uno is a microcontroller with an open-source coding environment. It can accept both analog and digital inputs and can produce both analog and digital outputs. This is the core of the ECU. This part defines how much assist to be given to the steering rack by the DC motor.
3] Servo motor - Servo motor is a rotary actuator that allows for precise control of angular position. We use this DC motor to move the steering rack in the direction of the steering wheel rotation.
4] Spring tension - We also use a spring tension to bring back the steering wheel to initial position automatically, further easing the maneuverability for the driver.

III. WORKING

The core of EPS system is an electric motor, usually mounted on the steering column or the steering rack. This motor is controlled by an electronic control unit (ECU) based on input from the sensors. The sensor used in the EPS is torque sensor which amplifies the input torque given in the steering column. The torque sensor sends the crucial data i.e. the amount of torque applied in the steering to the electronic control unit enabling it to adjust the assistance level accordingly. The ECU processes the data received from sensors and calculates the appropriate amount of assistance required based on the driving conditions.

The amount of assistance provided by the electric motor can vary depending on factors such as vehicle speed, steering wheel angle, and driving conditions. For example, at low speeds, such as during parking maneuvers, the system typically provides maximum assistance to make steering easier. At higher speeds, the assistance may be reduced to provide better road feel and stability. So, based on the calculation of ECU the optimal steering information is given to the electric motor. After receiving the information, the motor starts to rotate with the optimal speed and direction based on the input which causes the wheels to turn accordingly. In the EPS system, we incorporate fail-safe mechanism to ensure that steering assistance is still available in the event of a system failure. For instance, systems have a backup power source or a mechanical linkage that allows the driver to steer the vehicle manually in case of electrical failure.

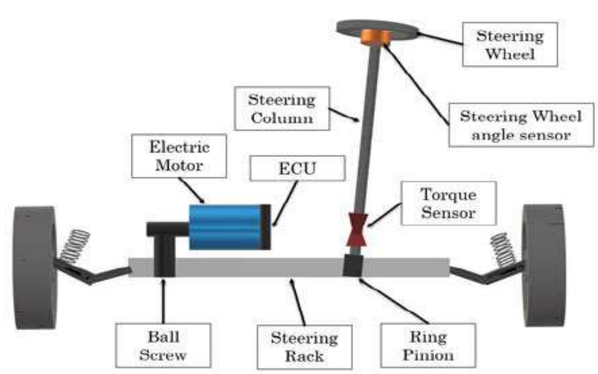

Fig.3. Structure of EPS

IV. ACTION PLAN

The potentiometer consists of 3 pins which include VCC, GND and the pin which is connected to the A0 (analog input) pin of the Arduino board. By turning the potentiometer manually there will be a change in resistance which measures the voltage. When the shaft is turned all the way in one direction, there are 0 volts going to the pin, and we read 0. When the shaft is turned all the way in the other direction, there are 5 volts going to the pin and we read 1023.

The servo motor also consists of 3 pins which include VCC, GND and the signal pin which is connected to the Port 9 of the Arduino board. The servo motor does not understand the voltage readings or the corresponding numerical values (0-1023), so it requires the angle at which it has to rotate. A map scale is used for this purpose. If the signal is 0 then the position is 0 degree if the signal is 1023 then the position is the maximum angle that we define in our Arduino code.

INPUT VOLTAGE	DIGITAL EQUIVALENT NO.	SERVO MOTOR ANGLE
0V	0	0
1V	204.6	24
2.5	511.5	60
4	818.4	96
5	1023	120

Fig 4. Input Voltage applied and the corresponding numerical value and servo motor angle

Next, we provide a spring tension on the steering (potentiometer) to bring it back to the initial position to make the steering mechanism easier for the driver.

V. CHALLENGES

EPS systems are composed of components, such as electric motors, sensors, controllers, and communication networks. These components need to work together seamlessly and reliably, as any failure or malfunction can compromise the safety and functionality of the steering system.

Also, EPS systems are vulnerable to cyberattacks, as they rely on electronic signals and data transmission. Hackers can potentially access the EPS system through wireless connections, such as Bluetooth or Wi-Fi and manipulate the steering commands, cause erratic behavior, or disable the system altogether and EPS systems are exposed to various environmental factors, such as temperature, humidity, vibration, and dust. These factors can affect the performance and durability of the EPS components, especially the electric motors and sensors. For example, high temperature can cause overheating, low temperature can cause freezing, and moisture can cause corrosion or short circuits.

EPS systems are more difficult to diagnose as they involve complex electronics and software. EPS systems can change the driving experience and feel of the vehicle, as they provide different levels of feedback and assistance than hydraulic or mechanical steering systems. Drivers need to adapt to the EPS system and adjust their driving habits accordingly.

VI. CONCLUSION

There is a need for electronically controlled steering systems for greater and smoother performance with increased maneuverability. This is where the Electric Power Steering (EPS) comes into effect. This method is more dynamic and energy-efficient method of assisted steering. EPS method offers

- High fuel efficiency
- Variable Steering Assistance
- Adaptive Steering
- Better Maintenance and Reliability
- Weight Reduction
- Customization and Tuning
- Improved Steering Feel

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AI-Enhanced Early Detection of Cystic Hygroma Using Fetal Ultrasound

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Abstract---Cystic hygroma, a congenital malformation characterized by the formation of fluid-filled sacs. This condition arises during fetal development when the lymphatic system fails to form properly. Cystic hygromas are usually discovered during prenatal ultrasounds, and their appearance can range from small, localized masses to larger and more diffuse ones. This project explores the integration of Artificial Intelligence (AI) into fetal ultrasound for early detection of cystic hygroma. The proposed AI-enhanced approach aims to improve the accuracy and efficiency of ultrasound image interpretation, facilitating timely identification of cystic hygroma during prenatal examinations. The ability to accurately identify and delineate cystic hygromas is quantitatively measured against ground truth annotations, demonstrating its efficacy in real-world scenarios. Early identification of cystic hygroma is imperative for timely intervention, informed parental counselling, and the optimization of prenatal care.

Keywords---Cystic Hygroma, Roboflow Annotation Tool, Yolov8, Artificial Intelligence, Prenatal Ultrasound.

I. INTRODUCTION

Cystic hygromas are abnormal growths in the lymphatic system, usually found in the neck, clavicle, or armpit areas. They're often noticed in babies or during pregnancy ultrasounds and can cause breathing problems, especially in infants. Surgery is the main treatment to remove them and prevent issues like infections. During development, these growths might form due to problems with the lymphatic system or changes in lymphatic channels. Sometimes, they're linked with chromosome issues or problems during pregnancy. Although not common, cystic hygromas are the most seen type of lymphangiomas, often appearing in babies within the first two years, mainly around the neck. They usually don't cause pain and are found accidentally during check-ups. Doctors can tell they're cystic hygromas by feeling for soft, fluid-filled lumps that shine light through and can vary in size from small to quite large. To confirm the diagnosis and see the extent of the growth, doctors use tests like ultrasound, CT scans, or MRIs. Treatment focuses on easing symptoms and avoiding complications, with surgery being the main approach. How well someone does depends on where the growth is and if any complications arise, with those found before birth generally having a tougher outlook. In summary, cystic hygromas are unusual growths in the lymphatic system that need careful attention for diagnosis and treatment. Using a mix of medical checks, scans, and specific treatments can help manage them and prevent problems.

II. LITERATURE SURVEY

1. R. Bassiouny, A. Mohamed, K. Umapathy and N. Khan, "An Interpretable Object Detection-Based Model For The Diagnosis Of Neonatal Lung Diseases Using Ultrasound Images," 2021 43rd Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC), Mexico, 2021, pp. 3029-3034, doi: 10.1109/EMBC46164.2021.9630169.

The paper introduces a unique method for utilizing Lung Ultrasound (LUS) to diagnose and monitor lung diseases in neonates. It emphasizes the importance of understanding LUS artifacts and proposes extracting seven specific LUS features associated with various pathological lung conditions. These features enable early prediction of respiratory distress symptoms. By training a multi-class object detection model (faster-RCNN) on LUS videos, the study demonstrates successful detection of these features, enhancing interpretability for clinicians and improving trust in automated diagnosis.

2. S. Nurmaini et al., "Accurate Detection of Septal Defects With Fetal Ultrasonography Images Using Deep Learning-Based Multiclass Instance Segmentation," in IEEE Access, vol. 8, pp. 196160-196174, 2020, doi: 10.1109/ACCESS.2020.3034367.

The study addresses the challenge of accurately screening for septal defects in fetal heart ultrasound images. Previous approaches failed to segment different objects within the fetal heart due to its complex structure and variations in image quality. The study introduces the use of Mask-RCNN (MRCNN) for instance segmentation, a first in medical applications for septal defect detection. The MRCNN model, utilizing ResNet50 and a low learning rate, demonstrates faster training and strong performance in detecting and segmenting heart chambers and defects. Results show high mean average precision for detecting various heart structures and defects, indicating the reliability of the proposed model for septal defect detection in both atria and ventricles.

3. J. Ker, L. Wang, J. Rao and T. Lim, "Deep Learning Applications in Medical Image Analysis," in IEEE Access, vol. 6, pp. 9375-9389, 2018, doi: 10.1109/ACCESS.2017.2788044.

The review explores the intersection of machine learning algorithms, particularly convolutional neural networks (CNNs), with the increasing use of electronic medical records and diagnostic imaging in healthcare. It highlights the clinical relevance of machine learning in analyzing medical images and emphasizes its advantage in discovering hierarchical relationships within big medical data without manual feature engineering. The review covers various research areas and applications of machine learning in medical image analysis, including classification, localization, detection, segmentation, and registration. It concludes by discussing research challenges, emerging trends, and potential future directions in the field.

4. Chen YN, Chen CP, Lin CJ, Chen SW. Prenatal Ultrasound Evaluation and Outcome of Pregnancy with Fetal Cystic Hygromas and Lymphangiomas. J Med Ultrasound. 2017 Jan-Mar;25(1):12-15.10.1016/j.jmu.2017.02.001. Epub 2017 Apr 17. PMID: 30065449; PMCID: PMC6029282.

Cystic hygroma, a type of lymphangioma, involves fluid accumulation mainly in the neck and axillary regions. It's associated with vascular anomalies and often linked to chromosome abnormalities and fetal complications like hydrops fetalis. Prognostic factors include chromosome abnormalities, hydrops fetalis, and characteristics of the hygroma. Prenatal management options include ultrasound monitoring, MRI, and intrauterine sclerosing agent injections. In cases of potential airway obstruction at birth, ex utero intrapartum treatment may be necessary. Detailed prenatal counseling is crucial for improving neonatal outcomes.

5. H. Sahli, A. Ben Slama, A. Zaafouri, M. Sayadi and R. Rachdi, "Automated detection of current fetal head in ultrasound sequences," 2016 International Image Processing, Applications and Systems (IPAS), Hammamet, Tunisia, 2016, pp. 1-6, doi: 10.1109/IPAS.2016.7880142.

The challenge of accurately diagnosing and predicting fetal conditions, particularly abnormalities in head formation, is a critical concern in ultrasound imaging due to the complexity of small fetal head images and low signal-to-noise ratios. This paper presents a fully automatic detection system that utilizes preprocessing filters to reduce speckle noise, followed by the application of the Hough transform technique to detect fetal head structures with 97% segmentation accuracy. Experimental results from five ultrasound sequences demonstrate the effectiveness and accuracy of the proposed method for diagnosing fetal head conditions.

6. Bianca S, Bartoloni G, Boemi G, Barrano B, Barone C, Cataliotti A, et al. Familial nuchal cystic hygroma without fetal effects: Genetic counselling and further evidence for an autosomal recessive subtype. Congenit Anom

2010; 50: 139-140, doi: 10.1111/j.1741-4520.2010.00273.x

The study examined the outcomes of fetuses with septated cystic hygroma (CH), finding that 40.6% had chromosomal abnormalities, with Turner syndrome being the most common. Additionally, 23.2% had structural malformations, while 36.2% had normal karyotype and morphology. Among live births, 18.8% had unfavorable neurologic follow-up. The findings highlight the association of septated CH with poor perinatal outcomes, suggesting karyotype analysis and ultrasound screening as initial steps, and expectant management for couples with normal morphology and euploid fetuses.

7. Molina FS, Avgidou K, Kagan KO, Poggi S, Nicolaides KH.Cystic hygromas, nuchal edema, and nuchal translucencyat 11-14 weeks of gestation. Obstet Gynecol 2006; 107:678-683,doi:10.1097/01.AOG.0000201979.23031.32.

The study aimed to determine the incidence of septations in fetuses with increased nuchal translucency (NT) thickness and explore their relationship with fetal karyotype. Among 386 fetuses examined, all showed septations within the translucency. However, abnormal karyotypes were found in 21.5% of pregnancies, with NT thickness being the only significant predictor. The study concluded that septations within the translucency cannot distinguish between increased NT and cystic hygromas. Additionally, the length of the translucency does not provide useful information regarding fetal karyotype beyond NT thickness alone.

.**8. T. Hope, N. Linney and P. Gregson, "Using the local mode for edge detection in ultrasound images," Canadian Conference on Electrical and Computer Engineering, 2005., Saskatoon, SK, C anada, 2005, pp. 374-377, doi: 10.1109/CCECE.2005.1556950.**

The study explores using quantitative ultrasound texture measures to detect white matter damage in very preterm infants, which can lead to cerebral palsy. Ultrasound speckle properties are analyzed to correlate with changes in scatterer properties in the brain. To enhance speckle edges in cranial ultrasound images, a non-linear filter (DM) is introduced, which outperforms traditional edge-enhancing schemes like Sobel. This filter leverages changes in speckle edges resulting from local mode filtering, maintaining edge center localization with large window sizes and performing well for diffuse edges. The paper discusses the filter, its parameters, and their application in detail.

9. Brumfield CG, Wenstrom KD, Davis RO, Owen J, Cosper P. Second trimester cystic hygroma: prognosis of septated and nonseptated lesions. Obstet Gynecol 1996; 88: 979- 982, doi: 10.1016/S0029-7844(96)00358-4.

The study compared karyotypic, ultrasonographic, and prognostic features of septated and nonseptated cystic hygromas in second-trimester fetuses. It found that septated hygromas were more likely to be aneuploid (85% vs. 56%), develop hydrops (60% vs. 19%), and less likely to be live-born (2% vs. 27%) compared to nonseptated hygromas. The most common abnormality in septated hygromas was 45,X karyotype, while trisomy 21 was common in nonseptated hygromas. These findings suggest that septated cystic hygromas are associated with poorer prognosis and higher likelihood of chromosomal abnormalities than nonseptated hygromas.

10. Bernstein HS, Filly RA, Goldberg JD, Golbus MS. Prognosis of fetuses with a cystic hygroma. Prenat Diagn 1991; 11: 349-355, doi: 10.1002/pd.1970110603.

The paper presents findings from the evaluation of 55 fetuses diagnosed with cystic hygroma in utero. It notes that approximately two-thirds had aneuploid karyotypes, with a notable link between septation and aneuploidy. Only five cases resulted in live births, mostly those with isolated hygromas, particularly small non-septated lesions that resolved during pregnancy.

III.METHODOLOGY

The working of the system starts with the collection of data and selecting the important attributes. Then the required data is pre-processed into the required format. The data is then divided into two parts namely training and testing data. The Yolov8 algorithms are applied and the model is trained using the training data. The accuracy of the system is obtained by testing the system using the testing data. The proposed system which is comprised of four stages. They are pre-processing stage, annotation and segmentation decision making stage and cystic hygroma detection. In the first stage, as input images are acquired. On the pre-processing stage where several steps are performed using Roboflow annotation tool. After the pre-processing, the main processing stage starts performing annotation and segmentation where the affected regions were segmented by removing backgrounds from the images and forms a bounding box around the affected regions with labelled values. Then the proposed yolov8 algorithm is used to train the AI 14 model with the help of train datasets. In the final stage, the detection of cystic hygroma is performed.

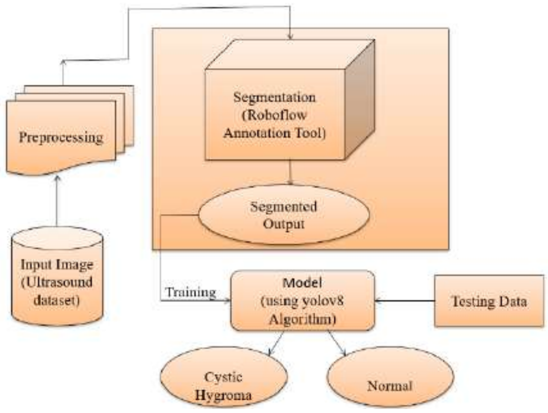

Figure 3.1 Block diagram of proposed system

Data Collection: Gather a large dataset of cystic hygromas containing various ultrasound images. These images should be annotated with bounding boxes around individual images, indicating their locations.

Data Preprocessing: Resize and normalize the medical images to ensure they are consistent in size and format.

Annotation and Segmentation: Convert the annotation data into YOLO-compatible format, which typically includes class labels (normal/ CH type) and bounding box coordinates relative to the image size.

Model Selection: Choose a pre-trained YOLO model suitable for object detection tasks.

Model Fine-Tuning: Fine-tune the selected YOLO model using your ultrasound dataset. This involves retraining the model on your dataset to adapt it to cystic hygroma detection.

Training: Divide your dataset into training, validation, and test sets. Train the YOLO model on the training set, monitoring its performance on the validation set. Adjust hyperparameters and model architecture as needed.

Evaluation: Evaluate the trained model on the test set using relevant metrics such as precision, recall, and F -score to assess its accuracy in cystic hygroma detection.

Visualization: Create a visualization system to display the detected cystic hygroma on the original images, making it easier for users to interpret the results.

Deployment: Deploy your model as part of an automated system for cystic hygroma detection. This could involve creating a user-friendly interface for users to upload images of ultrasound images and receive identification and classification results.

IV.RESULT AND DISCUSSION

A label correlogram assesses spatial relationships among categorical variables in a dataset, crucial for understanding spatial structure and informing analyses in fields like urban planning, environmental management, and public health. Annotation output, such as bounding boxes or segmentation masks, highlights cystic hygroma regions in medical imaging data, aiding in training ML models for automated detection.

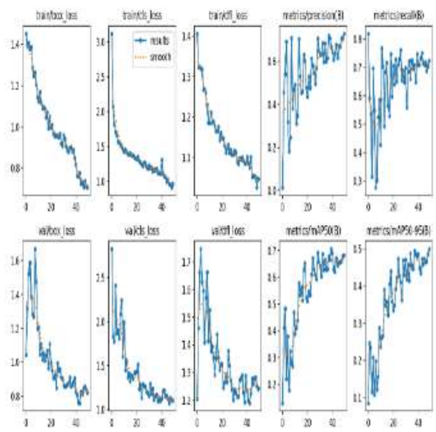

Figure 4.1 F1 score, precision and recall graph

TRUE POSITIVE (TP)	48.27 %
TRUE NEGATIVE (TN)	44.82 %
FALSE POSITIVE (FP)	5.18 %
FALSE NEGATIVE (FN)	1.73 %

ACCURACY	93.10 %

PRECISION	90.32 %
RECALL	96.55 %
F1 - SCORE	93.33 %

Figure 4.2 Performance Evaluation Calculation and Table

Leveraging annotated data improves accuracy and efficiency in diagnosis, guiding treatment planning. Treatment is individualized based on cyst characteristics, while prognosis varies depending on severity, response to treatment, and presence of complications. Early diagnosis and appropriate treatment can lead to favorable outcomes, but severe or untreated cases may carry higher risks of complications and long-term morbidity.

Figure 4.2 Detection of cystic hygroma

V.CONCLUSION

The project proposes an AI-driven approach using the YOLOv8 model and Roboflow annotations to enhance early detection of cystic hygroma during prenatal examinations. Through comprehensive evaluation, the model demonstrates robust performance, validated against ground truth annotations, promising improved accuracy and efficiency in ultrasound image interpretation. Early identification is vital for timely intervention and parental counselling, and integrating AI into fetal ultrasound analysis streamlines diagnostics, potentially impacting patient outcomes positively. The system offers a valuable tool for healthcare professionals to enhance cystic hygroma diagnosis, contributing to the evolution of prenatal care.

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BONE CANCER DETECTION: Enhancing EarlyDiagnosis and Treatment Through Advanced Computational Techniques

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Abstract*—Bone cancer represents a significant health concern, with timely detection being paramount for effective treatment. Conventional methods of analyzing bone scans are time-intensive and prone to errors, necessitating a more efficient and accurate approach. In response, we propose a novel automated detection system leveraging advanced deep learning techniques. Bone cancer, a malignancy affecting the skeletal system, demands prompt diagnosis to initiate timely treatment strategies. Traditional diagnostic methods rely on manual interpretation of bone scan images, a process burdened with subjectivity and potential oversight. Our approach introduces a sophisticated deeplearning architecture, custom-built to analyze bone scan images with unprecedented accuracy. Central to our methodology is the integration of the Convolutional Block Attention Module (CBAM), enhancing the model's ability to discern critical featuresindicative of bone cancer. Recognizing the unique challenges posedby bone scan images, our methodology incorporates tailored data augmentation and preprocessing steps. These techniques ensure the model's robustness in handling diverse imaging conditions and enhance its capacity to extract relevant information. Our proposed automated bone cancer detection system represents a significant advancement in medical imaging analysis. By harnessing the power of deep learning and innovative preprocessing techniques, we offer a promising solution to streamline diagnosis,ultimately improving patient outcomes in the fight against bone cancer.

Index Terms—**Bone cancer, CBAM, Image processing, Deep learning**

I. INTRODUCTION

Bone cancer presents a formidable healthcare challenge, characterized by uncontrolled cell growth within bones that can lead to tumors with potentially devastating consequences, including fractures and metastasis [6]. In 2018, an estimated 3,500 individuals in the United States were affected by bone cancer, with a mortality rate of 47%, underscoring the urgent need for improved diagnostic tools [6].

While X-ray imaging remains fundamental to diagnosis due to its ability to detect anomalies in bone tissue [1], its reliance on manual interpretation can be time-consuming and prone to error. Consequently, early detection is critical for successful treatment outcomes, driving the exploration of automated bone cancer detection systems [4].

These systems harness the power of machine learning and image processing to deliver rapid and accurate analyses, potentially revolutionizing diagnostic efficiency [4]. This paper introduces a novel deep-learning approach for bone cancer detection in bone scan images. Leveraging a custom DenseNet architecture with integrated CBAM and tailored data augmentation techniques, our method aims to enhance feature representation and address the unique complexities of bone scan images. By doing so, it holds promise as a valuable tool for computer-aided diagnosis, assisting healthcare professionals inthe early and precise detection of bone cancer

II. LITERATURE SURVEY

The prevalence of bone cancer imposes significant health challenges, warranting continuous advancements in detection methodologies to enhance diagnostic accuracy and treatment efficacy. Within this context, several research endeavors have been undertaken to explore innovative approaches, particularly leveraging machine learning techniques, in addressingthe complexities of bone cancer diagnosis. Shukla and Pa-tel (2020) undertook a comprehensive exploration into the integration of the biomedical field with computer science in the realm of bone cancer detection [7]. Their research delved into various image segmentation techniques, evaluating their applicability and efficacy in enhancing diagnostic accuracy [7]. By shedding light on the interplay between advancedimaging technologies and machine learning algorithms, their study paved the way for a deeper understanding of the intricate complexities involved in bone cancer diagnosis [7] Ponlatha et al. (2022) conducted a comprehensive study focusing on automated cancer and tumor detection in bone images. Their research delved into the intricate nuances of histological images, employing sophisticated deep-learning algorithms to predict and classify various types of bone tumors [4]. By harnessing the power of these algorithms, the study underscored the importance of accurate and efficient diagnosis, laying the foundation for more targeted treatment interventions [4]. In a similar vein, Georgeanu et al. (2022) embarked on a quest to predict tumor malignancy from magnetic resonance imaging (MRI) scans, employing cutting-edge deep learning algorithms [2]. By harnessing the capabilities of pre-trained classifiers, the researchers demonstrated the potential to significantly enhance diagnostic accuracy, thereby facilitating more informed clinical decision-making processes [2]. Sampath et al. (2024) proposed a holistic methodology that integrates image processing techniques with convolutional neural networks (CNNs) to classify normal and cancerous bone images [5]. Through meticulous experimentation and analysis, their study highlighted the critical role of early detection in improving patient outcomes, emphasizing the need for robust and reliable diagnostic tools in clinical practice [5]. In comparison, the study by Sreenivas et al. (2023) introduces a novel method, Generalised Gaussian Density (GGD) analysis, for sarcoma medical diagnosis utilizing processed bone MRI and sub-image analysis. While their approach offers potential benefits for bone tumor identification, it differs from previous studies in its focus on MRI-based analysis and unique algorithmic methodology [3]. Collectively, these studies represent significant contributions to the ongoing efforts aimed at advancing bone cancer detection and treatment strategies. By leveraging state-of-the-art machine learning techniques and interdisciplinary approaches, researchers are poised to revolutionizethe landscape of bone cancer diagnosis, ultimately improving patient outcomes and quality of life.

III. METHODOLOGY

In this study, a custom dataset comprising 400 images is utilized for bone cancer detection, meticulously curated to represent both tumor and normal bone conditions. The dataset is partitioned into training, testing, and validation sets with a ratio of 8:1:1, ensuring robust model training and evaluation. Leveraging this self-made dataset allows for tailored experimentation and validation, facilitating the exploration of variousmethodologies for accurate bone cancer classification.

A. Data augmentation

Training a deep learning model effectively becomes challenging with a limited dataset. To address this, we leverage data augmentation to artificially expand our dataset and introduce variability into the training samples. This enriches the training data with a broader and more diverse set of examples, enabling the model to learn more generalized features and perform better on unseen data.

1. Random Rotation: A critical technique for enhancing robustness to variations in orientation. With a limited dataset, maximizing training sample diversity is essential. This prevents over-fitting to specific orientations and improves model generalizability to unseen orientations.

2. Random Horizontal Flip: Random Horizontal Flip: It significantly increases the training dataset by augmenting samples with random horizontal flips. This technique provides optimization without altering their semantic content. This is particularly valuable in tumor identification as the patient positioning can vary.

3. Color Jitter: This is important in simulating variations in illumination, contrast, saturation, and hue, commonly encountered in image datasets related to medical research.This makes the model more robust and generalizes better across different imaging conditions and datasets. .

4. Random Resized Crop: Maximizes training sample diversity by randomly cropping and resizing images to a specified size. This presents the model with images containing different spatial configurations, encouraging it to learn features at multiple scales and improve object localization within the image.

5. Random Apply Gaussian Blur: Introduces noise and blur similar to real-world imaging artifacts, crucial for datasetswith limited samples. This technique prevents the model from memorizing noise or irrelevant details in the training data. Instead, the model focuses on learning robust features less sensitive to noise.

By incorporating these data augmentation techniques, we aim to overcome the limitations imposed by our dataset size and train a model that generalizes well to unseen data and diverse imaging conditions.

B. Preprocessing Pipeline

The performance of a neural network for bone cancer detection heavily relies on the quality of the input data. This section details our pre-processing pipeline designed to enhance data quality, reduce noise, and highlight features crucial for accurate analysis. Each step addresses specific challenges inherent to medical imaging datasets.

1. Grayscale Conversion:
For neural networks, fewer channels simplify processing. This reduces data complexity while preserving essential features with a single intensity channel, facilitating subsequent processing steps.

2. Noise Reduction with Controlled Variations:
Medical images can be corrupted by various noise types, hindering feature extraction. We address this by incorporating three types of noise reduction filters that introduce controlled noise variations:

- Gaussian Noise: Simulates sensor noise by adding random values sampled from a Gaussian distribution.
- Poisson Noise: Models random photon arrivals in lowlight imaging conditions.
- Speckle Noise: Simulates noise commonly found in ultrasound images.

These filters help the model learn to distinguish relevantfeatures from noise artifacts during training.

3. Data Augmentation with Medical Artifact Simulation:
Real-world medical images may contain scanner artifactsthat can affect model performance. To enhance robustness,we perform data augmentation that simulates these artifacts: Lines and Dots: These artifacts are randomly added to the image, mimicking scanner malfunctions (lines) and isolated noise (dots). By incorporating such variations, the model is exposed to a wider range of image characteristics, improving

its ability to generalize to unseen data and real-world scenarios with potential scanner imperfections.

4. Segmentation using Local and Global Thresholding: Thresholding separates objects of interest (foreground) from the background. We employ two techniques:

- Local Thresholding (Adaptive): it calculates thresholds for small image regions, adapting to variations in illumination and contrast.
- Otsu's Method: This global thresholding approach calculates an optimal threshold to separate the foreground (bones) from the background by minimizing intra-class variance.

5. Combining Binary Masks for Feature Completeness: Thresholding techniques generate binary masks highlighting regions of interest. These masks may contain complementary information. To leverage this, we combine the binary masks obtained from both methods using a logical OR operation. This ensures features identified by either method is retained in the final mask, potentially reducing false positives or negatives.

6. Watershed Segmentation for Object Separation: Segmentation aims to isolate and delineate objects of interest within an image. Watershed segmentation from scikit-image treats the grayscale image as a topographic surface. This technique identifies boundaries between objects by analyzing the gradient magnitude, effectively separating overlapping or touching objects like bones.

7. Active Contour Segmentation: While watershed segmentation provides a good initial separation, active contour (snake) segmentation refines the boundaries. This technique iteratively adjusts a deformable contour to align with the image edges, achieving a more accurate delineation of bone structures and boundaries.

8. Bilateral Blurring: Noise reduction and edge preservation are often competing goals. Bilateral blurring offers a solution. It preserves edges while smoothing the image by considering both spatial proximity and intensity similarity when averaging pixel values within a neighborhood. This technique effectively reduces noise and enhances overall image quality.

C. Custom DenseNet Architecture

Convolutional Block Attention Module (CBAM)
CBAM is a simple and effective attention module that can be integrated with any feed-forward convolutional neural network. Given an intermediate feature map, the CBAM module sequentially infers attention maps along two separate dimensions, channel and spatial. These attention maps arethen multiplied to the input feature map for adaptive feature refinement. This lightweight and general design allowsCBAM to be seamlessly integrated into any CNN architecture

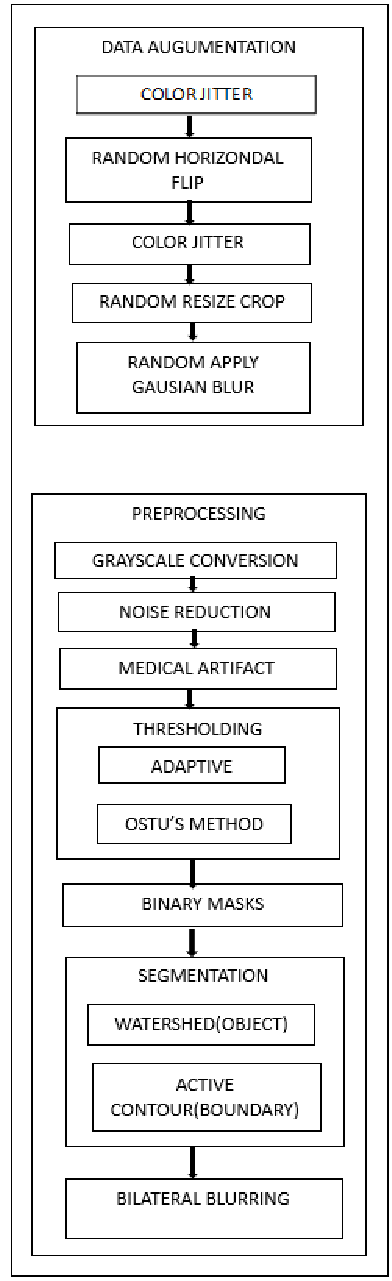

Fig. 1. The Data Preprocessing Pipeline

with negligible overheads [8].

It focuses on two key aspects:

- Channel Attention:
  This module emphasizes informative channels by learning weights for each feature channel based on their global average pooling and max pooling. These weights are then applied to the original feature maps, highlighting important channels that contribute most significantly to the classification task.
- Spatial Attention:
  This module focuses on enhancing informative spatial

locations within a feature map. It achieves this by performing a channel-wise maximum operation and applying a sigmoid activation to generate a spatial attention map. This map emphasizes important spatial regions within the feature map by assigning higher weights to those areas. The original feature map is then element-wise multiplied with this spatial attention map, effectively focusing the network's attention on these crucial regions.

DenseNet Architecture

Our custom DenseNet is a CNN specifically designed for classifying bone cancer in grayscale medical images. It follows a typical CNN structure, incorporating convolutional layers for feature extraction, pooling layers for dimensionality reduction, and fully-connected layers for classification.

- Input Layer: The network expects a single-channel grayscale image as input, reflecting the common practice in medical image analysis where color information might be less relevant compared to intensity variations.

- Convolutional Layers (conv1, conv2, conv3, conv4): These layers form the core of the network. Each convolutional layer extracts features using learnable weights. Following each convolutional layer, a **CBAM** module is inserted. This module focuses on informative channels and spatial regions within the feature maps, enhancing their representation. Activation functions (ELU or Tanh) are applied after the convolutions.

- Pooling Layers (pool, pool2): Following featureextraction and activation, pooling layers (max poolingin this case) reduce the dimensionality of the data by selecting the maximum value within local regions of the feature maps. This process helps manage computational costs and potentially improves model generalizability.

- Fully-Connected Layers (fc1, fc2): After featureextraction and dimensionality reduction, fully-connected layers take over for classification. These layers flattenthe feature maps into vectors and connect each neuron in one layer to all neurons in the next, enabling the network to learn high-level features that combine information from various image regions. The final fully-connected layer possesses two output neurons, corresponding to the two classes in the binary classification task: bone cancer and healthy bone tissue.

- Dropout Layer: A dropout layer with a probability of 0.3 is incorporated between the fully-connected layers. During training, this layer randomly drops a subset of neurons, promoting the network to learn robust features and preventing overfitting.

D. Training and testing

Training and testing are fundamental steps in the development and evaluation of deep learning models, especially in bone cancer detection. These stages encompass the processes of optimizing the model parameters andassessing model performance on unseen data, respectively, with the overarching goal of achieving accurate and reliable predictions for clinical applications.

Loss Function Definition:

The loss function selected for training the model is the Cross-Entropy Loss. This loss function is suitable for multi-class classification tasks like bone cancer detection, where each image is assigned to one of two classes: normal or cancerous. The Cross-Entropy Loss effectively measures the dissimilarity between the predicted class probabilities and the actual class labels.

Optimizer Configuration:

The optimizer chosen for updating the model parameters during training is Adam. Adam is a popular choice for optimization in deep learning due to its adaptive learning rate mechanism and momentum-based updates. The learning rateis set to 0.001, controlling the step size of parameter updates. Additionally, L2 regularization with a strength of 0.01 is applied to prevent overfitting by penalizing large parameter values.

Learning Rate Scheduler:

To enhance training stability and convergence, a learning rate scheduler is employed. This scheduler systematically adjusts the learning rate throughout the training process. Specifically, the learning rate is reduced by a factor of 0.5 every 10 epochs. This decay strategy helps the optimizer to navigate the parameter space more effectively, potentially improving the model's convergence to an optimal solution.

E. Evaluation and Comparison

The model achieved an accuracy of 0.802 when trained on non-preprocessed images. In contrast, the accuracy significantly improved to 0.913 when preprocessing was applied.

Discussion:

The substantial accuracy improvement highlights the critical role of preprocessing pipeline. Our Pre-Preprocessing techniques address challenges like noise, artifacts, and inconsistencies, leading to:

- Enhanced image clarity and standardization
- Improved feature extraction and classification
- More accurate disease detection

Without preprocessing, the model struggled with variations in image quality, hindering its ability to extract relevant features and distinguish between bone cancer and healthy tissues. This resulted in suboptimal performance (accuracy of 0.802). With preprocessing, the model provided more accurate feature extraction and classification, leading to a significant accuracy increase (0.913).

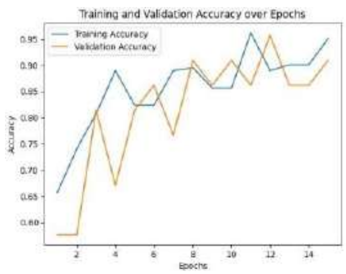

Fig. 2. The accuracy curve of the preprocessed model

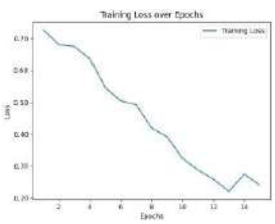

Fig. 3. The loss curve of the preprocessed model

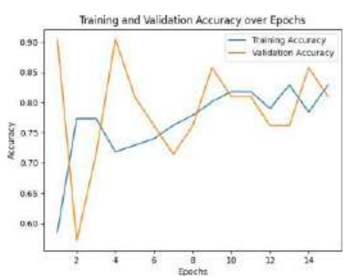

Fig. 4. The Accuracy curve of the non preprocessed model

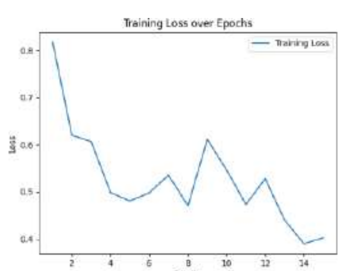

Fig. 5. The loss curve of the non preprocessed model

IV. CONCLUSION

Deep learning offers a promising avenue for non-invasive and potentially faster bone cancer detection using medical images. This research investigated the effectiveness of deep learning model for this purpose, emphasizing the critical role of preprocessing.

The model employed a custom DenseNet architecture with a CBAM attention module, facilitating efficient feature extraction for the classification of bone cancer and healthy tissues. However, the success of such models hinges on the quality of the input data. Our study highlights the crucialrole of preprocessing steps, including noise reduction, artifact removal, and contrast enhancement, in significantly improving image quality and addressing inherent challenges in medical imaging data. This meticulous data preparation process ultimately led to improved model accuracy in distinguishing between cancerous and healthy bone structures. Our findings underscore the importance of a two-pronged approach: a well-tailored deep learning architecture and meticulous data preprocessing. This combination is essential for achieving optimal performance in deep learning-based medical image analysis tasks like bone cancer detection.

Future work can explore further optimization of preprocessing techniques and delve deeper into the model architecture, potentially incorporating advanced feature extraction methods for even greater accuracy in bone cancer detection. By advancing these areas, we can contribute to a future where Deep learning models can be effectively integrated into clinical workflows, potentially leading to faster and more accurate diagnoses for improved patient care.

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Gyro and Accelerometer-based Head gesture detection for Intelligent Interfaces

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***Abstract*— This article presents an innovative approach for real-time gesture detection using Inertial Measurement Unit (IMU) sensors in conjunction with a Finite State Machine (FSM) model. Gesture recognition holds significant relevance for various fields such as human-computer interaction, virtual reality, and robotics. Unlike traditional vision-based methods, which encounter challenges in adverse conditions, our proposed system leverages IMU sensors known for their resilience and precise motion capture capabilities. The method involves designing a tailored FSM model to represent gesture sequences and facilitate seamless state transitions based on sensor data. Implementing this FSM model on embedded systems ensures real time performance, catering to scenarios where minimal delay is critical.**

To assess the effectiveness of our approach, we conduct experiments utilizing a diverse dataset encompassing various gesture types, including basic hand movements, multi-body part gestures, and dynamic gestures. Moreover, evaluating the system's robustness against noise, sensor drift, and variations in gesture speed and amplitude is performed. The results demonstrate that combining IMU sensors with the FSM model enhances gesture recognition accuracy, particularly in challenging conditions, surpassing the efficacy of vision-based methods. Through comprehensive testing and analysis, we establish the system's capability to effectively handle disruptions, highlighting its applicability in real-world environments. Detecting head gestures can be useful in wide range of applications.

It can be used in Human-Computer Interaction (HCI) systems, particularly in augmentative and alternative communication (AAC) devices for individuals with disabilities. It can be applied in automotive safety systems, where detecting driver head movements can help prevent accidents by alerting drowsy or distracted drivers.

Keywords—IMU sensor; True Wireless Stereo; Head gestures;

I. Introduction

In recent times, the incorporation of motion-sensing technologies into commonplace devices has heralded notable progressions in human-computer interaction. Amidst these developments, implementing Inertial Measurement Unit (IMU) sensors for head movement detection emerges as a promising approach, especially in True Wireless Stereo (TWS) devices. These petite and cord-free earbuds have become omnipresent companions in everyday routines, enabling uninterrupted auditory encounters. Utilizing IMU sensors integrated within TWS devices, the detection of head gestures provides an innate and effortless approach for interfacing with these devices.

True Wireless Stereo (TWS) devices have become essential companions in the dynamic world of wearable technology, providing effortless audio experiences while on the move. These small and cordless earbuds have transformed our music listening, phone calls, and interaction with digital assistants by seamlessly integrating into our everyday schedules. As the craving for intuitive user interfaces expands, there is a pressing demand to elevate the interaction paradigm of TWS devices beyond conventional touch controls or voice commands.

Utilizing Inertial Measurement Unit (IMU) sensors, the detection of head gestures offers a hopeful pathway toward accomplishing this objective. IMU sensors, encompassing accelerometers, gyroscopes, and magnetometers, have extensively been utilized for motion tracing and orientation sensing in a diverse range of applications. By harnessing the capabilities of IMU sensors, TWS devices can decipher even delicate head movements as directives, empowering users to browse through music libraries, modify audio levels, or manage incoming calls with effortless gestures.

Our research aims to investigate the practicality and effectiveness of utilizing IMU sensors in identifying fundamental head movements. Through a thorough analysis. of the sensor data acquired during these gestures, our goal is to devise a robust algorithm that can accurately interpret user intentions and translate them into actionable instructions for TWS devices.

This paper's predominant objective is to evaluate the practicality and effectiveness of utilizing IMU sensors to detect four elemental head movements: vertical, horizontal, leftward tilt, and rightward tilt. The incorporation of IMU sensors for head gesture detection in TWS devices signifies a revolutionary change in user interaction patterns, offering improved convenience and intuitiveness.

Our proposed solution's practicality and effectiveness will be showcased through rigorous experimentation and validation, paving the way for widespread adoption of head gesture detection in TWS devices. We envision a future where the effortless control of audio experiences, utilizing a simple nod, shake, or tilt, will enhance both convenience and accessibility in the realm of wearable technology.

II. GESTURE CONTROL

Head gesture control has emerged as a way to enhance human-computer interaction (HCI) in applications. By using the movements of the head this technology allows users to interact with systems without using their hands making it more intuitive and user-friendly.

At its core head gesture control relies on sensors, like accelerometers, gyroscopes, and magnetometers to track and understand head movements. These sensors pick up changes in orientation and speed which are then analyzed using signal processing methods such as filtering, normalization, and feature extraction. Machine learning algorithms are key in recognizing and categorizing gestures enabling systems to adjust to each user's movement patterns and preferences.

In the field of HCI head gesture control has a range of uses. Users can navigate through interfaces on devices manage media playback engage with augmented reality (AR) and virtual reality (VR) settings and access technology for individuals with disabilities. The hands-free aspect of head gesture control is especially valuable in situations where manual input is not practical or convenient. For example when operating devices while your hands are occupied or for users, with mobility limitations. Specific head gestures are executed by the user, providing a comprehensive framework for real-time and accurate head gesture detection in TWS devices.

Head gesture control extends its reach into various domains. In the sector, it can be incorporated into car entertainment systems to enable hand use improving driver safety and convenience. In healthcare environments, it aids professionals, in hands operation of medical equipment and accessing patient information during procedures. Moreover, in the realm of gaming and entertainment, it enhances gaming experiences by allowing players to interact with game features using natural head movements.

Head gesture control is a technology that has an impact, in different areas. Its capability to allow hands natural interaction with systems has great potential to improve accessibility, efficiency, and safety in various situations. As advancements in research and development progress head gesture control is expected to become more essential, in shaping the future of how humans interact with computers and changing the way we engage with technology.

III. IMU SENSOR

In the field of head gesture control, Inertial Measurement Unit (IMU) sensors have become a focus due, to their advantages over other methods. IMU sensors combine accelerometers, gyroscopes, and magnetometers to provide data on the position and movement of the device. Unlike cameras or depth sensors that may struggle to capture subtle head movements, IMU sensors are highly sensitive and precise. This feature allows them to detect the gestures accurately ensuring dependable and responsive gesture recognition in various settings and user scenarios.

Furthermore, IMU sensors are compact. Consume power making them ideal for integration into wearable gadgets such as headsets, smart glasses, and fitness trackers. Unlike camera-based systems that often require hardware and consume energy, IMU sensors operate efficiently with low power consumption. This efficiency does not extend the device's battery life. Also enhances user comfort during extended use. Additionally, the small size of IMU sensors improves the portability and versatility of devices allowing users to easily incorporate head gesture control into their activities without any hassle. These features establish IMU sensors as components in advancing head gesture control technology enabling comfortable interactions, in the digital domain.

A. *IMU Sensor Overview*

IMU sensors act as the foundation of motion sensing technology, encompassing sensors such as accelerometers, gyroscopes, and magnetometers. Together, they assess facets of movement, including linear acceleration, angular velocity, and orientation relative to the Earth's magnetic field. IMU sensors are essential in numerous applications due to their small size, minimal energy usage, and ability to provide instantaneous data. These applications range from aerospace piloting systems to motion tracking in virtual reality.

B. *Working of IMU Sensor*

IMU sensors work based on the concept of measurement, where they detect and measure changes, in motion using sensor components. When the device moves accelerometers, gyroscopes and magnetometers produce signals that indicate the forces and rotations affecting the sensor. These signals are then analyzed using techniques like filtering, normalization, and fusion to extract motion data. Additionally, machine learning algorithms can be used for recognizing gestures and categorizing them allowing for interactions with systems.

In terms, IMU sensors use physics principles and signal processing to capture and interpret motion. By utilizing accelerometers gyroscopes and magnetometers effectively IMU sensors provide a solution for motion-sensing applications like head gesture control. With improvements and innovations, IMU sensors drive progress, in technology and human-computer interaction fields by shaping future digital experiences across various sectors.

C. *Errors in IMU Sensor*

IMU sensors are prone to inaccuracies that can affect the precision of motion measurements. Factors such as sensor noise, bias, drift, and dynamic and environmental interferences contribute to these imperfections. Sensor noise introduces unpredictable fluctuations in recorded signals, while bias causes consistent deviations over time. Sensor drift refers to the gradual deviation of measurements from their true values due to internal deficiencies or external influences. Dynamic errors arise due to sudden changes in acceleration or angular velocity, leading to inaccurate readings.

IV. KALMAN FILTER

IMU sensors act as the foundation of motion sensing technology, encompassing sensors such as accelerometers, gyroscopes, and magnetometers. Together, they assess facets of movement, including linear acceleration, angular velocity, and orientation relative to the Earth's magnetic field. IMU sensors are essential in numerous applications due to their small size, minimal energy usage, and ability to provide instantaneous data. These applications range from aerospace piloting systems to motion tracking in virtual reality.

A. *Error Reduction in IMU Sensor Raw Data*

The implementation of a filter on the raw sensor data enables precise detection of subtle head movements while reducing sensor noise, bias, and drift. Fine-tuning the filter's parameters and integrating it with appropriate motion models enables robust and rapid detection of head gestures, ultimately enhancing the user experience.

Kalman filters effectively counteract biases found in IMU measurements by utilizing estimation and compensation mechanisms, guaranteeing consistent and precise readings over time. These filters minimize drift errors in IMU sensors by continuously refining the state estimate using fresh sensor data, lessening the effects of progressive inaccuracies. Integration of noise models allows Kalman filters to attenuate sensor noise, improving measurement accuracy, especially in dynamic settings. Kalman filters also demonstrate superior performance in dynamically mitigating errors by forecasting the system's state through its dynamics, and accommodating abrupt alterations or dynamic inaccuracies in IMU measurements, resulting in enhanced accuracy and dependability in processing sensor data.

B. *Equations*

The equations are in a generalized form and show the calculation methodology to perform the actual Kalman calculation library function needed.

The acceleration component is denoted as x_a, y_a, and z_a, and the gyro component is denoted as x_g, y_g, and z_g.

The R vector on the x,y,z axis follows the relation:

$$R^2 = R_x^2 + R_y^2 + R_z^2 \tag{1}$$

The rotation around the X-axis (φ)

$$\varphi = \tan^{-1}\left(\frac{y_a}{\sqrt{x_a^2 + z_a^2}}\right) \tag{2}$$

The rotation around the Y-axis (ρ)

$$\rho = \tan^{-1}\left(\frac{x_a}{\sqrt{y_a^2 + z_a^2}}\right) \tag{3}$$

We need gyro values to find out the Z rotational angle

$$GyroX_{rate} = gyroX / 131.0$$
$$GyroY_{rate} = -(gyroY / 131.0) \tag{4}$$

The rotational angle along with Z-axis can be defined as

$$gyro\_angle\_z = (gyroZ_{rate} \times dt) + lastZ_{angle}$$

$$kalAngleX = (accX_{angle}, gyroX_{rate})$$

$$kalAngleY = (accY_{angle}, gyroY_{rate}) \tag{5}$$

V. ALGORITHM

The algorithm for head gesture detection using IMU sensors in True Wireless Stereo (TWS) devices encompasses a systematic process to accurately identify and classify head movements. It begins with acquiring raw data from the IMU sensor embedded in the TWS device, followed by applying the Kalman filter to mitigate errors and enhance data accuracy. Subsequently, the filtered data undergoes normalization or standardization to remove errors and ensure consistency in the values relevant to gesture detection. The algorithm then calculates the pitch, yaw, and roll angles to determine the orientation of the head, generating coordinated points representing the detected gestures. The standard head gestures are modelled into a Finite State Machine (FSM) which on detection of particular state generates an interrupt of the gesture type.

A. *Gathering Data*

Use the built-in IMU sensors of the device to collect sensor information, which includes readings, from the accelerometer, gyroscope, and magnetometer. Ensure a sampling rate for the sensor data to maintain timing accuracy and ensure motion measurements. Combine data streams from axes for accurate analysis and integration of sensor readings.

B. *Data Preparation and Cleaning*

Process the raw sensor data to eliminate any noise, biases, or inconsistencies by applying techniques like filtering, standardization, and calibration. Combine information from accelerometers, gyroscopes, and magnetometers to create an overview of the position and movement of the device. Apply fusion algorithms like Kalman filters or complementary filters to merge sensor data effectively while correcting errors in individual sensor readings.

C. Find Pitch,Yaw,Roll

The pitch, yaw and roll of the system is found out by processing both normalized accelerometer and gyroscope data. Pitch is the up-and-down rotation around the lateral axis. Yaw is the side-to-side rotation around the vertical axis. Roll is the tilting movement from side to side around the longitudinal axis.

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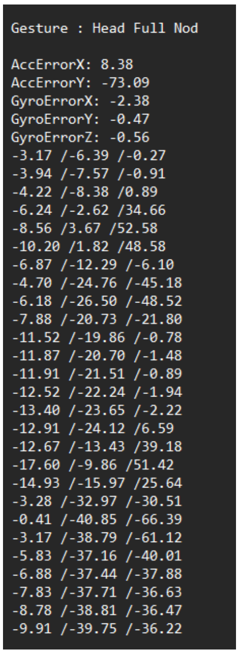

```
Gesture : Head Full Nod

AccErrorX: 8.38
AccErrorY: -73.09
GyroErrorX: -2.38
GyroErrorY: -0.47
GyroErrorZ: -0.56
-3.17 /-6.39 /-0.27
-3.94 /-7.57 /-0.91
-4.22 /-8.38 /0.89
-6.24 /-2.62 /34.66
-8.56 /3.67 /52.58
-10.20 /1.82 /48.58
-6.87 /-12.29 /-6.10
-4.70 /-24.76 /-45.18
-6.18 /-26.50 /-48.52
-7.88 /-20.73 /-21.80
-11.52 /-19.86 /-0.78
-11.87 /-20.70 /-1.48
-11.91 /-21.51 /-0.89
-12.52 /-22.24 /-1.94
-13.40 /-23.65 /-2.22
-12.91 /-24.12 /6.59
-12.67 /-13.43 /39.18
-17.60 /-9.86 /51.42
-14.93 /-15.97 /25.64
-3.28 /-32.97 /-30.51
-0.41 /-40.85 /-66.39
-3.17 /-38.79 /-61.12
-5.83 /-37.16 /-40.01
-6.88 /-37.44 /-37.88
-7.83 /-37.71 /-36.63
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-9.91 /-39.75 /-36.22
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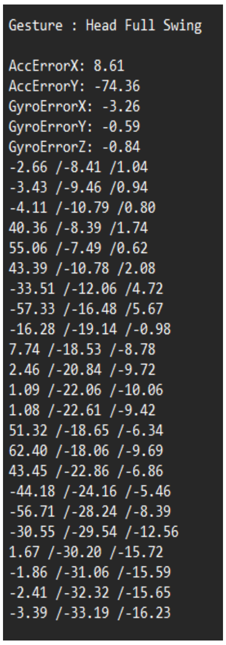

```
Gesture : Head Full Swing

AccErrorX: 8.61
AccErrorY: -74.36
GyroErrorX: -3.26
GyroErrorY: -0.59
GyroErrorZ: -0.84
-2.66 /-8.41 /1.04
-3.43 /-9.46 /0.94
-4.11 /-10.79 /0.80
40.36 /-8.39 /1.74
55.06 /-7.49 /0.62
43.39 /-10.78 /2.08
-33.51 /-12.06 /4.72
-57.33 /-16.48 /5.67
-16.28 /-19.14 /-0.98
7.74 /-18.53 /-8.78
2.46 /-20.84 /-9.72
1.09 /-22.06 /-10.06
1.08 /-22.61 /-9.42
51.32 /-18.65 /-6.34
62.40 /-18.06 /-9.69
43.45 /-22.86 /-6.86
-44.18 /-24.16 /-5.46
-56.71 /-28.24 /-8.39
-30.55 /-29.54 /-12.56
1.67 /-30.20 /-15.72
-1.86 /-31.06 /-15.59
-2.41 /-32.32 /-15.65
-3.39 /-33.19 /-16.23
```

D. Finite State machine Design

Various state of particular gesture is modelled. State variables and state functions are defined by analyzing the standard gesture libraries. In embedded applications, state variables and functions should be selected based on their relevance to system behavior and efficiency in memory and processing. Prioritize variables that capture critical system states and functions that efficiently manipulate them. Consider factors like real-time constraints, resource limitations, and modularity for maintainability. Additionally, choose variables and functions that minimize memory usage and optimize computational efficiency to meet performance requirements while ensuring reliable operation.

E. Integration and Deployment

Incorporate the detection algorithm into applications and devices that require head gesture control, such as virtual reality systems, wearable tech, or smart appliances. Ensure compatibility with software frameworks and hardware platforms, for integration and deployment. Collaborate with device makers and software developers to integrate gesture-based interactions into interfaces and applications enriching user experience and accessibility.

VI. WORKFLOW

A. Extraction of Standard Gesture Dataset

Compile a repository of cranial motions including upward, downward, lateral ward, and oblique tilts to the left and right. Ensure the dataset captures a wide range of gesture variations to capture diverse user behaviors and scenarios.

B. Derivation of Mathematical Models for Standard Libraries

Develop mathematical equations to model the standard gesture libraries based on the analyzed dataset. Create mathematical representations for each common motion, including equations for path, speed, acceleration, and orientation

C. Analysis of Raw IMU Sensor Data Using Error Correction Techniques

Apply error correction techniques to rectify errors, biases, and drift in raw data obtained from IMU sensors. Implement calibration procedures to mitigate sensor inaccuracies and ensure consistent and reliable data.

D. Extraction of Coordinate Points and Error Correction

Extract head movements in three-dimensional space by retrieving coordinate points from unprocessed IMU sensor data. Utilize error correction techniques like Kalman filtering or sensor fusion to enhance the accuracy and refinement of estimating coordinate points.

E. State Machine Design

State design starts with the identification of states and finding transitions from one state and another state. State functions are defined and final state is defined and actions are assigned based on the movement. The states are defined based on the factors that affect the state of the system and the independent variables.

F. Final Testing of Algorithm with Entire System

Enable the gesture detection algorithm to run in time, Incorporate the algorithm into the entire system, which includes IMU sensors, the Arduino microcontroller, and the user interface. Conduct thorough testing and validation of the algorithm in various conditions and user scenarios to assess its resilience and reliability. Evaluate the algorithm's performance metrics, such as accuracy, latency, and energy efficiency, to ensure compliance with desired specifications and requirements. embedded hardware or mobile devices.

VII. CONCLUSION

In our paper, we've thoroughly explored how head gestures can be detected using Inertial Measurement Unit (IMU) sensors. We combined this with data normalization and error correction methods. Implementing algorithms in the Arduino. By following a process involving extraction, analysis, mathematical modeling, algorithm creation, and final testing we've showcased the practicality and effectiveness of using IMU sensors, for hands-free interaction with digital systems.

Our study on gesture libraries supported by visualization techniques and mathematical models has given us insights into head movement dynamics. This has enabled us to derive equations that describe gestures accurately. Through analyzing IMU sensor data and applying error correction techniques like Kalman filtering we've improved gesture detection accuracy and reliability for real-world applications.

Bringing the head gesture detection algorithm to life on the Arduino is a step in translating research outcomes into real-world use. After testing and validation processes we have confirmed the algorithm's performance across metrics such as accuracy, response time, and energy efficiency. This affirms its suitability for integration, into tech gadgets, smart devices, and interactive technologies.
In summary, our study contributes to improving the way humans interact with computers by introducing a method for gesture-based interaction using IMU sensors.
By utilizing IMU sensor capabilities and incorporating error correction methods and algorithm enhancements we have created a responsive solution, for detecting head gestures. Potential future research areas may involve refining the algorithm exploring sensor technologies and investigating applications across various domains to push the boundaries of gesture-based interaction and enhance user experiences in the digital world.

By sharing our research findings in this paper we hope to encourage exploration and creativity in the realm of head gesture detection ultimately laying the groundwork, for accessibility, usability, and interaction methods in upcoming technological developments.

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We sincerely appreciate their help and teamwork. We are excited, about furthering our research projects in the days ahead.

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Integrating Arduino-Based Satellite System for Real-Time Space Parameter Monitoring

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Abstract*: Satellite, a miniature satellite concept, emerges as a promising educational tool for fostering interest andskills in space exploration among students. This abstractdelves into the design, development, and educational potential of Satellite missions, which involve the deployment of small-scale satellites contained within soda can-sized containers. Satellite missions provide students with hands-on experience in various aspects of satellite engineering, including payload integration, telemetry, and data analysis. The compact size and affordability of Satellites make them accessible toeducational institutions worldwide, facilitating participation in space-related projects and competitions.By simulating real satellite missions, satellite programs offer students a practical understanding of aerospace engineering principles and encourage interdisciplinary collaboration. Satellite missions encompass a wide rangeof scientific objectives, from atmospheric research to temperature, pressure, gas monitoring. The collected data is transmitted back to Earth through a Zigbee communication module, facilitating the seamless transfer of temperature, gas, and pressure readings from the satellite to a designated ground station. Toensure real-time accessibility and comprehensive visualization, an Internet of Things (IoT) system is implemented.

Keywords: **Arduino Uno, Zigbee, IOT**

I. INTRODUCTION

The satellites are compact in size which are designed to fit within the dimensions of a standard soda can, offer educational institutions a unique opportunity to engage students in practical hands-on experience within the field of aerospace engineering. This aims to delve into the multifaceted significance of Satellite projects, exploring their pivotal role in space exploration. Furthermore, Satellite projects offer a unique platform for students to gain practical experience in aerospace engineering. Satellite missions encompass a diverse range of capabilities, including sensor integration, data collection, and communication protocols. By incorporating sensors and instruments, satellites are capable of collecting valuable data on atmospheric conditions, environmental parameters, and other scientific phenomena. This data contributes to our understanding of Earth's systems much better. Moreover, satellite projects simulate the processes involved in larger-scale satellite deployments. Arduino, a widely-used open-source electronics platform, offers a versatile and cost-effective approach to building sophisticated monitoring systems. By leveraging Arduino's flexibility and accessibility, it becomes feasible to develop compact and efficient satellite payloads capable of collecting data on a wide range of space parameters. These parameters may include temperature, radiation levels, magnetic fields, atmospheric pressure, and more. The integration of Arduino-based systems into satellites opens up new opportunities for conducting space research and monitoring missions with increased affordability and efficiency. These systems can be tailored to specific mission requirements, allowing for customizable configurations and adaptability to various space environments.

II. LITERATURE SURVEY

"Low-Complexity Algorithm for Radio Astronomy Observation Data Transport in an Integrated NGSO Satellite Communication and Radio Astronomy System". AHMED M. MOHAMED AND HLAING MINN, 2021. An integrated non-geostationary orbit (NGSO) satellite communication and radio astronomy system (SCRAS), was recently proposed in as a new coexistence paradigm. In SCRAS, the transportation of the radio astronomical observation (RAO) data from the space to the ground stations is an important problem, for which proposed a linear programming optimization based algorithm. Reconfigurable Intelligent Surfaces Empowered THz Communication in LEO Satellite Networks". KURŞAT TEKBIYIK, (Graduate Student Member, IEEE), GUNEŞ KARABULUT KURT, (Senior Member, IEEE), ALİ RIZA EKTİ , (Senior Member, IEEE), AND HALIM YANIKOMEROGLU, (Fellow, IEEE),2021. Massive swarms of low Earth orbit (LEO) satellites are poising to serve for high-speed and low-latency ubiquitous connectivity with almost global coverage. Broadband inter-satellite communication is one of the key elements of satellite communication systems that orchestrate massive satellite swarms in cooperation. Broadband Connectivity for Handheld Devices via LEO Satellites: Is Distributed Massive". MOHAMMED Y.ABDELSADEK YEAR,2023. Significant efforts are being made to integrate satellite and terrestrial networks into a unified wireless network. One major aspect of such an integration is the use of unified user terminals (UTs), which work for both networks and can switch seamlessly between them. HST-NNC: A Novel Hybrid Satellite-Terrestrial Communication With NOMA and Network Coding Systems". MICHAIL KARAVOLOS, NIKOLAOS NOMIKOS, 2021. Hybrid satellite-terrestrial networks (HSTNs) are considered to be a promising solution in dealing with coverage and mobility challenges encountered in 5th generation (5G) networks that employ novel multiple access and connectivity schemes.Satellite Communications in the New Space Era: A Survey and Future Challenges", Oltjon Kodheli, Nicola Maturo,Bhavani Shanka, 2022.

III. PROPOSED WORK

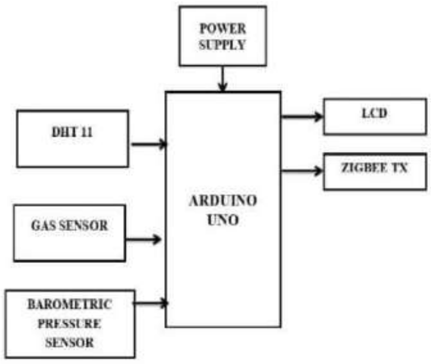
In the framework of space system parameter monitoring via a prototype satellite, our system is designed with the Arduino Uno microcontroller serving as the central processing unit. The Arduino Uno functions as the brain of our system, orchestrating the integration of various sensors to monitor critical parameters in space. For temperature monitoring, we employ the DHT11 sensor, which accurately detects the ambient temperature in the space environment. Additionally, a gas sensor is incorporated to identify and alert on abnormal gas concentrations present in space. To gauge atmospheric conditions, a barometric pressure sensor is utilized to measure the pressure values within the space environment. The collected data from these sensors is then transmitted back to Earth through a Zigbee communication module. This wireless communication technology facilitates the seamless transfer of temperature, gas, and pressure readings from the satellite to a ground station on Earth. To provide real-time accessibility and visualization of these parameters, an Internet of Things (IoT) system is implemented. The transmitted data is made available on a dedicated website, enabling stakeholders to monitor and analyze the space environment's vital statistics remotely. This comprehensive approach ensures efficient monitoring and management of space conditions through an integrated satellite system.

SENSORS	**RANGE**
GAS SENSOR	0-1025
TEMPERATURE SENSOR	0-100 C
PRESSURE SENSOR	0-2000000 Pa

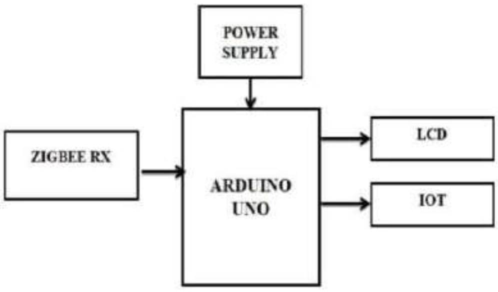
ADVANTAGES:

- Many components used in satellite projects, such as microcontrollers, sensors, and communication modules, can be reuse.
- Smaller satellites offer a more economicaloption for space exploration and research

TRANSMITTER:



RECEIVER:



IV.HARDWARE DESIGN:

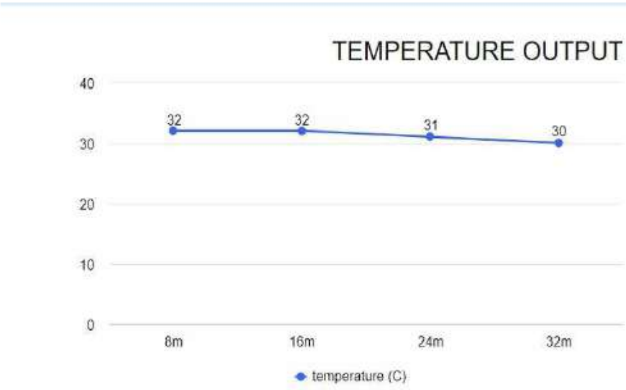
The DHT11 sensor provides precise ambient temperature detection, crucial for monitoring environmental conditions in space. The gas sensor detects abnormal gas concentrations in space, offering crucial insights into environmental safety. Integrated into the satellite, the gas sensor enhances situational awareness and facilitates timely responses to emerging threats. Pressure sensors are essential components for monitoring atmospheric conditions . Additionally, pressure sensors aid in calculating altitude and ensuring proper parachute deployment for a safe descent back to Earth. These sensors help track changes in air pressure at different altitudes, providing valuable data for analyzing flight dynamics and atmospheric profiles. The NRF24L01 module could be used for wireless communication between the satellite and a ground station. This module enables real-time data transmission from sensors onboard the satellite to the ground station for monitoring and analysis. Additionally, it can be utilized for remote control functionalities, allowing operators to send commands to the satellite during its mission. The circuit provides regulated +5V output with 100mA capacity, featuring overheating protection. It's simple, stable, and uses common components and tested successfully in electronics projects, suitable for various applications.

V.RESULTS AND OUTPUT

The result of our satellite system provides an output value based on three sensors i.e , temperature, pressure and gas sensors. The output of all the three sensor values are displayed on the website.

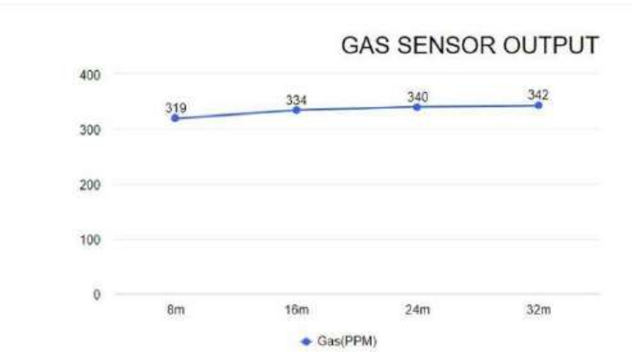
OUTPUT:

TEMPERATURE VERSUS HEIGHT



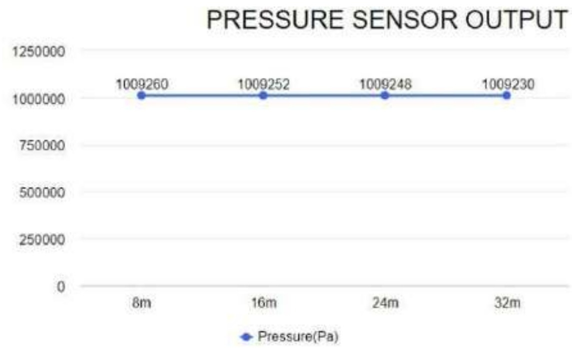
Temperature values have been noted and plotted in a graph for different heights. We can see that for each value of height the temperature changes respectively.

GAS SENSOR VS HEIGHT



Gas sensor values have been noted and plotted in a graph for different heights. We can see that for each value of height the gas sensor value changes respectively.

PRESSURE VS HEIGHT



Pressure sensor values have been noted and plotted in a graph for different heights. We can see that for each value of height the pressure changes respectively.

VI.CONCLUSION

In conclusion, our satellite project epitomizes a pivotal achievement in aerospace engineering, exemplifying the seamless integration of advanced technologies and meticulous project management methodologies. Through rigorous planning and execution, we have showcased the viability of designing and deploying a miniature satellite for scientific data collection purposes. Our project underscores the significance of interdisciplinary collaboration, systematic testing, and adherence to industry standards in achieving mission success. The invaluable insights garnered from this endeavor will inform future initiatives in space research and catalyze ongoing innovation in the realm of aerospace engineering.

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Patient's Details and Vitals Using Augmented Reality

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Abstract: The project introduces a real-time health data monitoring system customized for emergencycare in hospitals. Symptoms serve as screening tools to swiftly identify high-risk cases, directingthem to the Intensive Care Unit (ICU). Seniors receive special attention with expedited care inspections. Augmented Vision (AV) code printsand wearable sensors streamline treatment, integrating with IoT for seamless data transmission. Camera and scanner functionalities retrieve patient data, aidingquick decision-making. This innovative system optimizes resource allocation and improves patient outcomes, enhancing emergency treatment efficiency through technological advancements.

I. INTRODUCTION

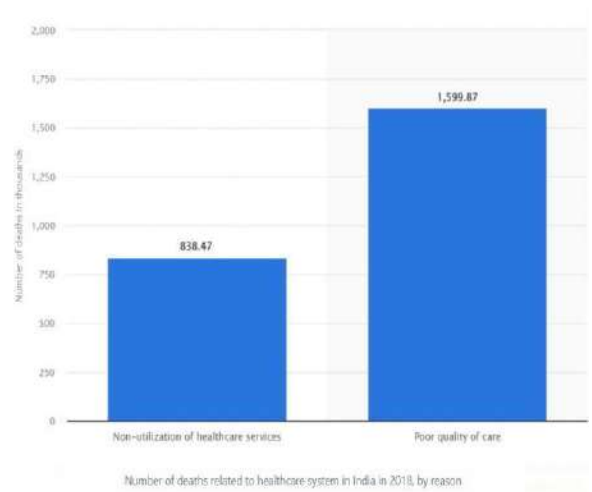
The project presents an innovative real-time health data monitoring system meticulously designed to cater to the exigencies ofemergency medical treatment in hospital settings. It employs a symptom-based screening mechanism to swiftly identify high-risk cases warranting immediate attention, ensuring timely interventions for critical conditions. Patients flagged as high- risk upon admission are promptly directed to the Intensive Care Unit (ICU) for prioritizedtreatment, with particular emphasis on the geriatric population to expedite care inspections and ensure timely interventions.

To streamline treatment processes and enhance patient care, the system incorporatesscannable Augmented Vision (AV) code prints and wearable sensors. These AV codes, coupled with sensors measuring vital signs such as Spo2, temperature, and heart rate, serve as unique patient identifiers, facilitating seamless integration with the Internet of Things (IoT) for real-time data transmission between monitoring devices and the central server. This enableshealthcare providers to monitor patients' health status in real-time, thereby expeditingdecision-making processes and optimizingresource allocation.

The system leverages camera and scannerfunctionalities to scan AV code prints,retrieving comprehensive patient vital signs and medical history. This wealth of information is presented through augmented reality interfaces, empowering healthcare providers with actionable insights for swift and informed decision-making during emergency situations. Overall, the system represents a significant leap forward in emergency care, revolutionizing traditional treatment paradigms by harnessing the powerof technology to prioritize timely interventions, enhance efficiency, and ultimately improve patient outcomes.

II. LITERATURE SURVEY

In a stark portrayal of healthcare disparities,statistics from the Civil Registration System for the year 2020 highlight a distressing reality: over 45% of reported deaths occurred in the absence of medicalassistance. The findings, as reported by The Indian Express, underscore the critical needfor improved access to healthcare services, especially in marginalized communities. Thisalarming trend reflects systemic challenges and inequalities in healthcare delivery, emphasizing the urgency for comprehensive reforms to ensure equitable access to medical care for all individuals, irrespective of socio-economic status. Addressing these issues requires concerted efforts from policymakers, healthcare providers, and civil society to bridge the gap in healthcare access and prevent avoidable deaths in the future.



Number of deaths related to healthcare system in India in 2018, by reason

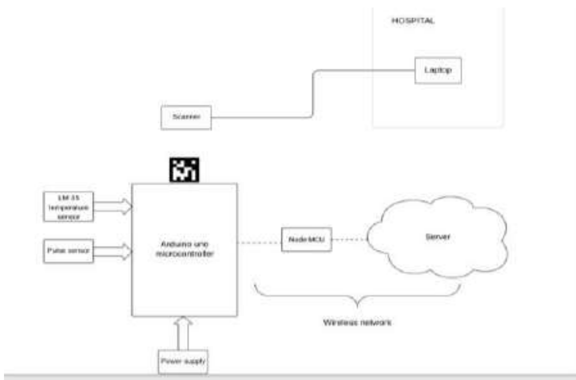
III. PROBLEM STATEMENT

In numerous hospital emergency wards, there is a dangerously high ratio of patients to doctors. For instance, if 25 patients are admitted within one hour, there may only be 3 to 5 doctors on duty. This scenario presentsa complex dilemma as there are insufficient doctors to handle a significantly large number of patients. Consequently, determining treatment priority becomes crucial, unlike scenarios where a first-come-first-serve approach suffices. Prioritization should be based on the severity of injuries and vital signs of patients.

Another issue that arises is when a patient, identified as John Doe or Jane Doe, is involved in an accident and brought to the emergency ward. Doctors may not be aware of any pre-existing medical conditions that could potentially conflict with the treatment they are administering.

Hence, the solution to the problem should focus on gathering medical records efficiently and devising a streamlined method for generating a priority list. This approach will provide doctors with a clear understanding of whom to prioritize for treatment.

WORKING MODEL



•

- **LM 35 Temperature sensor:**

LM35 is a temperature measuring device having an analog output voltage proportional to the temperature. It provides output voltage in Centigrade (Celsius). It does not require any external circuitry. The sensitivity of LM35 is 10 mV/degree Celsius.

• Pulse Sensor:

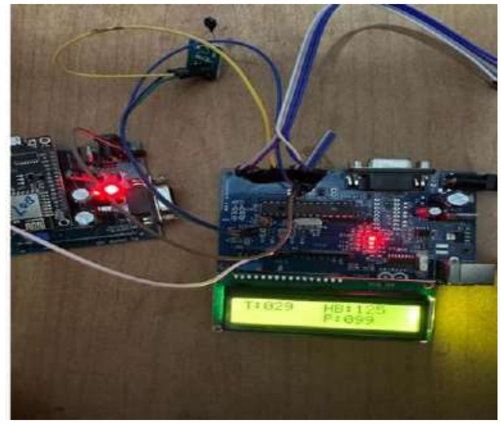
A pulse wave is the change in the volume of a blood vessel that occurs when the heart pumps blood, and a detector that monitors this volume change is called a pulse sensor.

• Arduino Uno Microcontroller:

Arduino microcontrollers are pre- programmed with a bootloader that simplifies the uploading of programs to the on-chip flash memory. The default bootloader of the Arduino Uno is the Optiboot bootloader.

• Node MCU Integration:

The Arduino communicates with the Node MCU to send sensor data. Node MCU connects to the Internet via Wi-Fi and communicates with the IoT server to fetch medical history data.



CIRCUIT MODEL

• **Medical History Retrieval:**

The IoT server provides relevant medical history information based on the patient's ID or another identifier.

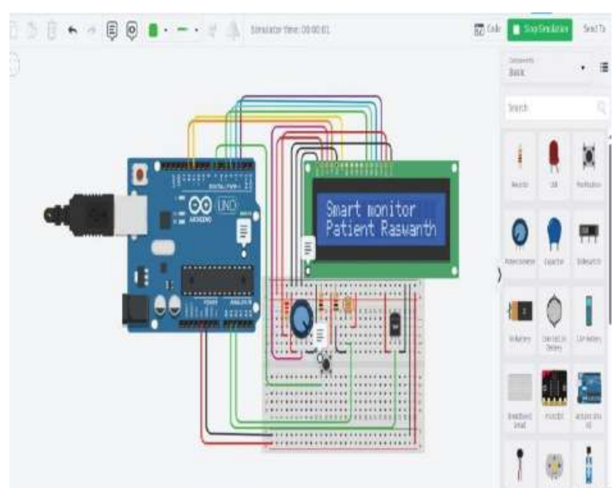
• **Augmented Vision Code Generation:**

The Arduino and Node MCU process the sensor data and medical history information to generate an augmented vision code. This code could contain a visual representation of vital signs, medical history, or other relevant information.

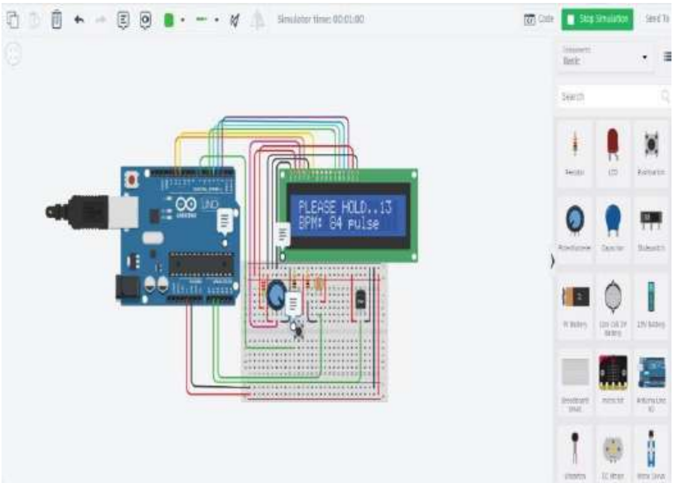
• **Code Scanning**:

The augmented vision code is presented to a software system that can interpret it. This could be a camera on a computer or a mobile device. The software system scans the code and processes the information.

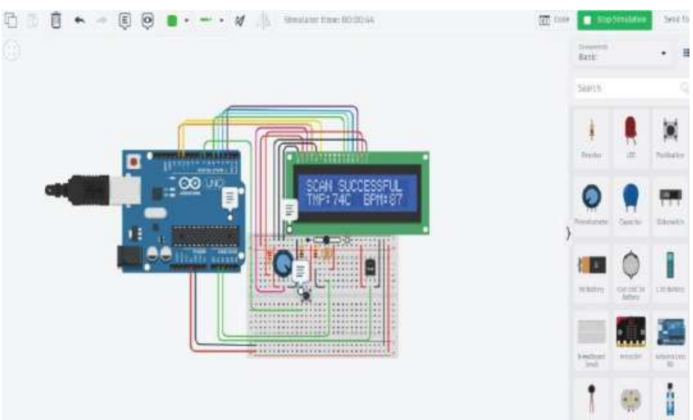
IMPLEMENTATION



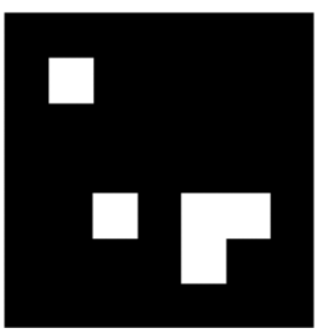
Displays the patient's details



Blood Preasure Monitor

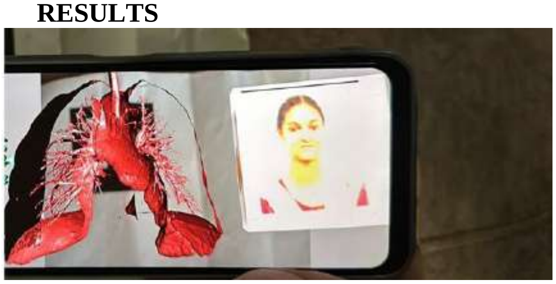


Scanned values



A V CODE

IV. RESULTS



RED IMAGE INDICATING MORE SEVERITY

GREEN IMAGE INDICATING LESS SEVERITY

V. CONCLUSION

The Digital Twin (DT) based real-time vision system for health tracking and control holds significant promise in revolutionizing healthcare delivery. Leveraging technologies like computer vision, IoT, AI, and data analytics, it enables accurate monitoring, early disease detection, personalized interventions, and remote patient management. Future enhancements may include integration with wearable and implantable devices, AR/VR applications, AI-driven predictive analytics, blockchain for data security, and interoperability with EHR systems. Additionally, it offers potential for remote surgical assistance, telemedicine consultations, chronic condition monitoring, and population health management, promising to improve access to healthcare, enhance patient outcomes, and drive innovation in personalized medicine and public health.

VI. FUTURE SCOPE

Integration with Wearable and Implantable Devices: Expanding the system to integrate with a wider range of devices enables comprehensive health monitoring.
Augmented Reality (AR) and Virtual Reality (VR) Applications: Incorporating AR and VR enhances user experience and facilitates immersive training in healthcare.
AI-driven Predictive Analytics: Advancements in AI and ML algorithms enable accurate prediction of disease risk and personalized interventions.
Remote Surgical Assistance and Telemedicine: Supporting remote assistance improves access to specialized healthcare services and enhances patient care outcomes.
Blockchain Integration for Data Security: Blockchain enhances data security and privacy while ensuring secure sharing of health records.
Population Health Management: Aggregating and analyzing health data enables targeted interventions and public health initiatives.
Remote Monitoring of Chronic Conditions: Enhancing remote monitoring empowers patients to manage chronic conditions effectively.
Interoperability with EHR Systems: Seamless integration with EHR systems facilitates real- time health data incorporation into patients' medical records.

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We express our sincere appreciation to Dr. S. Ganesh Vaidyanathan, Ph.D., Principal of Sri Venkateswara College of Engineering, for his enduring inspiration. Grateful acknowledgments to Dr. G A Sathish Kumar, M.E., Ph.D., Department Head of Electronics and Communication Engineering, for his invaluable mentorship. We also extend our thanks to Ms.S..Kalyani .

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Decrypting theft suspects in low-resolution snapshots

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***Abstract*—This paper introduces a novel people tracking system for enhancing public safety by enabling real-time detection and tracking of individuals in critical public areas. Leveraging YOLO for rapid object detection and DeepSORT for robust person tracking, the system employs surveillance cameras for continuous monitoring. Through seamless data exchange among cameras, anomalies and potential threats are swiftly identified, bolstering security measures. Additionally, the system alerts nearby police stations upon detecting listed suspects, enabling rapid response. Movement trajectories are plotted on maps for simplified identification and apprehension. The paper also discusses utilizing Siemens Neural Network for face recognition. Overall, the project aims to support law enforcement agencies in efficiently tracking suspects and improving public safety.**

Keywords— YOLO, DeepSORT, Siemens Neural Network, Suspect tracking, Real-time monitoring, Face recognition, Surveillance cameras, Police alerts

I. INTRODUCTION

In today's security-conscious environment, the integration of advanced technologies into surveillance systems presents significant potential for enhancing public safety. This report introduces an innovative approach that leverages state-of-the-art deep learning algorithms, notably YOLO for real-time object detection and DeepSORT for robust person tracking. By strategically deploying surveillance cameras in critical public areas, our system aims to seamlessly detect and track individuals across different locations, enabling continuous monitoring.

The primary objective of our project is to harness the combined capabilities of YOLO and DeepSORT to identify anomalies and potential threats in real-time, thus contributing to the enhancement of public safety. Going beyond conventional surveillance, our system focuses on tracking suspects by issuing alerts to nearby authorities and plotting their movements on maps for swift identification. Ultimately, our goal is to support law enforcement agencies in efficiently tracking suspects and strengthening overall public safety measures.

Additionally, this report discusses the integration of Siemens Neural Network for face recognition within our system, enhancing its capabilities in identifying individuals of interest. Through this paper, we provide detailed insights into the technical aspects of our proposed people tracking system, including its architecture, algorithmic frameworks, implementation strategies, and empirical results. Our aim is to contribute to the advancement of research and development in surveillance systems and security technologies.

II. LITERATURE SURVEY

One-shot image recognition is a type of computer vision task where the goal is to recognize or classify objects or scenes based on a single example or instance of each class. In traditional image recognition tasks, algorithms are trained on large datasets with many examples of each class to learn features and patterns associated with different objects or categories. However, in one-shot image recognition, the challenge is to recognize new objects or categories with only one example provided for each.

In Siamese Neural Networks for One-shot Image Recognition the authors **Gregory Koch**,**Richard Zeme**l,**Ruslan Salakhutdinov** introduce the concept of siamese neural networks, originally proposed by Bromley and LeCun in the early 1990s, which consist of twin networks joined by an energy function to compute a similarity metric between inputs. They use convolutional siamese networks, leveraging the power of convolutional neural networks (CNNs) in capturing spatial features from images.

Siamese Neural Network (SNN): It is characterized by its architecture comprising two identical neural network branches, often termed as twins, which share the same parameters learned jointly during training. This weight sharing enables the network to extract features from input data, typically through convolutional and pooling layers, to construct high-dimensional representations. The essence of SNN lies in its ability to learn a similarity metric between pairs of input samples, achieved through distance metric learning techniques such as Euclidean distance or contrastive loss. By leveraging shared weights and feature extraction, SNNs effectively compute the similarity between inputs, making them well-suited for tasks like image recognition, verification, and matching.

Several prior works in the field of one-shot learning are referenced, including Fei-Fei et al.'s variational Bayesian framework and Lake et al.'s Hierarchical Bayesian Program Learning (HBPL). These approaches highlight the importance of leveraging prior knowledge or generative models to facilitate one-shot learning.Experimental results on the Omniglot dataset demonstrate the effectiveness of the proposed approach, with convolutional siamese networks achieving near state-of-the-art performance in one-shot image classification tasks. The method outperforms several baseline models, including traditional machine learning algorithms and non-convolutional siamese networks.The paper also discusses the implications of the approach and its potential for generalization to other domains beyond image classification. It concludes by highlighting ongoing efforts to enhance the algorithm, such as incorporating stroke-level distortions to improve feature learning.

Object tracking is a fundamental task in computer vision that involves following the movement of objects over consecutive frames in a video or image sequence. Traditional object tracking methods often rely on techniques such as motion estimation, feature matching, and model-based tracking to maintain the identity of objects across frames. However, these methods can be computationally expensive and prone to drifting or loss of track in complex scenes.

Kim and Won's work on drone detection using YOLO-V8 is significant due to its emphasis on efficiency, adaptability, and robustness. By leveraging the capabilities of YOLO-V8, their system achieves real-time detection of drones in various environmental conditions. Their approach likely involves integrating YOLO-V8 with other technologies, such as sensors and communication systems, to enhance detection accuracy and reliability. Through rigorous evaluation metrics and real-world applications, Kim and Won demonstrate the effectiveness of their system in addressing security and safety concerns posed by drones. Additionally, their work likely provides insights into future research directions for further improving drone detection systems using advanced algorithms and sensor integration.

YOLO (You Only Look Once) offers a novel approach to object detection that enhances object tracking capabilities. By providing real-time and accurate detection of objects in each frame of a video, YOLO serves as a reliable source of object localization information. This information can then be integrated into object tracking systems to initialize object tracks, associate detections across frames, and refine the tracking trajectory.

YOLO-V8 stands out in the realm of object detection for its unparalleled efficiency, adaptability, and robustness. Leveraging a single neural network to predict bounding boxes and class probabilities concurrently, YOLO-V8 achieves remarkable speed without compromising accuracy, making it ideal for real-time applications like drone detection. Its architecture enables seamless integration with various hardware platforms, ensuring optimal performance across different computational resources. Furthermore, YOLO-V8's robustness against variations in lighting, weather conditions, and background clutter enhances its reliability in diverse environments. Its versatility allows for easy customization and fine-tuning for specific object detection tasks, empowering researchers and developers to address a wide range of challenges. With its widespread adoption and continuous refinement, YOLO-V8 continues to push the boundaries of object detection technology, promising even greater advancements in the future.

"GSM-Based Automobile Ignition Stopping and GPS Tracking with Thief Image Capturing" by **Ortiz,Calicdan,Oña and Torres** discuss the implementation of GPS tracking as a crucial component of their system.They used GPS for real-time location monitoring, tracking stolen vehicles, and integrating GPS data with other security measures.

GPS tracking, integral to modern surveillance and security systems, provides precise geographical coordinates of objects or individuals under surveillance. Ortiz et al.'s utilization of GPS serves multiple purposes within their system architecture. Firstly, it enables real-time monitoring of the vehicle's location, facilitating immediate response and recovery efforts in the event of theft. Secondly, by logging the GPS coordinates of the stolen vehicle, authorities can accurately track its movement, aiding in its retrieval and apprehension of the thief.Based on the insights from the referenced paper, our project aims to leverage GPS technology to plot the locations of surveillance cameras on a map. Additionally, it seeks to visualize the direction of movement of the thief by drawing lines connecting the locations where the thief is detected. This map, dynamically updated in real-time, serves as a valuable tool for law enforcement agencies by providing them with actionable insights into the whereabouts and trajectory of the thief. Ultimately, the goal is to enhance the efficiency and effectiveness of theft prevention and recovery efforts, enabling prompt response and apprehension of perpetrators.

III. PROPOSED SYSTEM

The proposed system builds upon the existing framework by introducing several enhancements aimed at further improving public safety and operational efficiency.

A. Enhanced Object Detection and Tracking:

In the proposed system, we aim to explore advanced object detection and tracking algorithms to improve the accuracy and reliability of the system. This may involve incorporating deep learning techniques for object recognition and trajectory prediction.The system leverages YOLO (You Only Look Once) for rapid object detection and DeepSORT for robust person tracking. YOLO enables efficient detection of objects within surveillance camera feeds, while DeepSORT maintains the identity of individuals across frames, facilitating continuous tracking.We have formed a adapter which make specific modification to the code to effectively use the DeepSORT and YOLO only for person detection to achieve maximum efficiency

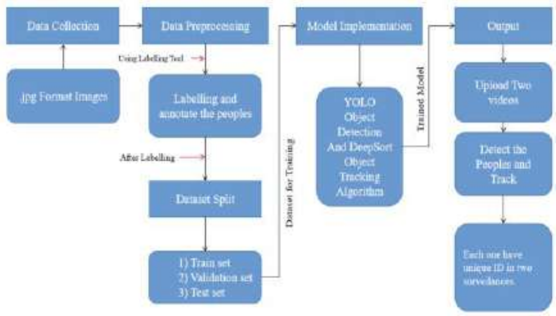

Fig. 1. Architecture of Object Detection

B. Image Preprocessing :

Resizing the Image:

The primary objective of resizing the image is to standardize its dimensions to 100x100 pixels, facilitating uniform processing across different datasets or applications. This step is crucial for ensuring consistency in image representation and downstream analysis. To achieve this, the image is read using a suitable library such as OpenCV, and then resized to the desired dimensions utilizing a resizing function.

Normalization of RGB Values:

Normalization of RGB values involves converting the pixel intensity values from the original range of 0-255 to a normalized range of 0-1. Additionally, a thresholding mechanism is applied, where pixel values greater than 0.5 are set to 1, and those below 0.5 are set to 0. This normalization process enhances the numerical stability of the data and ensures that pixel values are uniformly distributed within a standardized range.

Implementation Steps:

1.Read the image using a suitable library like OpenCV to ensure compatibility and ease of processing.

2.Resize the image to the desired dimensions (100x100 pixels) using a resizing function, maintaining aspect ratio if required.

3.Convert the resized image to a floating-point format to enable arithmetic operations necessary for normalization.

4.Normalize each RGB value by dividing it by 255, thereby scaling the values to the range 0-1.

5.Implement thresholding by setting pixel values greater than 0.5 to 1 and those below 0.5 to 0, ensuring binary representation of pixel intensities.

6.Iterate through all pixels in the image, applying the normalization and thresholding operations consistently to each pixel.

By following these implementation steps, the resizing and normalization of the image are performed systematically, resulting in a standardized representation suitable for subsequent processing tasks such as machine learning, image analysis, or computer vision applications.

C. Face Recognition :

Siemens Neural Network is employed for face recognition, enabling the system to accurately identify individuals of interest within the surveillance footage. After finding the person's frame using YOLO and DeepSORT we confirm whether the identified person is the suspect or not with the help of our custom trained Siemens Neural Network which is trained for facial recognition.

State-of-the-art models often incorporate a series of convolutional layers followed by fully-connected layers and a top-level energy function. Convolutional neural networks have demonstrated remarkable efficacy across various large-scale computer vision tasks, notably excelling in image recognition endeavors.

Convolutional networks are particularly attractive due to several factors. One such factor is local connectivity, which effectively reduces the number of parameters in the model. This reduction inherently incorporates a form of built-in regularization. However, it's worth noting that convolutional layers tend to be computationally more intensive compared to standard nonlinearities.

Nevertheless, the convolution operation employed in these networks holds a direct filtering interpretation. In this interpretation, each feature map undergoes convolution against input features to identify patterns, effectively grouping pixels. Consequently, the outputs of each convolutional layer correspond to significant spatial features within the original input space, offering some resilience to basic transformations. The main reason why we have this siemens neural network is due to its fast feature of one short image recognition for faster identification of thief in real time so he can be caught easily.

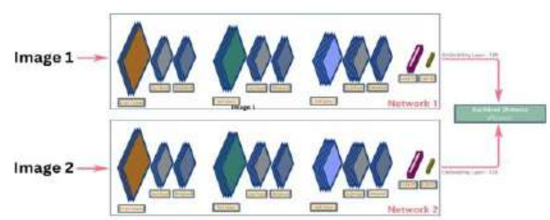

Fig. 2. Architecture of a Siamese Network.

Model Performance:

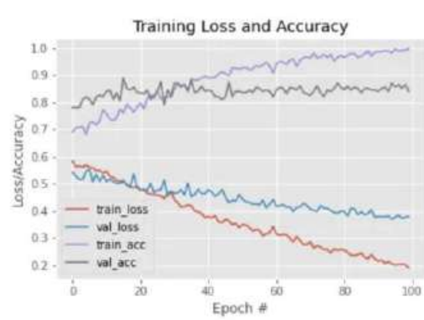

Fig. 3. Training Loss and Accuracy Plot

The presented graph illustrates the progression of model accuracy and loss throughout the training and validation phases. Over the course of 100 iterations, the validation loss demonstrates a consistent decline, peaking at approximately 80 iterations before plateauing. Concurrently, there is a lack of substantial improvement in validation accuracy beyond the initial iterations. Despite these observations, the final model obtained exhibits satisfactory performance, indicating promising outcomes.

One Short Comparison:

One-shot classification, also known as one-shot learning, is a machine learning paradigm aimed at training models to accurately classify or recognize objects based on just a single example or a very limited number of examples per class. Unlike traditional classification tasks that require large amounts of labeled training data, one-shot classification focuses on learning discriminative features or similarities between classes from a small number of instances. This approach is particularly useful in scenarios where acquiring labeled data is costly or impractical. One-shot classification methods often employ techniques such as siamese networks, metric learning, or transfer learning to generalize from a few examples to accurately classify unseen instances. By enabling models to make accurate predictions with minimal training data, one-shot classification holds significant promise for applications in domains such as image recognition, speech recognition, and natural language processing.

Suspect Detection and Alerts:

The suspect detection and alert system integrated into our framework operates with remarkable efficiency to identify listed suspects in real-time. Through continuous analysis of video feeds from surveillance cameras strategically positioned in critical public areas, the system employs sophisticated algorithms and machine learning techniques to detect individuals matching the description of suspects on watchlists. Once a suspect is identified, an automatic alert mechanism is activated, swiftly notifying nearby police stations or law enforcement agencies. This rapid dissemination of information empowers authorities to initiate prompt responses, enhancing their ability to apprehend suspects and maintain public safety.

Upon receiving alerts, law enforcement personnel can access detailed descriptions of the detected suspects, including physical attributes and any associated risk factors or criminal records. Armed with this vital information, authorities can swiftly assess the situation and implement appropriate response measures. Additionally, the system's logging capabilities capture all suspect detections and alerts, providing valuable data for post-incident analysis and law enforcement investigations. By documenting each instance of suspect detection, authorities can identify patterns, track suspect movements, and compile evidence essential for legal proceedings. Ultimately, the suspect detection and alert system serves as a pivotal component in bolstering security measures and mitigating risks in critical public areas, contributing significantly to the overall safety and well-being of communities.

Movement Trajectory Mapping:

In our system, movement trajectory mapping plays a crucial role in enhancing the effectiveness of law enforcement efforts. As individuals are detected by the surveillance system, their movement trajectories are meticulously tracked and plotted onto maps. This visual representation offers a comprehensive overview of the movements and behaviors of individuals within monitored areas. By observing these trajectories, law enforcement personnel gain valuable insights into the spatial patterns and interactions of individuals, facilitating the identification of suspicious behavior or anomalous activities.

Moreover, movement trajectory mapping serves as a powerful tool for simplifying the identification and apprehension of suspects. By overlaying the trajectories of detected individuals onto geographical maps, law enforcement personnel can quickly discern any deviations from normal behavior or movement patterns. This aids in the swift identification of suspects and allows for targeted intervention strategies to be deployed in real-time. Additionally, the visualization of movement trajectories enables law enforcement agencies to coordinate their efforts more effectively, optimizing resources and response times.

IV. Applications

Retail Loss Prevention:

The implementation of facial recognition systems in retail environments presents a robust solution for identifying known shoplifters or individuals with a history of fraudulent behavior. Integration with existing security camera systems allows for real-time flagging of suspicious individuals, empowering store staff to promptly take preventive measures and mitigate retail losses.

Access Control and Security:

Facial recognition systems deployed in high-security areas such as airports, government buildings, or corporate offices significantly enhance access control measures. By automating the identification process, these systems effectively identify unauthorized individuals attempting to gain access to restricted areas, thereby bolstering overall security protocols and preventing potential security breaches.

Education Campus Safety:

The deployment of facial recognition systems in educational institutions serves as a proactive measure to monitor campuses for individuals with a history of violent behavior or criminal activity. Early detection and alerting mechanisms provided by these systems enhance student and staff safety, fostering a conducive and secure learning environment.

Public Transportation Security:

Integration of facial recognition systems into public transportation systems plays a pivotal role in enhancing security measures. By identifying individuals on watchlists or with outstanding warrants, authorities can proactively mitigate potential security risks and ensure the safety of passengers. This proactive approach contributes to maintaining public transportation security and safeguarding the well-being of commuters.

Efficient Registration and Check-In:

Facial recognition technology enables swift and hassle-free registration and check-in processes for visitors. Upon arrival, visitors' faces are scanned, and their identities are verified against pre-registered information or databases. This eliminates the need for manual registration and reduces wait times, enhancing the overall visitor experience.

Improved Visitor Tracking and Management:

Facial recognition technology enables facilities to track and manage visitor movements effectively. Real-time monitoring of visitor traffic allows for better resource allocation and crowd management. Additionally, detailed visitor logs and records provide valuable insights for security audits and investigations.

Retail Loss Prevention:

Surveillance cameras monitor customer movements, triggering automatic alerts for suspicious behavior like concealing items or attempting theft. Staff receive instant notifications to intervene and prevent theft incidents, aided by the system's ability to track individuals' movement trajectories.

V. RESULTS AND DISCUSSION

The implementation of facial recognition systems and object tracking has gained significant importance in safety and security applications. Traditional methods of surveillance and criminal identification are often time consuming and rely heavily on human intervention. This system overcomes the drawbacks of identifying the criminal in the traditional way and provides an advanced and automated system to quickly and match individuals in real-time against a comprehensive criminal database and track them. This section provides a comparison of the results from existing literature and a proposed model for facial recognition system and object tracking ,highlighting the key methodologies and performance metrics used. Additionally, it discusses the superior performance of the proposed model.

A. Existing literature and limitation

"High-Speed Drone Detection Based On Yolo-V8" by J.-H. Kim, N. Kim, and C. S. Won:

The paper proposes a method for high-speed drone detection based on YOLO-V8, which is likely an enhancement or variation of the YOLO (You Only Look Once) object detection algorithm. It seems to address the growing need for drone detection in various applications, including security and privacy.

"Vehicle Detection and Tracking using YOLO and DeepSORT" by Zuraimi, M. A. B., & Zaman, F. H. K.:

This paper focuses on vehicle detection and tracking using a combination of YOLO (You Only Look Once) and DeepSORT (Deep Simple Online and Realtime Tracking) algorithms. It likely builds upon existing research in object detection and tracking, with a specific application to vehicles.

"A Sport Athlete Object Tracking based on DeepSORT and YOLO V4 in case of Camera Movement" by Zhang, Y., Chen, Z., & Wei, B.

This paper addresses the challenge of object tracking in sports scenarios using DeepSORT and YOLO V4 (You Only Look Once version 4) algorithms. It likely contributes to the field of computer vision by providing solutions for tracking fast-moving objects in dynamic environments.

"Object Tracking and Counting in a Zone using YOLO v4, DeepSORT, and TensorFlow" by Kumar, S., Sharma, P., & Pal, N.:

This paper focuses on object tracking and counting within a specified zone using YOLO v4, DeepSORT, and TensorFlow. It likely contributes to research on surveillance and monitoring systems by providing methods for accurately tracking and counting objects of interest.

"GSM-Based Automobile Ignition Stopping and GPS Tracking with Thief Image Capturing" by K. J. P. Ortiz, M. N. T. Calicdan, R. P. Oña, and R. F. H. Torres:

This paper presents a system for GSM-based automobile ignition stopping and GPS tracking with thief image capturing. It addresses the issue of vehicle theft by integrating GSM-based control, GPS tracking, and image capturing functionalities.

Table 1 Comparison of Literature and Proposed Model for decrypting thief suspect in low resolution snapshots.

Study	Title	Methodology	Limitation
Zuraimi, M. A. B., & Zaman, F. H. K. (2021)	Vehicle detection and tracking using YOLO and DeepSORT	The study aims to create a system for real-time tracking of vehicles. It uses YOLO for object detection and DeepSORT for tracking.	The performance of the system reduces when the image is blurry or not clear, impacting the accuracy of object detection and tracking.
Zhang, Y., Chen, Z., & Wei, B. (2020)	A sport athlete object tracking based on deep sort and YOLO V4 in case of camera movement	This study focuses on tracking sport athletes in scenarios involving camera movements. It employs DeepSORT in conjunction with YOLO V4 for object detection and tracking.	The performance of the tracking system degrades when applied to low-resolution snapshots, affecting the accuracy of object tracking, especially in cases of reduced visibility or clarity.
Kumar, S., Sharma, P., & Pal, N. (2021)	Simple Online and Realtime Tracking with a Deep Association Metric	The study aims to track and count objects within a specified zone using YOLO v4, DeepSORT, and TensorFlow.	The performance of the tracking system may be affected in low-resolution snapshots, leading to inaccuracies in object detection and counting.
J. -H. Kim, N. Kim and C. S. Won	ICASSP 2023 - 2023 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)	It uses YOLO-V8 for tracking	The accuracy and robustness of the detection algorithm in real-world scenarios could be a concern.
K. J. P. Ortiz, M. N. T. Calicdan, R. P. Oña, and R. F. H. Torres	2019 2nd World Symposium on Communication Engineering (WSCE), Nagoya, Japana	GSM-based automobile ignition stopping, GPS tracking, thief image capturing	The accuracy and timeliness of GPS tracking for real-time vehicle monitoring be a concern
Proposed system	Decrypting thief suspect in low resolution snapshots	We use yolo , Siamese model along with gps for image plotting	If no camera is present in the given area of surveillance

B. Overcoming Limitations with our Proposed Model

While traditional surveillance systems have made significant strides in enhancing public safety, they often face limitations in terms of accuracy, efficiency, and adaptability. Our proposed model aims to overcome these limitations by leveraging state-of-the-art deep learning algorithms and innovative system architecture.

Enhanced Accuracy through Deep Learning:

Traditional surveillance systems may struggle with accurately detecting and tracking individuals, especially in complex environments with occlusions or varying lighting conditions. By integrating deep learning algorithms such as YOLO and DeepSORT, our proposed model achieves enhanced accuracy in real-time object detection and person tracking, ensuring reliable monitoring and identification of potential threats.

Efficiency and Real-Time Response:

One of the key challenges in traditional surveillance systems is the delay in processing and response time, which can impact the effectiveness of security measures. Our model addresses this challenge by leveraging YOLO's real-time object detection capabilities, enabling swift identification of individuals and potential threats. Additionally, DeepSORT's online tracking algorithm facilitates continuous monitoring and tracking in real-time, ensuring timely intervention and response to security incidents.

Adaptability to Dynamic Environments:

Traditional surveillance systems may struggle to adapt to dynamic environments with changing conditions or unexpected events. Our proposed model addresses this challenge through its seamless integration of YOLO and DeepSORT, which are capable of robust object detection and person tracking across diverse environmental conditions. The model's ability to transfer tracking data between cameras enables continuous monitoring and tracking of individuals, regardless of their movement across different locations.

Scalability and Comprehensive Coverage:

As public safety concerns evolve and security needs grow, traditional surveillance systems may face challenges in scalability and comprehensive coverage. Our proposed model offers scalability through its modular architecture, allowing for the seamless integration of additional surveillance cameras and sensors as needed. By strategically placing surveillance cameras in key public areas, the model ensures comprehensive coverage and monitoring of potential security threats.

VI. FUTURE SCOPE

Technological Advancements: Future advancements in deep learning, computer vision, and neural network technologies may lead to improvements in object detection, person tracking, and facial recognition algorithms. This could enhance the accuracy, speed, and efficiency of the system.

Expansion of Use Cases: The system's capabilities could be expanded to address a broader range of use cases beyond public safety, such as personalized marketing, access control, and customer analytics. This would increase the system's versatility and potential applications across various industries.

Regulatory and Ethical Considerations: As facial recognition technology continues to evolve, there will be increased scrutiny and regulations surrounding privacy, data protection, and ethical use. Adhering to regulatory requirements and implementing ethical practices will be essential for the project's long-term viability and acceptance.

User Feedback and Iterative Development: Gathering feedback from users, stakeholders, and end-users will be crucial for identifying areas for improvement and refining the system's functionality. Adopting an iterative development approach based on user feedback will ensure that the project remains relevant and aligned with evolving needs and expectations.

VII. CONCLUSION

In conclusion, the fusion of state-of-the-art deep learning algorithms, including YOLO for real-time object detection, DeepSORT for robust person tracking, and Siemens Neural Network for face recognition, represents a transformative step forward in augmenting public safety through the development of an advanced people tracking system. This amalgamation of cutting-edge technologies has enabled the creation of a sophisticated surveillance infrastructure capable of continuous monitoring and swift anomaly detection in critical public areas. Leveraging YOLO's capabilities, our system achieves rapid and accurate object detection, enabling the real-time identification of various entities and potential threats. DeepSORT complements this by ensuring resilient person tracking, maintaining identity consistency across frames even in challenging environments. Furthermore, the integration of Siemens Neural Network for face recognition elevates the system's precision, facilitating the precise identification of individuals of interest and enhancing overall situational awareness.

By seamlessly exchanging data among surveillance cameras and triggering automatic alerts upon suspect detection, our system empowers security personnel with timely information, enabling proactive measures to be taken swiftly. This collaborative approach between advanced algorithms and real-time monitoring capabilities fortifies security measures and contributes to the creation of a safer environment for citizens. As we look to the future, further research and refinement of our people tracking system hold significant promise in addressing emerging security challenges and advancing the efficacy of surveillance systems worldwide. Through ongoing innovation and technological advancements, we anticipate continued enhancements in public safety infrastructure, ultimately leading to safer communities and enhanced societal well-being.

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Cardless and secure ATM cash withdrawal for rural areas

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Abstract*—A significant change in ATM transactions is imminent, ready to address the various problems found in traditional card-based systems. Relying on physical cards puts users at risk of theft and losing their cards, which is made worse by having to manage multiple cards. Introducing the innovative solution: a cardless ATM transaction process. Here, users verify themselves effortlessly using their unique fingerprint, removing the need for easily lost physical cards. This verification involves carefully comparing fingerprints with previously registered data, ensuring strict security measures. After successful verification, users see their bank accounts, each accessible only with a specific PIN. Advanced encryption techniques, like the AES algorithm, make this process much more secure. Connection between the user's verification device and the ATM is established easily using Zigbee, avoiding the need for internet connection. Once the PIN is entered correctly, users can freely conduct transactions, like withdrawing or depositing funds. Notably, the system allows for guest users to be designated and given transaction authorization, ensuring transactions are securely approved even when the original user isn't present, which increases peace of mind. Implementing this ground-breaking project in the real world promises to change ATM transactions significantly, improving security and convenience. Additionally, its independence from internet connection makes it suitable for areas with poor connectivity or harsh conditions, highlighting its accessibility and adaptability. In summary, this innovative system marks a new era for ATM transactions, offering increased security and convenience, ready to redefine financial transactions.

***Keywords*—Cardless, ATM, biometry, authentication, AES encryption, SHA-256, Zigbee.**

I. INTRODUCTION

The advent of digital technology has revolutionized banking and financial services, leading to innovations in secure and convenient transaction methods. In this paper, we present an innovative solution for cardless ATM cash withdrawal using biometric authentication. Our system leverages a fingerprint sensor for user identification, ensuring a seamless and secure experience. We explore two distinct modes of operation: fingerprint-based authentication and a friend option that utilizes a temporary PIN. Additionally, we address the security challenges associated with PIN transmission by employing cryptographic techniques. Our approach eliminates the need for physical cards and enhances user convenience while maintaining robust security.

II. SYSTEM ARCHITECTURE

Our system comprises the following components:

A. Fingerprint Sensor

The user interacts with the ATM application through a fingerprint sensor. Upon placing their finger on the sensor, the system captures and verifies the fingerprint against stored templates.

Fig. 2.1 Fingerprint Sensor

B. Zigbee Transmitter and Receiver

The hardware aspect of the system is connected to the software application through Zigbee. The Zigbee transmitter connected to the microcontroller transmits the fingerprint id to the receiver, which is connected to the device running the software application.

C. Buzzer and LED

The buzzer and LED are used to indicate the user if they are properly authenticated or not. The green LED glows when the fingerprint matches while the red LED glows and the buzzer rings when the fingerprint doesn't match.

D. LCD and Push Buttons

The LCD guides the user to operate the hardware by giving instructions for using the fingerprint sensor. The push buttons allow the user to enrol, verify or delete their fingerprint in the hardware.

E. User Interface

The ATM application provides a user-friendly interface for transaction management. Users can select their preferred bank, choose between deposit and withdrawal, and enter transaction details.

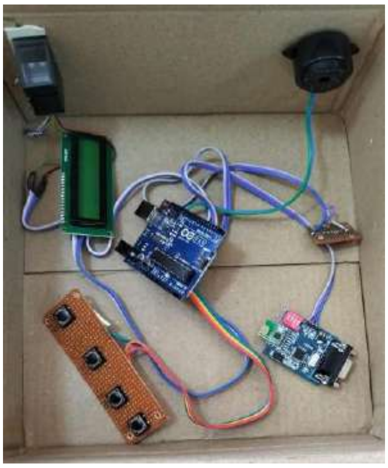


Fig. 2.2 Hardware Setup

Fig. 2.3 User Interface (Application)

F. Microsoft SQL Database

The Microsoft SQL Server Management Studio mimics the ATM server. It has tables that store and display the user's credentials and transaction details. With built-in encryption and auditing, this tool ensures data integrity and compliance.

G. Types of authentication

1) Fingerprint-Based Authentication:

Upon successful fingerprint verification, users proceed to the transaction page. Only the equivalent template of the fingerprint and not the original fingerprint image is stored thus maintaining security. They input their PIN, which is securely transmitted to the server.

2) Friend Option (Temporary PIN)

Users can opt for a friend option, where they set a temporary PIN. This PIN remains valid for a specified duration (e.g., 4 hours). During this period, users can access the application using the temporary PIN instead of their fingerprint.

Fig. 2.4 User interface (friend account)

H. Security Measures

1) *PIN Transmission:* To ensure PIN security, we follow a two-step process:

a) *Hashing:* The user's PIN is hashed using the SHA-256 algorithm. The SHA-256 algorithm, part of the SHA-2 family, is widely used for securing digital information. It generates a fixed-size 256-bit hash value, ensuring data integrity and authenticity. Developed by the NSA, SHA-256 applies cryptographic operations to input data, creating a unique and highly secure hash value. Its widespread adoption in blockchain, digital signatures, and password hashing highlights its reliability in ensuring data security.

b) *Encryption:* The hashed PIN is encrypted using the AES algorithm before transmission. AES (Advanced Encryption Standard) is a widely used encryption algorithm ensuring secure data transmission and storage. Developed by NIST, it employs symmetric key cryptography and operates on fixed-size data blocks. With key lengths of 128, 192, or 256 bits, AES encryption is highly resistant to attacks due to its multiple rounds of operations. Its efficiency, scalability, and strong security features make it essential for securing communication channels, data at rest, and information in transit over networks.

Fig. 2.5 AES Algorithm (Rounds details)

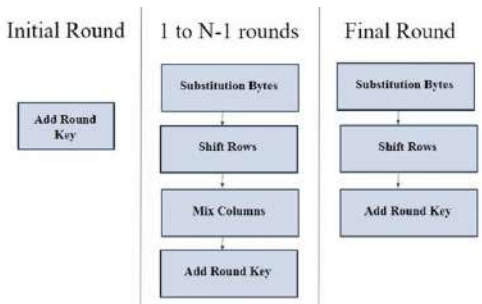
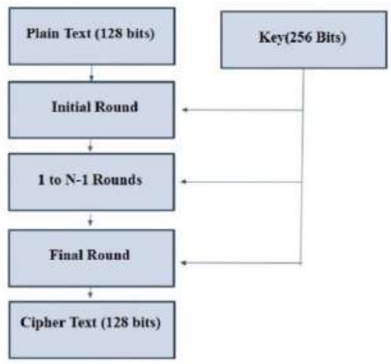


Fig. 2.7 Zigbee Receiver

Fig. 2.6 AES Algorithm (Overall Block)

2) *Zigbee Communication:* Our system establishes a secure connection between the ATM machine and the user's device via Zigbee. Zigbee ensures encrypted communication, eliminating the need for an internet connection. This approach mitigates the risk of data interception during PIN transmission.



III. IMPLEMENTATION DETAILS

This ATM application was developed using Visual Studio. The programming language used is C#. It is an object orientated language and it has rich libraries support. It is ideal for building scalable, secure and high-performance applications. The hardware components were integrated to Arduino microcontroller. The codes for the same was written in Embedded C using Arduino IDE platform. Cryptographic libraries facilitated secure PIN handling. Zigbee modules enabled seamless communication between the ATM and the user's device. Zigbee, operating on the IEEE 802.15.4 standard, offers reliable communication. Its mesh networking enables self-healing networks, enhancing reliability, while low power consumption extends device lifespan. With small packet size and low latency, Zigbee efficiently serves applications like home automation and sensor networks. Its interoperability and support for secure protocols make it versatile for diverse applications.

IV. APPLICATIONS

- Alternative withdrawal method for bank account holders, giving them more flexibility and convenience.
- Multi-Layered Authentication Protocols for Enhanced Security.

- Allows users to securely switch between linked accounts using biometrics.
- Reducing Dependency: The Move Toward a Card-Free Future.
- Integration Opportunities: A Technological Leap in Transaction.
- Enhanced Accessibility for Persons with Disabilities
- Integration with Smart Home Systems for Personalized Transactions

V. CONCLUSION AND FUTURE SCOPE

The cardless and secure ATM cash withdrawal system offers a robust alternative to traditional card-based transactions. By leveraging biometric authentication and secure communication channels, we enhance user convenience while maintaining stringent security standards. This solution eliminates the need for internet connection for the user, making it ideal for implementation in rural areas where internet connectivity is an issue. Future work involves scalability testing, developing ZigBee as a mobile portable device usability studies, and real-world deployment. It also eradicates the issues that can arise due to possessing multiple cards for multiple accounts thus providing an easier management option. This solution can reduce card related frauds to a large extent and provide the user with a hassle-free transaction experience.

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Robust Authentication and Encryption Protocol for Military Applications

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Abstract*— Ensuring military safety in an era of increased reliance on advanced technologies and interconnected networks is of paramount importance. This project addresses the critical concern of safeguarding sensitive data and infrastructure from cyber threats within the context of military operations. The project's goal is to create a soldier tracking and monitoring system utilizing wearable technology to track real-time health information, encrypt it, and securely transfer it to a base station via RF transceiver modules. The information is stored securely on a portal, protected by a login page, limiting access exclusively to authorized personnel within a closely monitored network. It enhances soldier safety through continuous tracking, enabling rapid responses to emergencies and optimizing resource deployment. Monitoring key health indicators, such as heart rate and blood oxygen level, helps assess soldier readiness. Utilizing encryption alongside error detection techniques ensures the protection of sensitive military data, maintaining confidentiality and safeguarding the security of military operations. This system is essential to meet the safety and operational needs of military personnel, prioritizing their readiness, safety, and security during missions and operations.

***Keywords*— IoT, Sensors, Authentication, Proxy Server, ChaCha20**

I. INTRODUCTION

Military security is primarily linked to the duty to protect the lives of the dedicated men and women who have chosen to dedicate themselves to the defense of their nation. Safe, healthy and well-trained military forces are inherently more effective and are capable of performing complex operations accurately and quickly. Military security is of utmost importance and is fundamental to the primary objectives of any armed force. Thus, this project primarily focuses on improving military security by developing a secure soldier monitoring system. The main objective is to provide soldiers with modern security measures that increase their operational readiness. The project enables real-time monitoring of the state of health by collecting vital signs, information about their location and facilitating immediate response to a crisis with the help of an emergency button. Additionally, keeping sensitive data private and shielding it from unwanted access is the primary objective of information security.

Also, in the context of military security, where the protection of sensitive information and the well-being of soldiers are most important, the development of security systems with secure pre-authentication and access control mechanisms becomes crucial. As the Internet of Things (IoT) continues to revolutionize many different areas, including military applications, the need to address potential security threats becomes increasingly important. They are widely used for collection and transmission of sensitive data across a network having applications in numerous fields contributing to our daily life.

Some of the common threats to the IoT devices are unauthorized access, data breaches, weak authentication and encryption protocols employed, etc. One of the more common attacks prevalent in IoT are the sniffing attacks where a third-party user can use a packet sniffer to capture and access confidential information for malicious purposes. Some of the other common attacks are discussed below. Eavesdropping is a form of cyber threat where an unauthorized individual intercepts and monitors communication between two users without their consent. To mitigate the risk of eavesdropping, encryption techniques are commonly employed which ensures that even if the attacker intercepts the data, they cannot understand the actual information owing to the absence of the decryption key. Data tampering or unauthorized modification of data by an entity can cause various security issues like misleading information and loss of personal information. To prevent this, proper error detection schemes must be employed which decreases the probability of the message corrupted by error or an external user. Other security threat that the IoT systems are commonly prone to are the timing-based attacks, which rely on analyzing the time taken by the system for a response and gain information about its internal working.

II. LITERATURE REVIEW

Afef Mdhaffar et al., in their paper "IoT Based Health Monitoring via LoRaWAN" (2017) [1] proposed a work on

IoT Based Health Monitoring in which collected bio sensor data is sent to analysis module through low cost, low power and secure communication using a LoRaWAN network framework. The average area covered by LoRaWAN is around 33km when the LoRaWAN gateway is put in outdoor on a 12-meter altitude and the power consumption of this monitoring module is claimed to be at ten times less than other long range cellular solutions, such as GPRS/3G/4G.

Brijesh Iyer et al., in their paper “IoT Enabled Tracking and Monitoring Sensor for Military Applications” (2018) [2] proposed an internet of things (IoT) based health monitoring and tracking system for soldiers which is mounted on a soldier's body to track their health status and current location using a GPS module. This information is then transmitted to the control room. It is a low-cost system employing only hardware sensors, transmission modules with no use of any software modules and cloud infrastructures.

T. Dharsni et al., in their paper "Soldier Security and Health Monitoring" (2018) [9] proposed that a soldier's body can be fitted with the structure consisting of compact portable physiological devices, sensors, and transmission modules which can track their health status and also measure the current location using a GPS module. This information is transmitted to the control room through distributed computing. Thus, when utilizing the suggested equipment, it is feasible to use minimal force to safeguard crucial human lives in a combat zone.

Sarker et al., in their paper “Lightweight Security Algorithms for Resource-constrained IoT-based Sensor Nodes” (2020) [9] explored various lightweight encryption techniques such as AES, ChaCha20, and ChaChaPoly-1305. The primary focus of their research is to evaluate the performance of these encryption methods when applied to Arduino-based microcontrollers, including but not limited to Arduino UNO, Arduino MEGA, and NodeMCU.

P. Koopman et al., in their paper "Cyclic redundancy code (CRC) polynomial selection for embedded networks" (2004) [7] describe the polynomial selection process for embedded network applications and proposed a set of good general-purpose polynomials. A set of 35 new polynomials in addition to 13 previously published polynomials provided good performance for 3 to 16-bit CRCs for data word lengths up to 2048 bits.

While current military surveillance systems excel at data collection, they often neglect the key aspect of secure data transmission, leaving sensitive information vulnerable to potential data breaches and compromises. Therefore, our proposed system not only includes comprehensive sensor data collection, but also prioritizes secure transmission methods to prevent data eavesdropping and provide strong protection. By using the right sensors, our system ensures the accuracy and reliability of monitoring soldiers' health and environmental conditions. In addition, the integration of strong security measures ensures the safe transfer of data in the transmission process to the control point. To strengthen data integrity and confidentiality, added authentication and authorization methods provide additional protection for this critical information. This approach increases the efficiency and security of military surveillance systems and allows for a safe and seamless process to ensure the safety and operational readiness of soldiers.

III. Proposed Methodology

The proposed system encompasses two main phases: soldier tracking and secure transmission of acquired information, followed by the proper storage and retrieval of data. In the first phase, there are two primary units: the soldier unit and the control room unit. The soldier's unit comprises a network of sensors that collect various parameters such as pulse rate, oxygen levels, latitude and longitude coordinates and ambient temperature. These location details are encrypted and transmitted to the control unit. Upon receiving this information, authorities can promptly initiate appropriate actions, such as deploying medical or rescue teams, based on the data received. Additionally, an emergency button is included in the soldier unit, which, when pressed, triggers an immediate response to the control room, enabling necessary assistance. The control unit is responsible for receiving, decrypting, and securely storing the transmitted data in a central database after verification through a proxy for sender authentication. This system plays an important role in providing real-time health status updates about the soldiers and ensuring timely assistance during emergencies. The following phases are defined for the project.

A. Collection of data

The soldier has the Arduino UNO and the sensors attached to him which primarily forms the soldier unit enabling continuous monitoring of health vitals and environmental conditions.

A temperature sensor is deployed to monitor ambient temperature, triggering an alert to the control room if it falls below a predefined threshold. This facilitates rapid assistance to soldiers in distress.

A pulse oximeter sensor monitors heart rate and oxygen levels, providing valuable insights into the soldier's health status and indicating the need for medical attention or replacement.

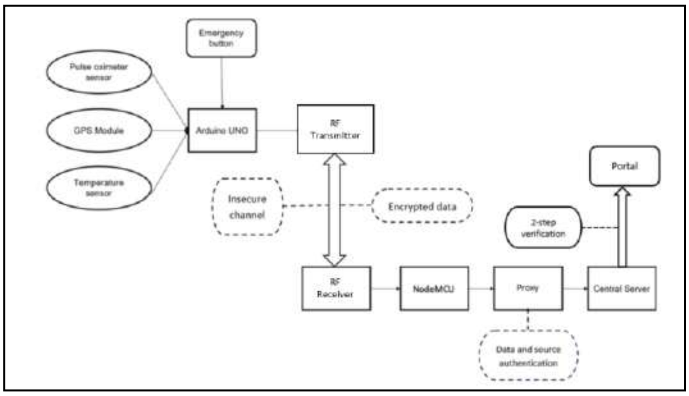

Fig. 1 Block diagram of the proposed work

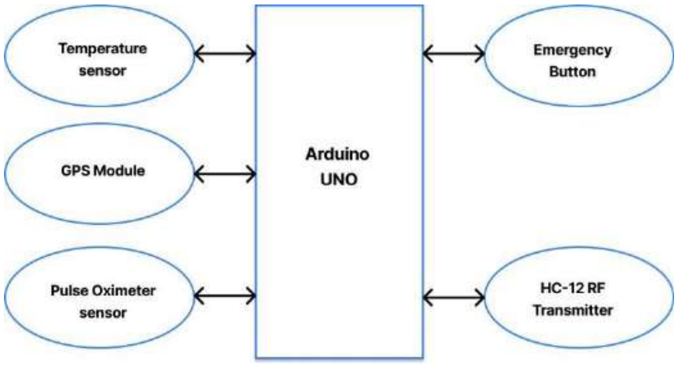

Fig. 2 Block diagram of the Soldier Unit

Additionally, a GPS module tracks the soldier's precise location, providing accurate latitude and longitude coordinates. A panic button is also incorporated for emergency situations, allowing soldiers to instantly alert the control room and transmit their location status for immediate assistance.

B. Encryption and Transmission

The location details are encrypted using the ChaCha20 encryption algorithm, which is implemented within the Arduino development environment using the Arduino Crypto library with some custom modifications. To generate the Initialization Vector (IV) required for encryption, a sequence number undergoes a series of mathematical operations, resulting in a 12-byte output. This process adds randomness to the encryption, enhancing its security. A 32-byte key is securely stored within the system.

Each of the five sensor readings (Latitude, Longitude, temperature, SpO2, pulse rate) is transmitted along with a sequence number to prevent data byte mixing and potential errors during decryption. Additionally, an 8-bit CRC (Cyclic Redundancy Check) is calculated and transmitted to verify the integrity of the data. Figure-3 depicts the transmitter section of the project.

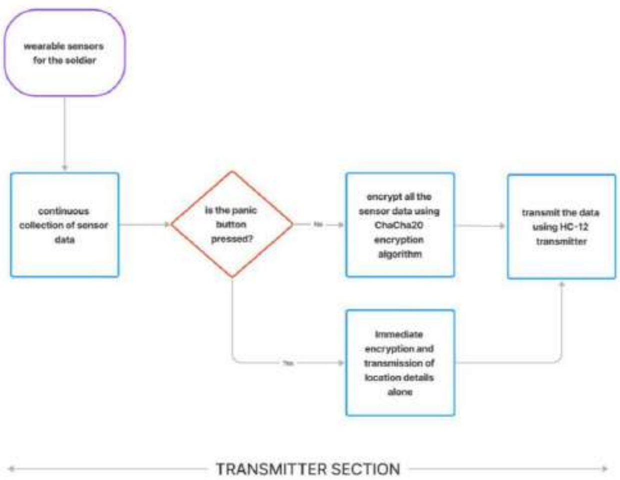

Fig. 3 Transmitter section

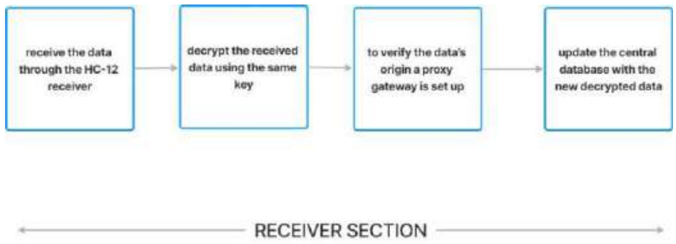

Fig. 4 Receiver Section

C. Decryption and CRC verification

At the receiver end, the Initialization Vector (IV) is computed using the same sequence number and a pre-shared 32-byte key is stored in the receiver system. These parameters are utilized for the decryption process, during which CRC values are calculated for each parameter. If the calculated CRC matches the received CRC, the data is appended to a JSON document. Conversely, if there is a CRC mismatch, the data packets are discarded, and the system awaits the next transmission burst. Once all data is included in the document, it is sent to the proxy server via an HTTP request, with added authorization headers. Figure-4 depicts the receiver section of our project.

D. Software Verification

1) Working of Proxy Server: The backend infrastructure includes a proxy server tasked with receiving requests from the NodeMCU and forwarding them to the central server. This proxy server only accepts requests from pre-registered IP addresses which are stored securely and requires each request to include a pre-established authorization header along with a necessary key for accessing the gateway.

It functions as an API gateway to the central server, effectively converting it into a virtual data center that remains anonymous to external entities and whose access is limited to itself. This confidentiality is achieved through the implementation of JSON Web Tokens (JWT), which verifies the authenticity of the request source.

JWT operates by taking the client's data, applying a secure key, and hashing it using a hashing algorithm like HMAC. The resulting hash, along with the original data, is then encoded in base64 format. Upon arrival at the server, the base64 encoded data is decoded and hashed using the same key employed by the client.

If the resulting hashes match, the JWT token is validated, ensuring the authenticity of the token. Any unauthorized attempts to tamper with the request, such as data alteration or accessing the server without a valid web token, are detected by the server. This ensures that only the proxy server is authorized to transmit data to the central server, maintaining system security.

2) Data Verification: Initially, the proxy server checks whether the IP address of the NodeMCU is listed among the registered IPs. If a match is found, the proxy verifies the data format. If any data is missing, the proxy rejects the data transmission with an HTTP response and prohibits further processing until all data is present. Subsequently, the proxy examines the transmitted data for any unwanted special characters. If such characters are detected, an error response is sent, and the data is discarded. If both checks pass without errors, the proxy forwards the response to the server, and the data is inserted into the database.

E. Secure Data Access Portal

A portal has been developed to allow higher officials to view the stored health vitals and personal information of the soldiers. To further boost security, a login system has been implemented, ensuring that only authorized personnel can access sensitive information.

IV. Results and Discussion

The sensors worn by the soldiers are responsible for collecting the vital signs including the heartrate, blood oxygen level, ambient temperature and the GPS location. This data is then securely encrypted using ChaCha20 encryption algorithm.

If there is an emergency and the panic button detects a signal, it will initiate the immediate transmission of the encrypted location data. This transmission takes precedence over all other ongoing processes, and it is facilitated through the HC-12 RF transmitter module

The encryption process uses the ChaCha20 encryption algorithm, a stream cipher which helps overcome the overhead of a block cipher which can sometimes be problematic for a smooth transmission. It also provides better security against cache-collision attacks and is found to be four times faster than similar AES variants in terms of key setup which makes it a viable option for a resource constraint device like NodeMCU [8]. The CRC bit calculated ensures that if there are any errors generated during the transmission, they are all detected. The choice of polynomial was 0xA6 which was found to be providing the most optimal error detection for the requirements of the current system. It provided a maximum Hamming distance of 3 for a message of size up to 247 bits with the size of resulting CRC being 8-bits [7].

Figure-5 represents the different data collected from the sensors and their values. It also showcases the calculation of the different Initialization Vector (IV) used for the encryption of latitude and longitude.

```
22:59:21.385 -> Latitude:81.75
22:59:21.385 -> Longitude:71.43
22:59:21.425 -> Temperature:27.18
22:59:21.425 -> SPO2:97.00
22:59:21.425 -> Pulse Rate:72.00
22:59:22.405 -> IV:
22:59:22.405 -> 0 1 2 3 4 5 6 7 8 9 10 11
22:59:24.056 -> IV:
22:59:24.056 -> 16 1 2 3 20 5 6 7 24 9 10 11
```

Fig. 5 Data sent from the transmitter

```
23:27:21.315 -> Latitude:81.752525
23:27:21.315 -> Longitude:71.429047
23:27:21.361 -> Temperature: 27.18
23:27:21.393 -> spo2: 97.00
23:27:21.534 -> Pulse rate: 72.00
23:27:21.674 -> HTTP Response code: 200
23:27:21.674 -> Rows matched: 1  Changed: 1  Warnings: 2
```

Fig. 6.1 Data at the receiver end

```
DATA:  {
  id: 1,
  latitude: '81.752525',
  longitude: '71.429047',
  temperature: '27.18',
  spo2: '97.00',
  heart_rate: '72.00',
  humidity: '72'
}
valid schema, forwarding to next stage
```

Fig. 6.2 Data schema at the proxy server

The encrypted data received by the HC-12 receiver module underwent a decryption process and is subsequently transmitted to the proxy server. The proxy server serves as a gateway responsible for verifying the data's source and then relays this information to the central server. The central server, in turn, processes the decrypted data and updates it into the database.

Before updating the central database, decryption is to be performed and the data schema is verified for correctness. Figure-6.1 represents the data at the receiver after decryption and represents the response it gets after successful verification and Figure-6.2 depicts the acceptance at the proxy server following which it is forwarded to the server.

```
23:27:11.532 -> HTTP Response code: 400
23:27:11.532 -> Invalid schema, bad request
23:27:11.650 -> 7:188
23:27:11.650 -> Latitude:81.752525
23:27:11.650 -> Longitude:71.429047
23:27:11.688 -> Temperature: 27.18
23:27:11.732 -> spo2: 97.00
```

Fig. 7.1 Data at the receiver end in-case of bad schema

```
DATA:  { id: 1 }
"heart_rate" is required
::ffff:192.168.31.96
```

Fig. 7.2 Error message at the proxy server

Fig. 8.1 Portal page showcasing the heath details of the soldiers

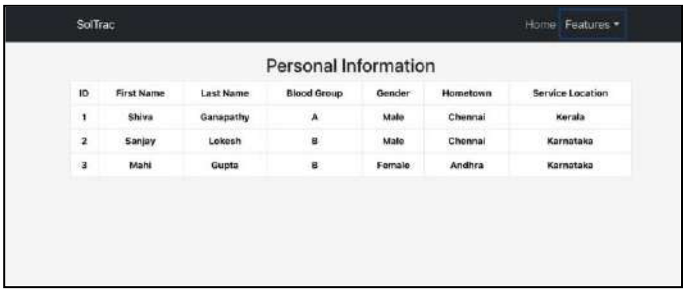

Fig. 8.2 Portal page showcasing the personal information of the soldiers

Figure-7.1 represents the data at the receiver after decryption and represents the response it gets after a failed verification and Figure-7.2 depicts the issue at the proxy server that arises due to the missing value.

A portal was created using ReactJS to display all the information. Figure-8.1 displays the page which is used to display the various vital signs. These values are collected using various sensors connected to the soldier unit. Figure-8.2 displays the page which is used to display the personal information of the soldier deployed. These personal data are fed into the database previously and can be accessed when needed by the commanding officers.

V. Conclusion and Future Scope

In conclusion, this project presents a comprehensive soldier monitoring and data transmission system designed to enhance military safety and operational efficiency. By leveraging Arduino-based sensors and advanced encryption techniques, the system enables continuous monitoring of vital health parameters and real-time transmission of encrypted data to a central server. The implementation of ChaCha20 encryption algorithm and CRC verification ensures the integrity and security of data during transmission. Moreover, the inclusion of a proxy server with JSONWebTokens authentication enhances system security by restricting access to authorized personnel only. Furthermore, the portal with an authenticated login provides secure access to stored data for higher officials, safeguarding sensitive information. Overall, this project offers a robust solution for addressing the critical need for ensuring soldier safety and data security in military operations.

To further enhance the capabilities of the soldier monitoring system and address emerging challenges in military operations, several avenues for future development and improvement can be explored like incorporating a unique key exchange algorithm, such as Elliptic-curve Diffie-Hellman (ECDH) or Diffie-Hellman Key Exchange (DHKE), can strengthen the system's defense against potential breaches. Moreover, data security and communication integrity can be improved by introducing tokens for hashing and storage. To increase the transmission range of HC12 transceivers for long-distance communication, intermediate repeaters can be deployed. These repeaters act as signal amplifiers, allowing for seamless communication over long distances.

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Prediction of eye diseases based on Retinal images

Retina Scan: Proactive Eye Health Monitoring through Image Analysis

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Abstract: This paper aims to create a framework for recognizing diseases like Cataract (CA), Diabetic Retinopathy (DR), Glaucoma (GL), and NORMAL from retinal images, a vital task in healthcare. This framework relies on retinal vessel segmentation, a key preprocessing step, and the power of Convolutional Neural Networks (CNNs) which recognizes disease. We examine the efficiency of various CNN architectures, including VGG16, VGG19, ResNet50, and DenseNet, for disease recognition from retinal images, aiming to identify the most suitable architecture(s). The framework includes preprocessing, feature extraction, and classification stages. During preprocessing, retinal images are segmented to isolate vessels, crucial for disease-related feature extraction. Then, feature extraction is performed using CNN architectures, followed by classification based on the extracted features. We test each CNN architecture's performance in disease recognition tasks using a diverse dataset of retinal images. Performance metrics like accuracy, precision, recall, and F1-score are used to assess each architecture. This study's findings could advance disease recognition in retinal images and improve diagnostic accuracy, thereby facilitating timely disease management.

Index Terms: Retinal Imaging, Disease Recognition, CA, DR, GL, CNN, Vessel Segmentation, Feature Extraction, Deep learning.

I. INTRODUCTION

The prevalence of Diabetic Eye Disease (DED) poses a significant global concern for health, that affects millions of individuals around the world and leading to severe vision impairment and blindness if left untreated [3]. Among the various types of DED, Diabetic Retinopathy (DR), Glaucoma, and Cataract stand out as major contributors to vision loss in individuals aged 20 to 74 years [1]. The alarming rise in diabetes cases, projected to reach 692 million by 2045, underscores the urgency of addressing DED as a public health priority [2]. Moreover, the economic and social burden of diabetes-related complications emphasizes the need for effective screening and diagnosis strategies [3].

In the realm of ophthalmology, retinal imaging plays a crucial role in detecting and monitoring DED, allowing for early intervention and management [4]. Fundus images provide valuable insights into the structural changes occurring in the retina, enabling the identification of pathologies such as DR [6]. However, retinal images that analyzed manually consumes time , prompting the exploration of automated methods for disease diagnosis [7].

Sophisticated deep learning models trained on retinal images sourced from prominent databases have proven pivotal in the detection and diagnosis of various ocular diseases [4]. Noteworthy public retinal image repositories such as DRISHTI-GS, RIMONE, DRIVE, STARE, and CHASE-DB are commonly leveraged for assessing the performance of deep learning algorithms[4]. These datasets offer a comprehensive collection of images along with meticulously annotated ground truth data, encompassing both healthy and diseased cases. This provision greatly facilitates the evaluation process for these models [4].

Various approaches have been proposed for retinal vessel segmentation, ranging from unsupervised methods utilizing image filters and morphology-based techniques to supervised ML algorithms [5, 6]. Convolutional neural networks (CNNs), have emerged as powerful tools for feature extraction and classification in medical image analysis [6]. CNN architectures such as VGG16, VGG19, ResNet50, and DenseNet have demonstrated remarkable performance in detecting retinal pathologies, including DR, glaucoma. [7].

The development of AI-enabled diagnostic systems for DED holds immense potential in revolutionizing clinical practice and population-level screening programs [4]. Automated retinal image analysis offers several advantages, including reduced human error, improved efficiency, and the ability to detect subtle abnormalities with greater accuracy [3, 6]. By harnessing the power of deep learning and image processing techniques, researchers aim to create robust and reliable tools for early disease detection and intervention.

In conclusion, the integration of AI and deep learning methodologies into retinal image analysis represents a transformative approach to combating DED. By automating the disease diagnosis process and screening, these innovative technologies have the potential to revolutionize healthcare delivery, reduce the burden on healthcare systems, and ultimately improve patient outcomes.

II. LITERATURE SURVEY

Advanced deep learning models trained on retinal images from leading databases detect and diagnose various eye conditions [4]. Notable public retinal image datasets, including DRISHTI-GS, RIMONE, DRIVE, STARE, and CHASE-DB, are frequently utilized to assess the effectiveness of deep learning algorithms [4]. These datasets offer images alongside annotated ground truth data for both healthy and diseased cases, streamlining the evaluation process for models [4].

Transfer Learning (TL) is a common approach adopted in diabetic eye disease detection, where pre-trained models are utilized to initialize network parameters, facilitating feature extraction. TL has been effectively applied in various studies for diseases like diabetic retinopathy (DR) [1]. TL architectures have been extensively explored for DR identification, with models like InceptionV1, InceptionV2, and VGG16 showing promising results, particularly in limited dataset scenarios [1]. TL methods, although widely used, may not be optimal for real-time image classification in medical field due to the origins in non-medical domains [1].

Various methods and algorithms are proposed for automated diagnosis of eye diseases, especially DR [4]. Image processing techniques, ML algorithms, and deep learning architectures are employed for disease detection and classification [4]. Different studies focus on preprocessing, feature extraction, segmentation, and classification to achieve accurate disease diagnosis [4].

Recent advancements include the development of novel DL pipelines like DR-VNet and Genetic U-Net, aimed at improving retinal vessel segmentation [4]. Techniques like multi-scale CNNs and attention mechanisms are integrated into DL models to extract refined features and improve segmentation accuracy [4]. Automated systems combining image processing and artificial intelligence show promising results in detecting various types of retinal abnormalities [4].

Recent studies have explored new DL frameworks for automated detection of diabetic eye diseases, presenting models like Siamese-like CNN structures and DL approaches for predicting DR class and severity [1]. Research has compared different CNN architectures such as DenseNet, ResNet50, and VGG16 for detecting diabetic retinopathy, with DenseNet showing effectiveness in multi-label classification tasks [1].

Diabetic retinopathy (DR) is a major focus due to its prevalence and impact on vision loss [4]. DR has been damaging retinal blood vessels, leads to blindness if not detected early [4].

Deep learning architectures like VGG19, Inception-V3, and custom CNN models are utilized for image classification tasks [4, 7]. Techniques such as ensemble learning, transfer learning, and feature selection are explored to improve classification accuracy [4, 7]. Several studies utilize public datasets like DIARETDB0, HRF Image Database, STARE, and others for training and evaluation of models [4, 7]. The performance of models is assessed based on metrics such as sensitivity, specificity, and accuracy [4, 7].

III. METHODOLOGY

Background: Eye disorders like cataract and glaucoma are widespread worldwide, significantly contributing to vision impairment. Timely detection and precise diagnosis play pivotal roles in facilitating prompt intervention and efficacious treatment.

Objective: The focus of this investigation is to create an automated system employing deep learning methodologies to categorize eye ailments utilizing retinal images.

Significance: Automatizing the classification procedure has the potential to enhance productivity, diminish human fallibility, and facilitate the implementation of scalable screening initiatives, particularly in regions with limited resources.

A) ***Data Collection and Preprocessing***:

1.Dataset Acquisition:

Source: Retinal image datasets are obtained from publicly available repositories (e.g., Kaggle, NIH) or collaborations with healthcare institutions.

Description: The dataset comprises images of varying resolutions and quality, categorized into diabetic retinopathy, normal, cataract, and glaucoma classes.

Data Integrity: Quality checks are performed to ensure data integrity, including removal of duplicate images, correction of labeling errors, and anonymization of patient information.

2.Data Preprocessing:

Image Rescaling: Images are resized to a standard dimension (e.g., 224x224 pixels) to ensure uniformity across the dataset and facilitate model training.

Normalization: Pixel intensity values are normalized to the range [0, 1] to standardize the input data and improve model convergence.

Data Augmentation: Augmentation techniques such as random flips, rotations, and zooms are applied to increase the dataset size, enhance model generalization, and mitigate overfitting.

B) Model Development:

1.Selection of Deep Learning Architecture:

Model Choice: The VGG16 architecture, pre-trained on the kaggle dataset, is selected as the base model due to its proven effectiveness in image classification tasks.

Transfer Learning: The pre-trained VGG16 model serves as a feature extractor, with its weights fine-tuned to learn discriminative features relevant to eye disease classification.

2.Model Modification:

The VGG16 model's fully connected layers have been swapped with custom ones to fit a multi-class classification task for identifying diabetic retinopathy, normal, cataract, and glaucoma cases.

Regularization: Dropout layers are incorporated to prevent overfitting by randomly deactivating neurons during training, thereby improving model generalization.

Activation Functions: Rectified Linear Unit (ReLU) activation functions are used to introduce non-linearity and enable better feature learning in the model.

C) ***Training Strategy:***

1.Dataset Splitting:

To maintain balanced class distributions within each subset and ensure the representation of normal and diseased cases, the dataset undergoes stratified sampling, resulting in the creation of training, validation, and test sets.

2.*Training Configuration:*

Hyperparameter Tuning: Techniques such as grid search or random search are utilized to optimize batch size, learning rate, and optimizer settings (e.g., Adam, RMSprop), aiming to enhance model performance.

Learning Rate Scheduling: Dynamic adjustment based on validation performance is facilitated through the utilization of learning rate schedulers (e.g., ReduceLROnPlateau). This adaptive approach expedites convergence and improves optimization.

3.Model Training:

The models are trained using backpropagation and gradient descent optimization to minimize a loss function, that measures the difference between predicted and true class labels.

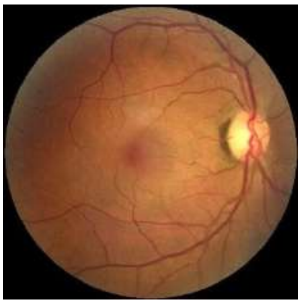
Training progresses over multiple epochs, with periodic evaluation on the validation set to monitor model performance, detect overfitting, and adjust hyperparameters accordingly.

D) ***Evaluation Metrics and Analysis:***

1.*Performance Metrics*:

Accuracy: The fundamental metric used to assess classification performance, calculated as the proportion of accurately classified samples out of the total samples within the test set.

Confusion Matrix: A structured presentation illustrating true positives, true negatives, false positives, and false negatives

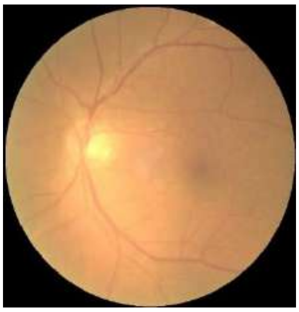


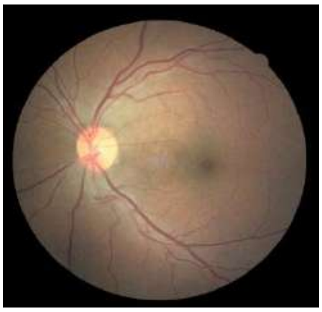
predictions across each class, offering insights into the model's efficacy and limitations.

Precision, Recall, F1-Score: Supplementary metrics offering nuanced performance evaluation for individual classes, particularly valuable in scenarios involving imbalanced datasets.

2.*Visualization and Interpretation:*

Performance metrics are visualized using plots such as loss curves, accuracy curves, and confusion matrices to analyze model behavior, identify potential areas for improvement, and gain





insights into model predictions.

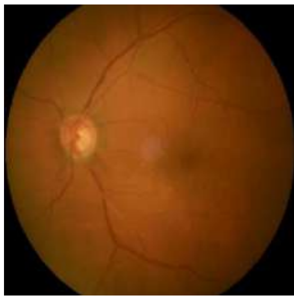
Interpretability techniques such as CAM or Grad-CAM are employed to visualize model predictions and understand which image regions contribute most to classification decisions.

Normal

Glaucoma

Diabetic Retinopathy

Cataract



Pre-processed image

E) Results and Discussion:

1.*Experimental Findings:*

The trained model's performance is evaluated on the test set to assess its generalization capability and real-world applicability, comparing results with existing state-of-the-art methods and benchmarks.

Results are discussed in terms of accuracy, robustness, computational efficiency, and potential clinical impact, highlighting the model's strengths and limitations.

2.*Interpretation and Insights:*

Detailed interpretation of experimental findings, including factors influencing model performance, sources of errors, and implications for clinical practice.

Insights gained from interpretability techniques are discussed to provide a deeper understanding of the model's decision-making process and identify avenues for further improvement.

F) Conclusion and Future Directions:

1.Summary of Findings:

A concise summary of research findings, emphasizing key takeaways, contributions to the field, and implications for future research and clinical practice.

The developed model's potential for improving early disease detection, patient management, and healthcare outcomes is underscored.

2. Future Research Directions:

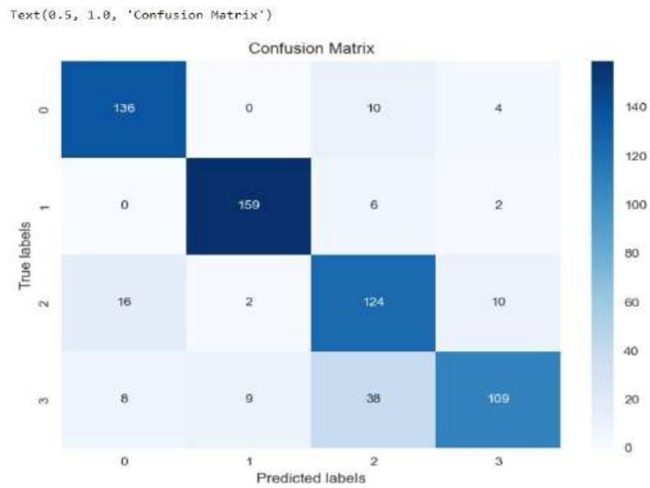
Exploration of future research directions, including refinement of model architecture, integration of additional clinical data modalities (e.g., optical coherence tomography), and investigation of interpretability techniques to enhance model transparency and trustworthiness.

Deployment of the model in real-world healthcare settings, validation through prospective clinical trials, and integration into clinical decision support systems are identified as crucial steps for practical implementation and adoption.

G) VGG16 Architecture:

1. Data Collection and Preparation:

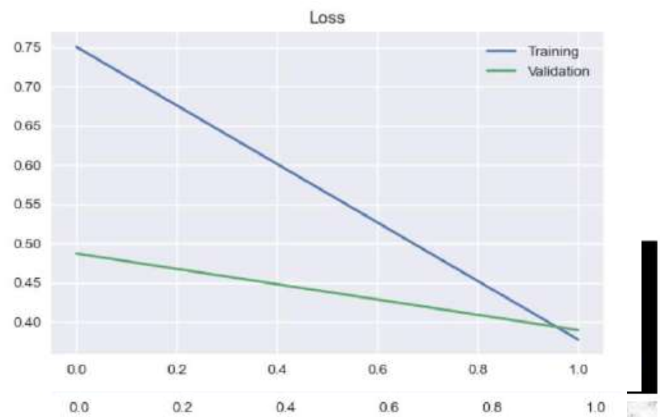
Acquire a dataset containing retinal images or scans captured using imaging modalities such as fundus photography, optical coherence tomography (OCT), or others. Ensure the dataset comprises a diverse range of images depicting various eye diseases, including diabetic retinopathy, glaucoma,

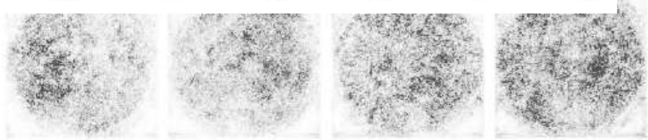


macular degeneration, retinal detachment, and others. Annotate the images with labels indicating the presence or absence of different eye diseases, preferably by ophthalmologists or medical experts.

2. Model Selection and Architecture Modification:

Choose the VGG16 architecture as the base model due to its effectiveness in image feature extraction. Modify the architecture to suit the eye disease prediction task. While VGG16 is originally designed for the classification of image on





the Kaggle dataset, adjustments are necessary to adapt it to the specific nuances of medical image analysis.

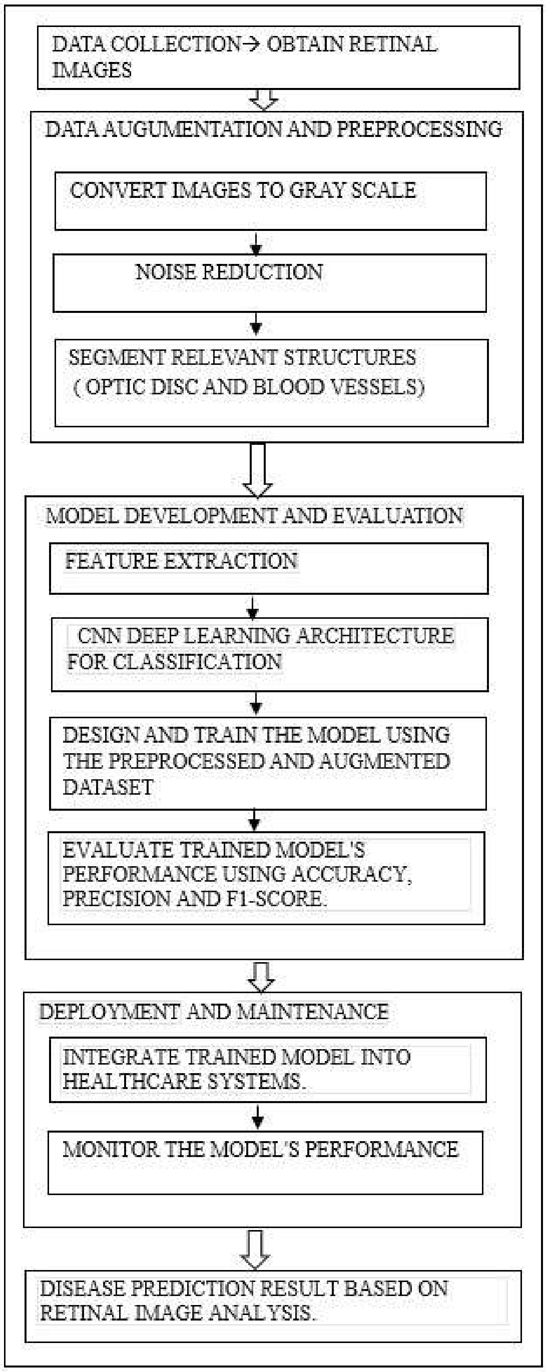
Replace the final classification layer of VGG16 with a custom output layer tailored for eye disease prediction. This output layer should have the appropriate no. of neurons corresponding to the classes of eye diseases being predicted.

Adjust the activation function of the output layer to suit the prediction task. For multi-class classification, softmax activation is commonly used, while sigmoid activation is suitable for binary classification tasks.

3. Fine-tuning and Training:

To begin, initialize the modified VGG16 model with pre-trained weights acquired from training on ImageNet or similar large-scale datasets. This step capitalizes on the model's prior knowledge of general image features. Then, fine-tune the model on the retinal image dataset through transfer learning techniques.

Throughout fine-tuning, adjust the model's parameters iteratively to minimize a suitable loss function, such as binary cross-entropy or categorical cross-entropy, aiming to optimize performance in predicting eye diseases. Employ methods like data augmentation to enhance the diversity of training samples and bolster the model's robustness.



4. *Evaluation and Validation:*

Evaluate the trained VGG16 model on the validation set to assess its performance metrics, such as accuracy, precision, recall, F1-score, and area under the receiver operating characteristic curve (AUC-ROC) Conduct thorough validation experiments to ensure the model's generalization across different eye diseases and imaging conditions. Employ techniques like k-fold cross-validation to validate the model's robustness and mitigate overfitting.

5. Deployment and Integration: By systematically following these steps, the VGG16 model can effectively predict eye diseases, aiding in early diagnosis and personalized treatment. Deployment in clinical settings post-validation, along with user-friendly interfaces, ensures seamless interaction for healthcare professionals. Compliance with regulatory standards, including data privacy, is essential. Continuous monitoring and feedback incorporation refine and enhance the model's performance over time, benefiting ophthalmology outcomes.

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A Novel Digital Stethoscope for Diagnosis of Heart Attack

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Abstract-- This project proposes the development of a digital stethoscope integrated with a microphone to collect heart rate data. The device aims to provide a convenient and accessible means of monitoring heart health. The collected data will be transmitted to an artificial intelligence model trained in machine learning techniques for heart rate analysis. Through predictive analytics, the AI model will generate insights and predictions regarding the user's heart health status. The integration of digital technology with traditional medical instruments facilitates real-time monitoring and early detection of potential cardiac abnormalities. This innovation holds promise for improving preventive healthcare and enabling timely interventions. The proposed system demonstrates the synergy between medical instrumentation, digital technology, and artificial intelligence in advancing personalized healthcare solutions.

Keywords— Health care, AI model, Real-time monitor, Machine learning.

I. INTRODUCTION

This title describes a situation in which a cardiovascular condition is diagnosed and treated. "Cardiovascular disease" here refers to a group of problems that affect the heart and blood arteries, including heart failure, arrhythmias, coronary artery disease, and valvular illnesses. The focus is on identifying a particular cardiovascular condition and then getting a prescription from a licensed healthcare provider. This scenario involves the patient assessment procedure, which could involve a thorough medical history, a physical examination and possibly diagnostic tests like blood, echo, or electrocardiography. The aim of this assessment is to identify the specific cardiovascular disease that the patient is experiencing. The next step after the diagnosis is for the physician to write a prescription for medication. This prescription probably contains treatment recommendations, which could include a mix of medication (to control symptoms or address underlying causes), lifestyle changes (like dietary adjustments or exercise routines), and referrals for specialized interventions like heart procedures or surgery.The scenario highlights the vital role that healthcare professionals play in preserving and enhancing cardiovascular health and highlights the significance of expert medical advice and intervention in managing cardiovascular illnesses.

II. LITERATURE SURVEY

Shuenn-Yuh Lee et al., (2023) proposed the whole system with ECG patch and stethoscope includes four parts namely, an analog front-end circuit for bio signals acquisition a heart sound classifying an integrated circuit with convolution neural network(CNN) a user friendly application that synchronously displays the heart sound and ECG signals.

Latha.R et al., (2020) proposes a blood viscosity-based heart disease risk prediction model using partially observable markov decision process (POMDP). In emergencies, doctors use fog computing to alert patients and send ambulances to critical situations. The paper highlights the growing interest in fog computing in healthcare, particularly in cardiovascular disease, which is influenced by increased blood viscosity. Risk factors for heart disease include high blood pressure, obesity, diabetes, and increased blood viscosity. The POMDP model uses states, observations, beliefs, and probability transitions to note patient health and compute policy approximations using states and timeslots. Rewards are tabulated using policy approximations

Rahul katarya et al., (2020) proposed Predicting and detecting heart disease is a critical and challenging task for healthcare practitioners, as expensive therapies and operations are often required. Early detection of heart disease can help people take necessary actions before it becomes severe. Heart disease is a significant problem in recent times, primarily due to alcohol, tobacco, and lack of physical exercise. Machine learning has shown effective results in making decisions and predictions from healthcare industry data. Some supervised machine learning techniques used for heart disease prediction include artificial neural networks (ANN), decision trees (DT), random forest (RF), support vector machines (SVM), naïve Bayes (NB), and the nearest neighbour algorithm.

Abderrahmane Ed-daoudy et al., (2020) proposed Heart disease is the leading cause of global death, and early detection and continuous monitoring can reduce mortality rates.This system uses Apache Spark, a large-scale distributed computing platform, to stream data events against machine learning through in-memory computations. The system consists of two main sub parts: streaming processing and data storage and visualization. The first uses Spark ML with Spark streaming to apply classification models to predict heart disease, while the second uses Apache Cassandra for storing the generated data. This breakthrough technology can be more powerful and less expensive in the healthcare field.

Sanjeev et al., (2020) proposed a decades of research has revealed several links between cardiovascular diseases (CVDs) and mental illness, and has even suggested that both may actually cause one another. Emerging research is beginning to uncover high prevalence of behavioural risk factors in patients with mental illness that may lead to cardiovascular disease. A descriptive cross-sectional study was designed to assess the prevalence of psychiatric comorbidities in cardiovascular disease patients and to identify the behavioural risk factors in them. A semi-structured questionnaire including Self Reporting Questionnaire (SRQ-20) by WHO was used to screen psychiatric symptoms among 190 purposively selected samples. Data were analysed by using descriptive and inferential statistics with SPSS version 20.0. Among the 190 respondents, 150 (78.95%) were SRQ positive and table 1 shows majority (63.33%) was male.

P. Umashankar et al., (2018) proposes a decision support system for heart disease diagnosis using interval vague set and fuzzy association rule mining. Cardiovascular disease (CVD) is the most common heart condition, causing symptoms like fatigue and chest pain. The framework includes pre-processing, interval vague set, fuzzy association rule mining, and fuzzy correlation rule mining for decision making. It focuses on identifying criteria causing heart attacks among people. The pre-processing step reduces the heart disease dataset size, while the Rule Mining algorithm generates rules for predicting heart diseases based on selected criteria. The interval vague set is used to solve decision-making problems for doctors in hesitant patients.

Tsipouras G et al., (2008) proposed a fuzzy rule-based decision support system (DSS) is developed for diagnosing coronary artery disease (CAD). The system is generated automatically from an annotated dataset using a four-stage methodology: induction of a decision tree, extraction of rules, transformation of crisp rules into fuzzy models, and optimization of fuzzy model parameters. The dataset consists of 199 subjects with 19 features. Tenfold cross validation is used, and the system achieves an average sensitivity and specificity of 62% and 54% using the decision tree rules, and 80% and 65% using russification and optimization stages.

Sharon-Lise T et al., (2001) proposed the process of profiling involves comparing resource use and quality of care among medical providers to community or to normative standards. Information from provider profiles may be used to determine whether providers deviate from acceptable standards in the type of care they deliver. In this paper we profile hospitals based on 30-day mortality rates for a cohort of 14,581 Medicare patients discharged with acute myocardial infarction (AMI) in 1993 from hospitals located in Alabama, Connecticut, Iowa, or Wisconsin. Clinical and socio-demographic information for the study cohort were collected retrospectively from individually reviewed medical charts and administrative files.

R Scott Wright et al., (2001) proposed an Impact of community-based education on health care Community education programs focused on raising public awareness of the symptomatology of acute coronary syndromes have had mixed results. The Wabasha Heart Attack Team project, a unique multidisciplinary public education effort in Minnesota, sought to educate area citizens about signs and symptoms of acute myocardial infarction (MI).

Annette J Dobson et al., (1991) proposed an Passive smoking and the risk of heart attack or coronary death to estimate the prevalence of passive smoking in an Australian population, the magnitude of risk of myocardial infarction or coronary death associated with passive smoking and the extent to which fibrinogen concentrations might be affected by passive smoking.

III. METHODOLOGY

The core of this project is an Arduino Uno microcontroller, serving as the central component. Utilizing a stethoscope, the system captures the patient's heart rate data, which is then relayed to an AI model for analysis. Additionally, manually inputted data supplements this analysis. The AI model processes the combined information, generating predictive results for the user's heart health. Communication of these results is facilitated through a GSM module, enabling notifications to be sent to the user. Furthermore, an LCD display provides real-time updates and feedback. This innovative system amalgamates traditional medical instruments with advanced digital technology and artificial intelligence, promising enhanced monitoring and prediction capabilities for cardiovascular health, thereby contributing to personalized healthcare solutions.

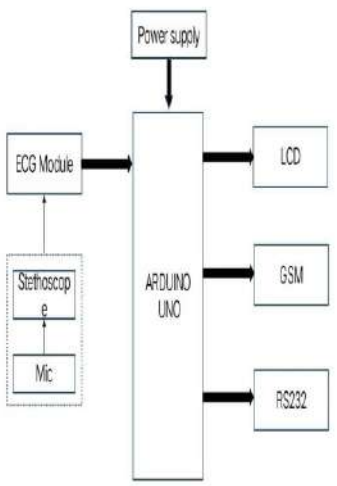

Fig 3.1 Block Diagram

Fig 3.1 shows the block diagram and the hardware components.

ARDUINO UNO: Arduino UNO is used to receive the heart signals and convert into numerical values. Here it is used as a transmitter between input and output. It receives the heart signals from the stethoscope and transmit the signals to the LCD. The UNO is the best board to get started with electronics and coding. If this is your first experience tinkering with the platform, the UNO is the most robust board you can start playing with. The UNO is the most used and documented board of the whole Arduino family.

GSM:The GSM specifications define the functions and interface requirements in detail but do not address the hardware. The reason for this is to limit the designers as little as possible but still to make it possible for the operators to buy equipment from different suppliers. The GSM network is divided into three major systems: the switching system (SS), the base station system (BSS), and the operation and support system (OSS). The basic GSM network elements are shown in Fig 3.2

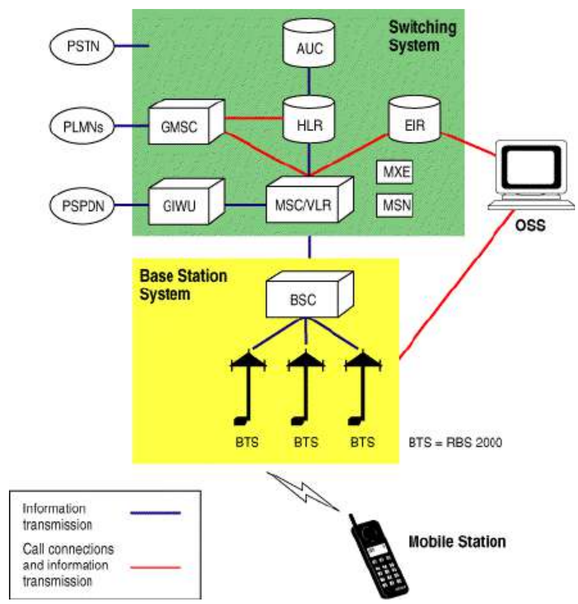

Fig 3.2 GSM

LCD:LCD screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

ECG MODULE:The electrocardiography or ECG is a technique for gathering electrical signals which are generated from the human heart. When someone experiences physiological arousal then the ECG sensor allows us to recognize the level, however, it is also used for understanding the psychological state of humans. So, an AD8232 sensor is used to calculate the electrical activity of the heart. This is a small chip and the electrical action of this can be charted like an ECG (Electrocardiogram). Electrocardiography can be used to help in diagnosing different conditions of the heart. This article provides an overview of the AD8232 ECG Sensor.

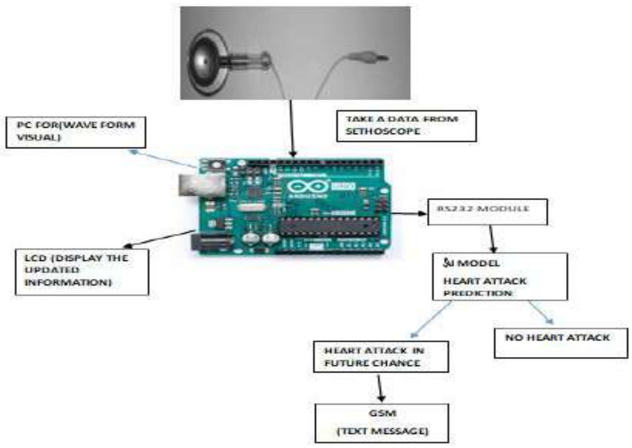

Fig 2: **Assembled Hardware**

Fig 2 shows the assembled hardware components of the stethoscope

IV. CONCLUSION

Developing a digital stethoscope integrated with a microphone to capture heart rate data and leveraging machine learning (ML) algorithms to analyze and predict outcomes presents a promising avenue for healthcare innovation. By digitizing traditional stethoscope functionality, this solution enables efficient, accurate, and real-time monitoring of cardiac health. The integration of AI models in ML enhances diagnostic capabilities, potentially enabling early detection of abnormalities or predicting cardiovascular events. This holistic approach empowers both healthcare professionals and individuals to proactively manage heart health. The conclusion underscores the transformative impact of merging medical devices with advanced technologies, ultimately advancing personalized healthcare and improving patient outcomes.

V. FUTURE ADVANCEMENT

For decades, scientists have looked for an effective treatment for spinal cord injuries, often with little success. Now, new research by Northwestern University scientists has resulted in a game-changing innovation: an injection that uses "dancing molecules" to repair spinal tissue and reverse paralysis

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Smart Mountain Climbers Health Monitoring and Position Tracking

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Abstract— The well-being checking and efficient monitoring for mountain climber is gaining its importance nowadays. Several precautions must be taken regarding the safety of climbers. In order to track the wellness of the climbers they must carry pulse rate sensors suitable communication devices to connect with the control rooms. At worst heath conditions, it turns out to be incompetent for the mountain climbers to utilize it and communication issues increases inefficiency after a particular altitude. The health and position tracking system with Global Positioning System GPS to detect the live location and furthermore measuring the temperature and heartbeat of the climber is proposed in the work which overcomes the shortcomings of the techniques used by the mountain climbers. providing them instant health Monitoring includes activities such hiking, hill climbing and more But it becomes dangerous and involves high risks. Common accidents include altitude sickness, missing persons and accidental falling. Due to mountaineering activities lots of cases with heavy injuries and deaths are reported. There is a need for monitoring the mountaineer accidents and providing a rescue system. This issue is addressed and Wireless Sensor Networks along with Telehealth is seen as a promising solution. It can cut cost in power and wiring. Devices which is low powers needed to transmit the data over very long distances were there are no network coverages. So Wireless technologies like Long Range LoRa which is a network being able to transmit over long distances without high power consumptions can be used under these conditions. A monitoring device is implemented which is used for monitoring the person for safety via LoRa technology. A cloud server is set up by using LoRa gateway combined with Internet of Things IoT. This system provides an architecture system for monitoring, tracking and early rescue.

Keywords— Gps , Lora , Heart rate Sensor , Peltier , MEMS Sensors

I. INTRODUCTION

Mountain climbing or trekking count is increasing currently owing to their interest in improving their health, balancing mental and physical health. It also viewed in the point of body weight exercise, better flexibility and blood circulation. Especially these passionate climbers undergo several risks during their climbing activity. So, it is necessary to beware of the risks of accidents in climbing process High altitude mountain climbing exposed to low heart rate, low temperatures ,physical and mental stress. This sudden variation causes abnormal variation blood pressure and heart rates . The major risk incudes of shortness of breath due to insufficient oxygen at high attitudes and climbing in extreme warm and cold environment involves in getting the risk of injuries, hypothermia and heat stroke. In additional to the climatic conditions, getting contact with the insects and poisonous plants causes allergies and variation in blood pressure needs medical attention. At this situation, immediate contact of rescue team by the person affected is difficult and this time lagging in identifying the affected climbers leads to severe illness. The automatic tracking of mountain climber location and reaching the spot by the rescue is needed Mountain climbers can communicate with their team or if emergency they contact the rescue team or medical team with the communication medium, but the range of signal availability after a particular altitude is difficult. Mountain climbers often face unexpected situation with power and signal issues so, LoRa Long Range is a wireless radio frequency technology that has been gaining high popularity for integration with Internet of things IoT networks worldwide.

LoRa along with IoT has been used to solve some of the biggest challenges facing us such as the reduction in the natural resources used, infrastructure efficiency, pollution control and even energy management. The Long Range provided by the LoRa is key feature as it can reach up to 10Km in rural areas by using proper directional antennas. It also penetrates to a higher extent in urban conditions compared with other wireless technologies. LoRa is a low cost and low power replacement Thus, the LoRa is a combination of both Wi-Fi and Cellular networks making it an efficient, inexpensive and flexible alternative for other wireless technologies. Peltier technologies used to maintain the temperature of climbers.

II. PROPOSED METHOD

The main aim of our project is to monitoring the health of mountain climber and tracking of the climber location. The health monitoring can be done using the pulse sensor and temperature sensor. Pulse sensor give the heart rate, when the heart rate crosses the limit given by the user it will alerts Temperature sensor will give the temperature of the climber on the LCD screen. In stage two through GPS location of the climber can be detected, and automatically information is sent to the higher authorities or rescue team. through Blynk app the temperature, pressure, altitude, longitude, latitude, Pulse rate can be seen.

A. NODEMCU ESP8266

The NodeMCU ESP8266 is an open-source software and hardware development environment built around an inexpensive System on a Chip SoC called the ESP8266.The NodeMCU Development Board can be easily programmed with Arduino IDE since it is easy to use Programming NodeMCU with the Arduino IDE will hardly take 5-10 minutes. All you need is the Arduino IDE, a USB cable and the NodeMCU board itself.

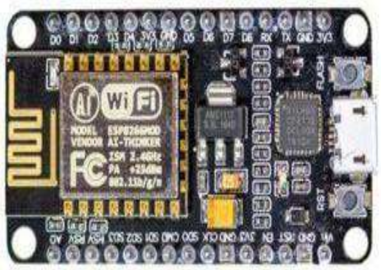

Figure 1: NODEMCU ESP8266

B. LoRa

LoRa Long Range is a wireless communication technology designed for low-power, long-range communication in the Internet of Things IoT applications. It operates in the sub-gigahertz frequency bands, providing extended range with low power consumption. LoRa is known for its efficiency in transmitting small amounts of data over considerable distances.

Figure 2: LoRa

C. GPS MODULE

A GPS module is a compact electronic device that receives signals from satellites to determine its precise location on Earth. It utilizes trilateration to calculate coordinates, enabling accurate positioning for various applications such as navigation, tracking, and location-based services. Commonly integrated into devices like smartphones and vehicle navigation systems, GPS modules play a crucial role in providing real-time location information

Figure 3: Gps Module

D. PELTIER

A Peltier sensor, also known as a thermoelectric cooler, is a device that utilizes the Peltier effect to create a temperature difference across its surfaces when an electric current is applied. It can function as both a cooler and a heater, making it suitable for temperature control applications. Peltier sensors are commonly used in electronics, medical devices, and other industries requiring precise thermal regulation.

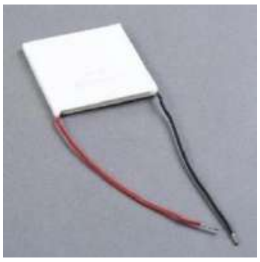

FIGURE 4: PELTIER

III. BLOCK DIAGRAM

The block for the transmitter side is shown in the Figure 5 and receiver side is shown in Fig.6. The transmitter side is referred as mountain climber side contains the temperature sensor, heart beat sensor, MEMS sensor and Peltier.

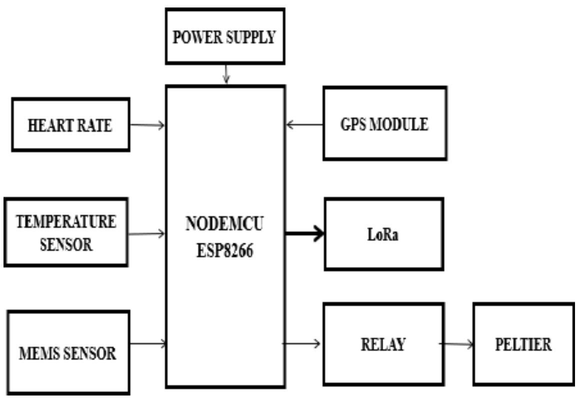

Figure 5: Block Diagram of Transmitter side

All the input sensors are connected to the NODEMCU ESP8266.The NODEMCU ESP8266 used to monitor and control the temperature sensor, Heart beat sensor, LoRa and Global Positioning System.

The LoRa and GPS module are connected to transmitter side for transferring the information and location. Temperature sensor is used to monitor the body temperature of the mountain climber and also heart beat sensor monitor the heart rate of the mountain climber. When the heart beat value and temperature sensor value goes below the predetermined value of health condition, then the GPS location will send the Alert Message using LoRa. The Liquid Crystal Display (LCD) display shows the value of the heat beat and temperature of the mountain climber and also it show the Position..

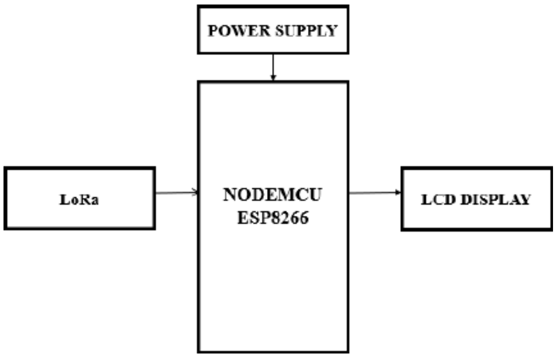

Figure 6: Block Diagram of Receiver side

In receiver side buzzer is used and it is controlled by the Radio Frequency (RF) Receiver. This receiver side is present in the medical camp. When the abnormal variation in temperature or heart beat.

IV. BLYNK CLOUD

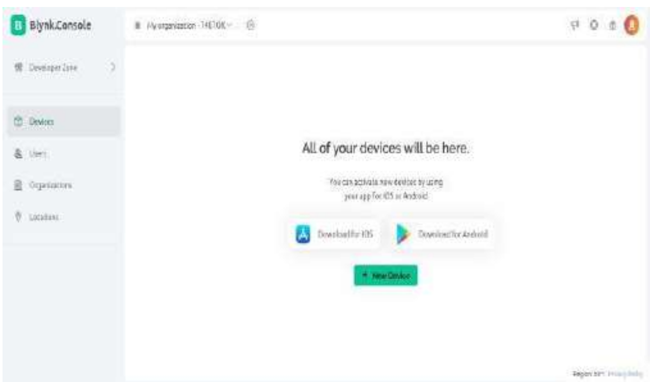

Figure7: Blynk Application

Blynk is a platform that allows you to easily build and control IoT (Internet of Things) projects. It provides a mobile app that you can use to create a custom interface for your IoT devices, allowing you to monitor and control them remotely. Blynk supports a wide range of hardware platforms, making it easy to integrate with different sensors, actuators, and other IoT components. With Blynk, you can quickly prototype and deploy IoT projects without needing to write complex code or build your own mobile app.

V. CIRCUIT DESCRIPTION

A. Transmitter Side:

Heart Rate Sensor:
The Output Pin (A0): Connect to the analog pin of the NodeMCU ESP8266.Ground: Connect to the ground of the power supply board.VCC (5V): Connect to the 5V pin of the power supply board.

Temperature Sensor:
The Data Pin (D3): Connect to a digital pin of the NodeMCU ESP8266.Ground: Connect to the ground of the power supply board.VCC (5V): Connect to the 5V pin of the power supply board.

MEMS Sensor:
The Data Pin (D1): Connect to a digital pin of the NodeMCU ESP8266.Ground: Connect to the ground of the power supply board.VCC (5V): Connect to the 5V pin of the power supply board.

Relay:
The Control Pin (D4): Connect to a digital pin of the NodeMCU ESP8266.12V Connection: Connect to the power supply board.Ground: Connect to the ground of the power supply board.

LoRa Module:
The CSS Pin:Connect to a digital pin of the NodeMCU ESP8266.MISO:Connect to pin D7 of the NodeMCU ESP8266.MOSI:Connect to pin D6 of the NodeMCU ESP8266.SCL:Connect to pin D5 of the NodeMCU ESP8266.Reset:Connect to pin D0 of the NodeMCU ESP8266.DIO:Connect to pin D2 of the NodeMCU ESP8266.Ground:Connect to the ground of the power supply board.VCC (3.3V): Connect to the 3.3V pin of the power supply board.

B. Receiver Side:

LCD:
The Power (5V): Connect to the power supply board.Ground: Connect to the ground of the power supply board.SCL:Connect to the SCL pin of the NodeMCU ESP8266.SDA: Connect to the SDA pin of the NodeMCU ESP8266.

LoRa Module:
Same connections as the transmitter side.

Buzzer:
The Control Pin (D3): Connect to a digital pin of the NodeMCU ESP8266.Ground: Connect to the ground of the power supply board.

VI. PROTOTYPE

The components connected as per circuit for transmitter is shown in Figure 8 and receiver side is shown in Figure 9. The working model displays the variation in temperature and Heart beat. Component of prototype is shown in table 1.

COMPONENT OF PROTOTYPE

S.no	*Product used*	*Quantity*
1	NODEMCU ESP8266	2
2	Heart Rate Sensor	1
3	Temperature Sensor	1
4	MEMS Sensor	1
5	Peltier	1
6	GPS Module	1
7	LoRa	2
8	LCD Display	1
9	Relay	1
10	Buzzer	1
11	12V Battery	1

VII. RESULT

The prototype delivers the information through Blynk app to monitor the mountain climber health parameters using different sensors. The change in temperature, heartbeat and location will be detected by respective sensors this will be displayed in virtual terminal that connected to transmitter pin of NODEMCU ESP8266 board is shown in Figure 8

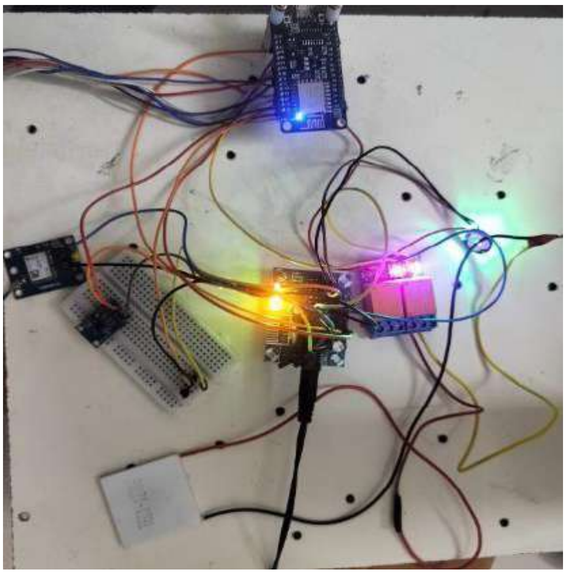

Figure 8: Transmitter Side

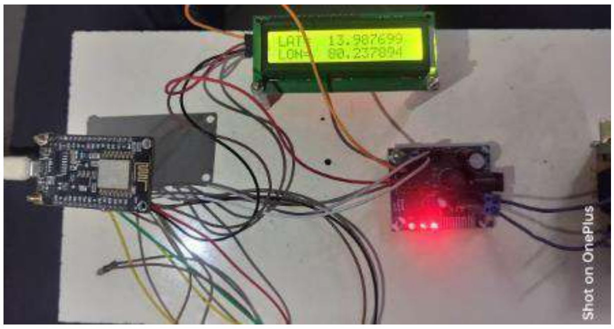

Figure 9: Receiver Side

VIII. CONCLUSION

In the realm of mountain climbing, where the exhilaration of scaling heights meets the challenges of treacherous terrains, safety is paramount. The methodology presented here outlines a meticulous approach to addressing the critical need for a robust monitoring and rescue system. By integrating advanced technologies such as pulse rate sensors, GPS modules, LoRa communication, and cloud-based infrastructure, this methodology strives to safeguard the well-being of mountain climbers in hazardous environments. Through the systematic analysis of requirements, the methodology identified the essential components necessary for effective monitoring, including pulse rate sensors, communication devices, and GPS modules. By delving into the limitations of existing techniques, particularly in communication inefficiencies and limitations at higher altitudes, the groundwork was laid for a comprehensive solution. The selection of cutting-edge technologies such as Wireless Sensor Networks and Long Range communication technology was strategic, aiming to overcome the challenges faced by climbers in remote and rugged environments. The design and development of the monitoring system, coupled with the establishment of a cloud server infrastructure, promise real-time health monitoring and precise location tracking for climbers.

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IoT-based Real-Time Cattle Health Monitoring with Immediate Feedback

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Abstract— A significant risk to the production of dairy cow milk is disease. A healthy cow can yield 12 to 15 liters of milk a day, which is a substantial quantity. However, when cows become unwell, this yield might drop dramatically to 5–10 liters. Maintaining the health and production of the herd depends on early detection and treatment. Unfortunately, this procedure is frequently hampered by breeders' inadequate awareness of illnesses and their occasional surveillance. In order to address these issues, this study suggests a dairy cow health management system that includes detection and monitoring features. The system offers a complete solution by utilizing intelligent systems and Internet of Things (IoT) technology. The monitoring system uses sensors to gather data on the temperature and heart rate of the cows, enabling a real-time assessment and categorization of their health (normal or abnormal).Breeders enter symptom data into the detection system, which is then analyzed to provide important insights into possible diseases, treatment alternatives, and preventative actions. The system's usefulness has been shown through experiments. With a temperature error of ±0.6°C and a heart rate error of ±3.5 bpm, the monitoring device shows good accuracy. Additionally, the detecting technology claims a 90% accuracy rate in dairy cow disease diagnosis.

Keywords—Health management system; internet of things;dairy cow; intelligent system.

I. INTRODUCTION

The importance of domestic milk production is highlighted by the Indonesian government's attempts to improve the quality of the country's food consumption, especially by increasing protein intake. Even so, the country's milk production is still insufficient, providing only 21% of the country's consumption needs in 2016, with the remaining 79% coming from imports. This is despite of the growing need for milk as a source of protein. Because of the high reliance on imports, domestic dairy farms suffer direct losses. These losses are mostly caused by the low productivity of dairy farming, which is caused by a number of issues, including the health of the animals.

Dairy cow productivity levels depend on their health being at its best. When cows are sick, such when they have mastitis, their milk production is decreased, which results in significant financial losses.For example, mastitis can result in a daily reduction in milk output of 14.6% to 19% per head, which can translate into substantial annual losses. Breeders must implement efficient health management strategies in order to minimize these losses, which calls for all-encompassing maintenance plans that include routine health examinations and prompt disease treatments.

Traditional cattle health monitoring techniques have drawbacks, chiefly in the form of scarce human resources and sporadic monitoring schedules. Three daily inspections by breeders are the norm for animals, however this may not be enough for medium-sized to big farms with lots of dairy cows. The lack of expertise among breeders in illness diagnosis makes this sporadic surveillance regime even more detrimental to early disease detection and treatment.Numerous studies have looked into creative methods for illness diagnosis and health monitoring in cattle as a reaction to these difficulties.Promising solutions can be obtained by utilizing technology like the Internet of Things (IoT). Smart wearable with Internet of Things (IoT) capabilities continuously monitor important health metrics in real time, allowing for early abnormality identification and timely intervention. These multi-sensory devices affix securely on cattle and wirelessly send data to centralized processing units.

IoT-based wearable technologies aim to help breeders manage their health more proactively by quickly identifying and warning them about possible health problems.These technologies provide breeders the ability to treat animals on time, modify management techniques, and get veterinary help as necessary. Additionally, these technologies have predictive capabilities by utilizing machine learning and advanced analytic, allowing breeders to foresee health patterns and take proactive measures to address future issues.To sum up, the creation of smart wearable systems based on the Internet of Things for monitoring the health of cattle is a noteworthy progress in the practices of livestock management. These technologies improve productivity, promote sustainability, and boost profitability in the livestock farming sector by giving breeders access to real-time knowledge, proactive intervention tools, and predictive analytic.

II. PROPOSED STATEMENT

The goal of this project is to create a novel approach to the whole management of the health of dairy cows, including

model is created by applying the decision tree technique. Testing data is then used to create classification predictions during the testing phase, which particularly diagnoses diseases in dairy cows and provides information on
proper handling and preventive measures.

1) Acquiring Knowledge

The process of obtaining information in the form of expert knowledge from veterinarians who are participating in this study is known as knowledge acquisition. The interview approach is used to gather data from experts by methodically eliciting and documenting their insights and knowledge. The results of these interviews are then modeled and organized with the aid of a knowledge editor, converting them into models or data structures that can be processed computationally. The basic training data for the intelligent systems used in the study is this carefully selected data.

2) Information Education

Training data is an essential collection of data that is used to help intelligent systems learn and draw conclusions that are consistent with their intended functions. The training data in the intelligent system includes detailed information about diseases, such as their symptoms, course of treatment, and preventive measures.The process of formulating training data entails modelling the information pertaining to diseases, in which illness kinds function as classes or labels and symptoms as attributes. Every characteristic in the training set has two binary values: 1 denotes presence or true, and 0 denotes absence or false. For this investigation, the training data consists of eight disease categories and 23 training-designated symptoms.

3) The Tree of Decisions

The decision tree functions as a categorization technique that converts data into a format that is structured and shown by rules and trees. As can be seen in TABLE I, the training data for this study is arranged into tables containing attributes and classes (or labels), where instances of each attribute are represented by binary values (0 for false and 1 for true).Training data is first transformed into a tree structure in order for the decision tree algorithm to function. This tree is made up of nodes that are arranged according to the computed Entropy H(a) value, which is determined by formula (1):

$$H(a) = -B \log2 B, Q \log2 Q,..., Bn \log2 Bn \quad (1)$$

Here:

- Entropy (A) is the approximate amount of bits needed in the sample space S to extract a class or label from the datasets. The sample data space used for training is denoted by S.
- B indicates how many positive or negative answers there are for a given set of criteria in the sample data.

The next stage is to convert the tree into a set of rules after the node placements are determined based on entropy values. These rules are then saved as a model for later testing stages.

4) Model of Classification

After training, the final model takes the form of a tree represented by rules. Using this methodology, intelligent systems go through a testing phase where diseases in dairy cows are diagnosed by processing input data in the form of symptom values seen in the animals. A tree formed post-training process where it is then represented as rules. To ensure lucidity, every attribute is given a unique identity, indicated as A1, A2, and A3. The derived rules have the following structure after the tree is represented as a set of rules:

R1: IF A1 >= 0.5
THEN Class = 3

R2: IF A1 <= 0.5 ^ A2 >= 0.5
THEN Class = 5

R3: IF A1 <= 0.5 ^ A2 <= 0.5 ^ A3 >= 0.5
THEN Class = 3

Rn: IF An
THEN Class = n

These rules succinctly encapsulate the decision-making process, aiding in the classification of diseases based on the observed attributes within the input data.

5) Examining Data

The datasets used to evaluate models created after training is referred to as data testing. Breeders entered the symptom data in this datasets, which consists of observations of symptoms in dairy cows. Each symptom is represented as either 1 (True) or 0 (False). The intelligent system then processes the symptom data, producing findings about the diagnosis of the ailment, suggested courses of therapy, and preventive actions.

6) *Classification Prediction:*

This term refers to the results of the testing procedure that take the form of forecasts for disease diagnosis, treatment strategies, and prophylactic actions. These forecasts are practical insights that help breeders resolve health issues and maximise the welfare of dairy cows.

C. Information Capturing

Each and every piece of gathered data is carefully kept in a specified data storage system. In this research, file-based data storage and the use of MongoDB databases are the two different approaches to data storage.File-based data mostly consists of rule models that are obtained from the decision tree in the intelligent system. The models are stored in a file format ending in ".pkl," which is then utilized during the testing procedure.On the other hand, information from the monitoring system and some information from the intelligent systems are stored in the MongoDB database. This database acts as a reliable storage option, making it easier to store and retrieve a variety of datasets that are essential to the goals of the study.

D. Front-end

The front-end part is an essential interface for the study that includes user interactions and visualization approaches. This element is further divided into two sections: an application- and web-based user interface, as well as a node design. Breeders now have an easy-to-use platform to acquire and understand relevant health-related data about dairy cows.

On the other hand, presents the node's design, which stands for the hardware interface that is employed during the data gathering and transmission procedures. The integration of sensors and electrical components necessary for data collection and real-time monitoring is included in the node architecture.

IV. RESEARCH TESTIMONY

The study's experiments are divided into two main stages, each of which focuses on a different component of the created system. In order to assess the monitoring system's effectiveness in remotely presenting the health status of dairy cows in real-time, experiments are conducted on the system during the first phase. The second phase consists of intelligent system experiments where the accuracy of the disease diagnoses that the system provides for dairy cows is evaluated. Every stage of the investigation will be covered in detail in the part that corresponds to it.

A. Keeping Track of System Trials

The monitoring system's studies are intended to evaluate the system's performance and confirm that it can successfully track the health status of dairy cows.In order to achieve these goals, the experiments that have been carried out are divided into two categories: technical experiments, which examine the operation of the system, and measurement experiments, which assess the sensor-generated data that the system has collected.

1) Technical Trial

The purpose of the technical experiment is to confirm that the system operates flawlessly. By examining particular parameters, it evaluates if each part or component is operating as intended, with a primary focus on data transfer. Data transmission validates each component's successful operation if it follows the predetermined scenario.

The data communication scenario used in this study is as follows: the node uses the MQTT protocol to send data to the gateway once every second. Every 30 seconds, the gateway then calculates the average data and sends the combined results to the server. The socket.io library is used by the server to broadcast the data when it has received it, enabling real-time front-end data visualization.The technical experiments have yielded the following observations based on the results:

- Every second, the node successfully transfers data to the gateway.
- Every 30 seconds, the gateway sends the results of its accurate computation of the average data to the server.
- The server efficiently emits and saves data, allowing the front-end to visualize it in real time.

These findings confirm that data transmission corresponds with the intended scenario, confirming the strong operation of every part in the surveillance system. While Fig. 10 presents evidence of the installation testing of nodes on dairy cows, Fig. 9 shows a visualization of data on the web interface during node data transmission.

2) Measurement Trial

The goal of the measuring experiment is to see whether the body temperature and heart rate recorded by the nodes' sensors agree with those recorded using more traditional techniques. The purpose of this comparative study is to confirm if the sensor measurement data and the real values match.

TABLE I. Comparison of Heart rate value

TABLE II. Comparison of Temperature value

Number of experiments	Temperature		Difference
	Node	Stethoscope	
1	37.1	36.3	0.8
2	36.6	37	0.4
3	37.1	36.4	0.7
Average			0.63

Using a stethoscope and thermometer, the experiment's scenario entails comparing and identifying differences between the temperature and heart rate readings that the nodes' sensors provide and those that are received using traditional methods.The experimental results are shown in TABLE I, which compares the temperature readings recorded by the node's sensor with those recorded by the thermometer during the course of three trials. Every experiment shows an average difference of 0.6 degrees Celsius. This small discrepancy suggests that the sensor's temperature readings are reliable and consistent with those obtained from a traditional thermometer.

TABLE II presents the experimental results in a similar manner, showing a comparison between the heart rate readings from the stethoscope and the sensor on the node over three trials. In all experiments, an average difference of 3.5 beats per minute was noted. The sensor's heart rate data appear to be accurate and in line with readings from other sources, based on this marginal variance.

These findings demonstrate the precision and dependability of the sensor readings, giving rise to trust in the devices' capacity to accurately track dairy cows' body temperature and heart rate.

B. Experiments on Intelligent Systems

The purpose of the intelligent system experiments is to assess how well the system performs in correctly diagnosing symptoms. Veterinarians participate in these trials as validators of the diagnoses the system provides.For the purposes of this experiment, formula (2) is used to determine the error value or diagnostic error provided by the system

$$100\% - \left(\frac{\text{number of error}}{\text{number of experiments}}\right) \times 100\% \qquad (2)$$

Veterinarians enter patient symptoms into the system, then compare the outcomes of the system-generated diagnoses with their own diagnostic to determine whether the system's diagnosis is accurate. The veterinarian decides whether the results are accurate or not based on this comparison.

Samples	Doctor diagnosis	System diagnosis	True / False
Sample 1	Mastitis	Mastitis	True
Sample 2	Bloat	Bloat	True
Sample 3	PMK	PMK	True
Sample 4	Anthrax	Anthrax	True
Sample 5	Brucellosis	Brucellosis	True
Sample 6	Scabies	Myiasis	False
Sample 7	Leptospirosis	Leptospirosis	True
Sample 8	Myiasis	Myiasis	True
Sample 9	Brucellosis	Brucellosis	True
Sample 10	Anthrax	Anthrax	True

TABLE III. Experimental result

Out of the ten studies, the system produced one diagnosis error, according to an analysis of the experimental results from TABLE III. The system's performance is then determined using formula in the manner shown below:

$$100\% - \left(\frac{1}{10}\right) \times 100\% = 90\ \%$$

Consequently, it is found that the intelligent system has a 90% accuracy rate and a 10% error rate. Because the physical symptoms of myiasis and scabies are similar, including both diseases' major symptoms in experiment 6 led to identification errors that were the cause of the diagnosis error. The method might incorrectly identify the ailment if the primary symptoms of both diseases are present.These results highlight how crucial it is to improve the system's accuracy and reduce errors in symptom-based diagnoses.

D. CONCLUSION

Health management in dairy cows, particularly in disease handling and prevention, presents challenges for Breeders. Limited real-time monitoring capabilities and Breeders' knowledge gaps hinder timely identification and intervention for diseased cattle. To address these challenges, this research introduces a comprehensive system integrating monitoring and intelligent systems using IoT technology. This system enables remote health monitoring of dairy cows and early disease detection.

Experiments demonstrate the functionality of both monitoring and intelligent systems. The monitoring system effectively measures key parameters like temperature and heart rate, facilitating remote health monitoring with an error rate of 0.6 degrees Celsius and 3.5 beats per minute. Meanwhile, the intelligent system achieves a 90 percent accuracy rate in diagnosing diseases, enabling early intervention by Breeders.Moreover, the IoT-based smart wearable system for cattle health monitoring represents a significant advancement in precision livestock farming. It offers real-time monitoring of health parameters, data analytics for insights into individual animal health, and operational efficiency through automation. However, challenges such as data security, sensor accuracy, and scalability need to be addressed for widespread implementation.

In conclusion, the IoT-based smart wearable for cattle health monitoring holds promise in revolutionizing livestock management practices. By providing actionable insights, enhancing animal welfare, and increasing productivity, this innovative system contributes to sustainable and efficient animal agriculture practices globally. Continued research and development are essential to address challenges and realize the full potential of this technology.

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Corn Seed Defect Detection Using Deep Learning

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Abstract - In agricultural industries, ensuring the quality of seeds, such as corn, is crucial for maximizing crop yield and overall productivity. However, manual inspection of seeds for defects is labor-intensive, subjective, and prone to errors. To address this challenge, we propose an automated defect detection system that combines deep learning techniques and image processing. Our system aims to accurately identify and classify defects in corn seeds, including mold, cracks, discoloration, and other imperfections. The process involves collecting a diverse dataset of high- resolution images containing both healthy and defective corn seeds, followed by preprocessing, labelling, and training a convolutional neural network (CNN) model. Through rigorous experimentation and validation, our approach demonstrates promising results in accurately detecting and categorizing defects in corn seeds. In addition to these challenges, traditional methods of seed quality assessment, particularly spectroscopy, present their own set of difficulties like cost, infrastructure, Maintenance. The proposed system offers significant potential to streamline seed quality inspection processes, enhance efficiency, and ensure consistent product quality in agricultural production systems. By automating the defect detection process, our system contributes to reducing labor costs and improving overall seed quality assurance.

Keywords: Deep learning, image processing, corn Seed Defect Detection, CNNs, Transfer Learning

I. INTRODUCTION

Traditionally, the inspection of corn seeds for defects has been a manual and labour-intensive task, relying heavily on human expertise and visual inspection. However, this approach is inherently subjective, time-consuming, and prone to inconsistencies and errors. With the advent of advanced technologies in image processing and machine learning, there is a growing opportunity to automate and enhance the seed quality inspection process. The integration of advanced technology is bringing about a significant revolution in the agricultural environment. One such innovative discovery is the use of deep learning for the detection of faults in corn seeds. Precision agriculture is becoming more and more important as the world's demands for sustainable food production rise, making the use of cutting-edge methods to improve crop quality and output necessary. Corn, a staple crop with diverse applications in food, feed, and industrial sectors, serves as a linchpin in global agriculture. In response to these challenges, the integration of deep learning techniques emerges as a transformative solution, promising accuracy and efficiency in corn seed defect identification. A seed's quality can be determined by a variety of factors, including its germination rate, genetic purity, and lack of abnormalities. Defects in corn seeds, which can range from visible flaws to latent anomalies, can weaken plant health, lower potential production, and aid in the spread of illness. Poor seed quality has significant economic consequences, which emphasizes the need for cutting-edge technologies that can accurately and quickly determine the integrity of maize seeds. Inspired by the neural networks found in the human brain, deep learning is a branch of machine learning that is revolutionizing a number of sectors. With its capacity to recognize complex patterns and learn autonomously from data, deep learning is a great fit for challenging jobs like image recognition. In this context, we propose an automated defect detection system leveraging deep learning techniques and image processing algorithms to accurately identify and classify defects in corn seeds. By harnessing the power of convolutional neural networks (CNNs) and sophisticated image processing techniques, our system aims to provide a reliable and efficient solution for seed quality inspection.

II. LITERATURE SURVEY

Chao Li [1] introduce a lightweight and effective network for maize seed defect identification. This network integrates the Convolutional Block Attention Module (CBAM) with the pre-trained MobileNetV3 architecture. CBAM helps the network focus on critical features in both the channel and spatial domains, leading to improved convergence and performance. In this way, the network can be focused on useful feature information, and making it easier to converge.

Peng Xu [2] establish a fast, non-destructive, and effective approach for defect detection in maize seeds based on hyperspectral imaging (HSI) technology combined with deep learning. A convolutional neural network architecture (CNN-FES) based on a feature selection mechanism was proposed according to the importance of wavelength in the target classification task. In addition, a convolutional neural network architecture (CNN-ATM) based on an attentional classification mechanism was designed for one-dimensional spectral data classification and compared with three commonly used machine learning methods, linear discriminant analysis (LDA), random forest (RF), and support vector machine (SVM).

Sandeep Musale [3] explores the application of image processing techniques in developing a smart seed quality analyser. The system leverages image analysis to assess various seed quality parameters, aiming to offer an automated, objective, and rapid method compared to traditional manual inspection. The authors highlight the potential of this approach in the food industry, particularly for examining and grading wheat grains. They discuss the different image processing stages involved, including pre-processing, segmentation, and feature extraction. The extracted features likely encompass characteristics like size, shape, colour, and other geometric aspects of the seeds. These features are then potentially employed for classification purposes, allowing the system to categorize seeds based on their quality.

Eakeshwari V et al., investigates the use of deep learning, specifically the YOLOv5 (You Only Look Once version 5) model, for seed quality testing. The authors address the limitations of traditional seed quality assessment methods, like sieving and handpicking, which are labor-intensive, time-consuming, and require expertise. They propose an automated system called "Mixed Cropping Seed Classifier and Quality Tester (MCSCQT)" to address these challenges: Dataset Preparation, Comparative Analysis, System Development are involved to find the solution. This paper suggests that deep learning and YOLOv5 offer a promising approach for automating seed quality testing in agriculture.

Aqib Ali [5] investigates the use of machine learning for classifying corn seed varieties. It proposes a method that captures digital images of various corn seeds, extracts a combination of features like colour distribution, texture patterns, and spectral information (forming "hybrid features"), and employs different machine learning algorithms for classification. The promising results demonstrate the effectiveness of this hybrid feature approach for accurate corn seed classification, potentially benefiting the agricultural industry.

Budi Dwi Satoto [6] explores using a convolutional neural network (CNN) for classifying corn seed quality. Their method incorporates two key aspects: region proposal to focus on the seed itself and data augmentation to artificially increase the dataset size and improve model robustness. This approach achieved high accuracy in classifying corn seed quality, outperforming other methods and potentially offering a valuable tool for the agricultural sector.

Aznan [7] investigate the potential of combining image processing and artificial neural networks for rice seed variety identification. Their approach involves extracting colour features from captured rice seed images and feeding them into an ANN for classification. This method demonstrates promising results, suggesting the potential of colour-based image analysis with ANNs for rice seed variety differentiation, which could be beneficial in agricultural applications.

Nale R. K. [8] employs Google Net and convolutional neural networks for detecting maize seed defects, crucial for global crop production. By curating a diverse dataset and leveraging transfer learning, the model accurately identifies various defects like fungal infections and physical damage. Google Net's intricate architecture proves effective, promising automated seed quality control, enhancing food security worldwide. The study highlights the potential of this approach for improving maize seed quality and consequently enhancing agricultural outcomes.

Chunguang Bi [9] This paper presents a novel approach integrating deep learning and machine vision, leveraging Swin Transformer's basis, to enhance maize seed recognition. This improved model leverages feature attention mechanisms and multi-scale feature fusion to achieve accurate recognition while maintaining low model complexity, potentially offering a practical solution for the agricultural industry.

Kantip Kiratiratanapruk [10] explore using a combination of colour and texture features for corn seed classification via machine vision. They extract these features from images of corn seeds and utilize them with a machine learning classifier to differentiate between different varieties. This approach demonstrates the potential of using visual information alongside machine learning for accurate corn seed classification.

Raghavendra Srinivasaiah [11] explores the application of machine learning for seed quality assessment. The propose a system that utilizes Convolutional Neural Networks (CNNs) to analyse seed images and categorize them based on quality levels (high, standard, or regular). The authors emphasize the potential of this approach to improve upon traditional seed quality evaluation methods, which are often subjective and lack robust validation techniques. The research suggests that the CNN-based model achieves promising results in differentiating between seed quality levels. However, the paper acknowledges limitations in terms of the study's scope and the need for further validation on larger datasets. Overall, the work highlights the potential of machine learning for seed quality prediction, potentially leading to improved agricultural practices and crop yields.

Shima Javanmardi [12] explores the use of deep learning for automatically classifying corn seed varieties based on their visual characteristics. They compared two approaches: Extracting low-level visual features (colour, morphology, texture) and using them for classification. Employing a pre-trained CNN model (VGG-19) to extract high-level features and then feeding them into a Support Vector Machine (SVM) classifier. They also explored combining both types of features for classification. both low-level and CNN-extracted features yielded comparable results to using CNN features alone. The study demonstrates the effectiveness of deep learning for automated corn seed variety classification.

III PROPOSED SYSTEM

The proposed system integrates deep learning and image processing using CNNs for accurate corn seed defect detection. It employs cloud-based processing for efficient data handling, addressing computational needs and ensuring scalability. The approach aims to revolutionize agricultural quality control with a more precise, efficient, and scalable solution.

Data Acquisition:

The performance of deep learning-based systems is significantly influenced by the quality and diversity of the training data. For the proposed corn seed defect detection system, a two-step data acquisition approach was employed to ensure comprehensive coverage and optimize model performance. First, a general dataset containing a wide variety of corn seed images was used to train the core components of the Convolutional Neural Network (CNN) model. This dataset was obtained from publicly available repositories and carefully selected to include a diverse range of corn seed varieties, defect types, and imaging conditions.

Image Preprocessing:

Image preprocessing plays a crucial role in preparing the input data for the deep learning model and ensuring optimal performance. In the proposed defect detection system, several preprocessing techniques were employed to enhance the quality and consistency of the collected corn seed images. One of the key preprocessing steps involved resizing the input images to a consistent resolution. Data augmentation techniques, such as random cropping, flipping, and rotation, were applied to the training dataset.

Model Architecture:

The proposed defect detection system leveraged the power of transfer learning and fine-tuning techniques to achieve high accuracy in identifying and classifying defects in corn seeds. The ResNet-50 model was initially pre-trained on a large-scale dataset, such as ImageNet, which allowed it to learn generalized features and representations applicable to a wide range of image recognition tasks.

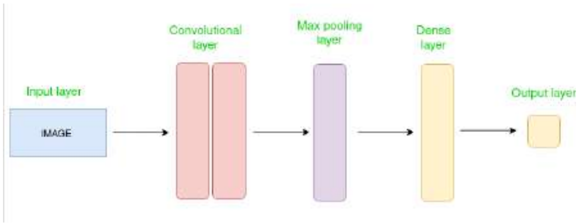

Figure 3.1 Block Diagram of ResNet 50

Model Training:

The training process began by defining the data transformations and normalization techniques to be applied to the input images. The `transforms.Compose` function from the PyTorch library was utilized to create separate transformation pipelines for the training and validation datasets. During each training epoch, the model was evaluated on both the training and validation datasets. Performance metrics such as loss and accuracy were computed and monitored to assess the model's progress and identify potential overfitting or underfitting issues.

Cloud and CUDA:

Due to the demanding nature of deep learning model training, especially with large datasets and intricate architectures, the system utilized cloud-based infrastructure equipped with high-performance NVIDIA A100 GPUs for faster processing. These GPUs, designed for parallel computing, significantly reduced training time through workload distribution across multiple units. Their large VRAM capacity allowed for training with bigger batches, improving model performance.

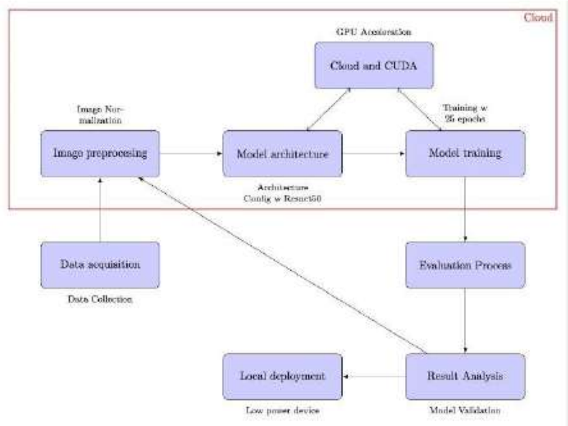

Figure 4.1Block diagram of the proposed system

Evaluation and Result Analysis:
To evaluate the performance of the defect detection system, the image data was preprocessed to ensure consistency. Each seed image was processed by extracting the relevant area, applying preprocessing techniques, and inputting the processed image into the model for classification as either "healthy" or "defective." The output of this process was a final image with color-coded bounding boxes surrounding each seed, where green boxes indicated healthy seeds and red boxes indicated defective seeds, allowing for easy visual inspection of the results.

Local Deployment:
While powerful hardware is crucial for training deep learning models, deploying the trained model for real-time inference can be achieved on devices with lower computational power like embedded systems or even mobile phones. This local deployment allows for on-site defect detection, minimizing data transfer and latency.

IV RESULTS

The corn seed defect detection system leveraged a diverse dataset containing high-resolution images of corn seeds with various imperfections, including structural abnormalities and subtle defects. A Resnet-50 convolutional neural network, trained extensively on this labeled dataset, achieved a remarkable accuracy of 86% in identifying and classifying defects. This training involved optimizing the model's parameters through backpropagation and ensuring generalization capability through a separate validation dataset. Precision, recall, and F1-score metrics further supported the model's effectiveness in minimizing errors. To assess these results visually, individual corn seeds within the dataset were identified using bounding boxes. Green boxes indicated healthy seeds, while red boxes denoted those classified as defective by the model, providing a clear understanding of the system's performance.

Parameter	Value (in percentage)
Accuracy	85.714%
Precision	85.719%
Recall	85.714%
F1 score	85.714%

Table 4.1 Parameters for model training

Confusion matrix:
True Positives (TP): The cases where both the true label and the predicted label are "good". This is represented by the bottom right cell with the value of 1218.

False Positives (FP): The cases where the predicted label is "good" but the true label is "bad". This is represented by the top right cell with the value of 195.

True Negatives (TN): The cases where both the true label and the predicted label are "bad". This is represented by the top left cell with the value of 1212.

False Negatives (FN): The cases where the predicted label is "bad" but the true label is "good". This is represented by the bottom left cell with the value of 210.

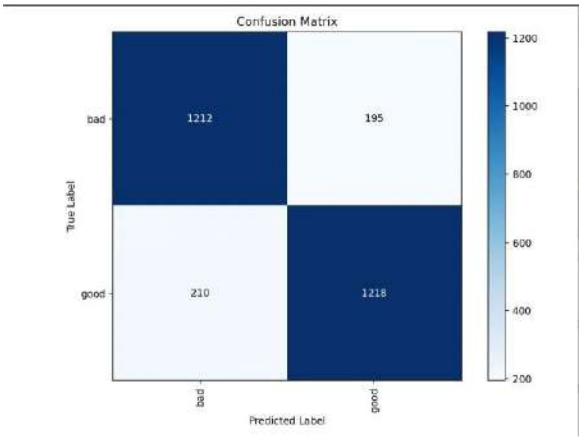

Figure 4.1 confusion matrix

Precision: It is the measure of exactness or fidelity of the model's predictions, precision articulates the proportion of true positive outcomes among all instances flagged by the algorithm as positive. It is the statistical reflection of the model's capability to minimize false positives, thereby ensuring that when a prediction is positive, it is reliable.

Recall: It is quantified by the ratio of true positive predictions to the total number of actual positive cases. High recall indicates that the model is adept at detecting positive instances, reducing the risk of false negatives.

F-measure (F1 Score): The F-measure harmonizes precision and recall into a single metric, providing a balanced gauge of the model's overall predictive accuracy.

In the analysis of corn seed defect detection using our deep learning model, each individual corn seed within the 4x6 image dataset was recognized and distinguished through bounding boxes. These bounding boxes, color-coded for clarity, served as visual indicators of the model's classification results, with green boxes denoting pure seeds and red boxes identifying defective ones.

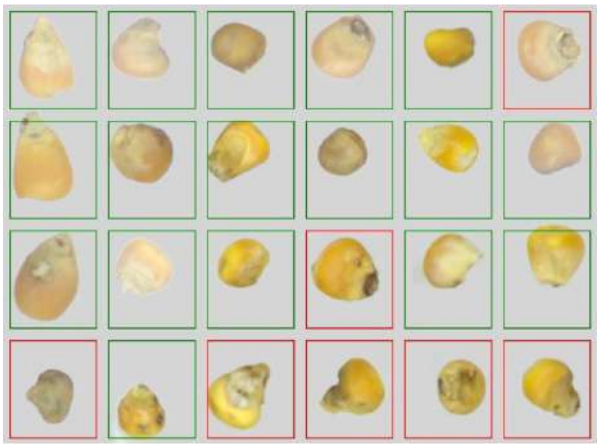

Figure 4.2 4x6 corn seed image

V CONCLUSION AND FUTURE SCOPE

In summary, leveraging deep learning for detecting defects in corn seeds has markedly enhanced efficiency and productivity in agriculture. Automated seed quality analysis expedites inspections, delivers consistent accuracy, and effectively manages vast datasets. These advancements benefit seed producers and farmers through faster inspections and increased yields, reinforcing the role of this technology in modern, sustainable farming practices.

Continued research is warranted to expand the model's capabilities. Enhancing detection accuracy could involve integrating more diverse data, like multispectral imaging, and deploying sophisticated neural network architectures. Real-time detection systems, in combination with edge computing, could enable immediate on-site analysis, further aiding farmers' decision-making processes. Collaborations with agricultural entities promise to scale and refine this technology, with the overarching goal of transforming agricultural practices through the intersection of deep learning and precision farming.

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Braille Enabled Smart Communications for Deaf blind People

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Abstract: Deafblind people are excluded from most forms of communication and information. This project focuses on addressing communication challenges faced by individuals who are blind or deaf-blind, aiming to enhance their inclusivity and self-reliance in society. Utilizing cost- effective components, the initiative introduces a Smart- Glove system designed to interpret the Braille alphabet and facilitate tactile communication. The Smart-Glove enables deaf-blind users to compose Braille-coded text messages through strategically placed push-button switches. These messages are then converted into standard text and transmitted to other mobile users via the TTGO T CALL V1.4 ESP32 SIM800L wireless communication module. Additionally, Smart-Glove incorporates small vibration motors, providing tactile feedback for blind individuals to perceive incoming messages. A noteworthy advantage of this system is its ability to enable communication with blind individuals without requiring prior knowledge of Braille.

Keyword: **assistive technology, Braille, deaf-blind, haptics, mobile communication, sensory, impairment, wearable device**

I. INTRODUCTION

Our daily lives now involve technology on some level. It has radically transformed communication, particularly over large distances. In the past, letters were the primary means of communication between individuals. Alexander Graham Bell, the inventor of the telephone, then emerged.

The telephone had its ups and downs, but over time, improvements were made, and it became accessible to the common people. Subsequent investigation gave rise to the era of mobile communication, which greatly simplifies communication while on the road. The pinnacle of telecommunications technology is mobile phones. Even with all the advancements in the realm of telecommunications, access to these technologies is still restricted for those who are physically deaf-blind. Restricted access does not imply inability to pay; their comfort was disregarded. While normal people were comforted by inventions and advancements in all facets of life, the needs of the physically and deaf-blind people were never prioritized.

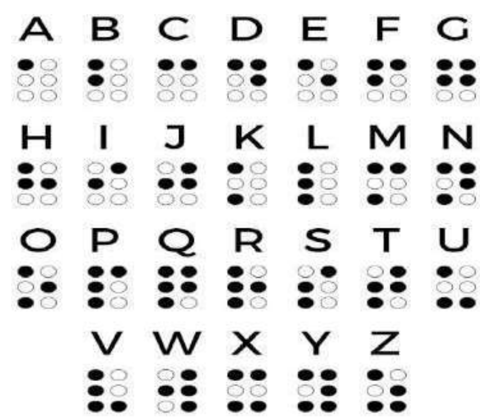

Figure 1. Standard braille format

'Braille' sign language for reading and writing. Through the use of touch, those who are blind or partially sighted can read and write using the Braille writing system. The French instructor of the blind, Louis Braille (1809–1852), created it. Reading in braille requires tracing each line with the hand from left to right. Since then, Braille technology has advanced significantly, allowing those who are deaf blind or blind to experience the comfort of today's modern devices. Here are a few newspaper articles that highlight the challenges faced in the past and the advancements made in the modern world. Following Braille's efforts, the code was redesigned to use only six dots per cell rather than twelve, as seen in the sample below. This advancement was significant because it allowed a fingertip to quickly go from one cell to the next and cover the entire cell unit with a single impression. Over time, braille became widely recognized as the primary written communication method for visually impaired people, and it is still essentially used today much as it was when it was first developed.

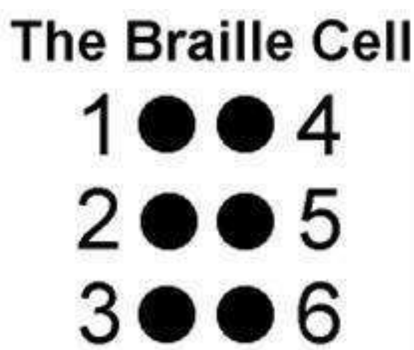

Figure 2. Representation of braille cell

Braille books, slate stylus, bricks, and other materials are examples of braille teaching methods. These were primarily helpful to the deaf-blind, and since they need extra attention, this project primarily aims to make it possible for them to utilize the push button to provide the necessary information, which will subsequently be converted into a text message. The GSM module is used to forward this message to the final recipient. A system to receive incoming messages and convertthem to braille is also included in this project.

II. LITERATURE SURVEY

Researchers in [1] suggest a smart glove that can independently send and receive SMS messages for deafblind people by translating Braille input into text messages and vice versa. They are better able to connect with others and break down barriers to communication as a result. The glove probably connects via Bluetooth to a mobile device to send and receive messages, employs sensors to identify Braille input, and processes data on a microprocessor.

A glove developed in [2] is intended to facilitate communication for deafblind individuals. It forms readable braille characters on the wearer's fingertips by using small motors to raise bumps. The glove's touch sensitivity enables the user to "write" in braille by applying pressure with their fingertips. People who are deafblind may be able to communicate more freely and readily with the use of this technology.

The research report [3] discusses a glove intended to assist those with vision impairments in reading braille, much as [2]. It forms braille characters that the user can feel and understand by using inflatable actuators to raise bumps on the fingertips. Similar to SmartFingerBraille, this technology may help people with visual impairments communicate more effectively and become more independent.

A few well-developed options for deafblind internet access were discovered in an assessment of the technology in [4], the majority of which were still in the early stages and concentrated on specialized activities rather than comprehensive online browsing. The study emphasizes how important it is to include deafblind individuals in the development process, close the gap between theoretical potential and practical application, and carry out more research to increase accessibility.

A novel kind of wearable gadget is described in a research study in [5] that aims to help those who are visually impaired read Braille. The gadget, a glove with a Braille display, uses a cutting-edge method to deliver improved tactile feedback. In contrast to conventional Braille displays, which employ mechanically raising and lowering pins to create Braille characters, this novel glove has an inventive mechanism that modifies the pressure applied to the user's fingertips to produce a more dynamic and subtle tactile sensation. This study examines the glove's design, implementation, and assessment, emphasizing how it might enhance the user experience and efficiency of Braille reading for those who are visually impaired.

In [6], a Hand Gesture Recognition-based Communication System for Mute People is presented as a means of assisting those who are mute in communicating. It does this by interpreting hand movements and translating them into voice or text. Usually, the system combines software and physical components. The hand motions are recorded by the hardware component, which might be a camera or data glove. The software component analyzes the recorded data and converts it into comprehensible text or voice using machine learning methods. People who struggle with speaking might see a big improvement in their communication skills thanks to this technique.

A system that enables visually challenged people to interact using SMS and Braille is described in the paper in [7]. The system makes use of a Braille keyboard and a refreshable Braille display. SMS messages that are converted into Braille characters and shown on the screen are available to users. In response, users may use the keyboard to input their message in Braille. The system will then convert it back into text and send it as an SMS. This technology provides a cost-effective and portable means of SMS communication for those with vision impairments.

The gloves in [8] use sensors to identify objects in the wearer's route, and noises or vibrations provide important environmental information. Their sense of confidence and independence may grow dramatically as a result, making it easier for them to go around and carry out everyday duties. It's crucial to keep in mind that these gloves are still in the early stages of development, and that the individual design may affect the functions and restrictions of each pair.

Individual demands lead to a variety of approaches for deafblind communication, which were examined by [9]. To accommodate a range of sensory abilities and preferences, common ways combine touch (Braille, handshapes, objects), sound (speech, amplified sound, vibration), and technology (screen readers, Braille displays).

III. PROPSED SYSTEM

This project’s prototype consists of a glove to be worn on the left hand of the individual, with the input side as the dorsal side and the output side as the palmer side of the glove.

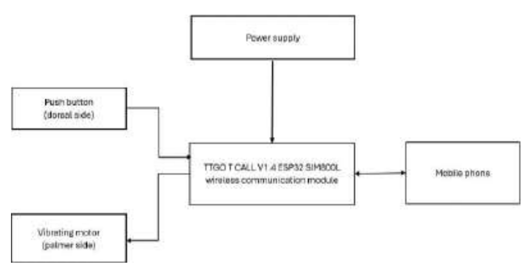

Figure 3. Overview of System

The user can send and receive the message using the push button and the vibrator motors placed on the dorsal and palmer sides, respectively. For sending the message, the user needs to enter the message using the push button according to the braille pattern and select the mobile number to which they need to send the message. The input message is then sent to the provided mobile number using the TTGO TCALL V1.4 ESP32 SIM800L wireless communication module, which has the SIM card integrated into the SIM800L module.

For receiving the message, the sender will send the SMS message to the mobile number of the SIM integrated in the SIM module, and then the incoming message will be recognized and converted into braille code by the microcontroller and presented to the user using the vibrator motor. By using this method, deafblind people can easily send and receive messages.

IV. METHODOLOGY

The hardware components of our prototype consist of TTGO T-CALL V1.4 ESP32 SIM800L wireless communicationmodule,cointypevibrator,2N 22atranistor,1N40 01 diode,1K transistor and push button. The TTGO TCALL V1.4 ESP32 SIM800L wireless communication module incorporates the SIM card into the SIM800L module.

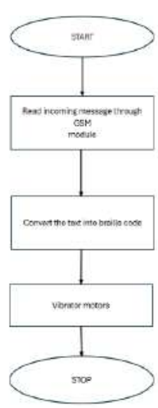

Figure 4. Text to Braille conversion.

The prototype's receiving side is made up of a microcontroller-connected six-coin vibrator motor that is mounted on the glove's palm side. Through the GSM module, the system can read the incoming message. The microcontroller reads the message and converts it to braille characters. Vibrant motors provide hepatic feedback, which allows people to decipher information without the use of visual aids. Users may read the message by touching the vibrating motors and identifying the braille characters thanks to this tactile sensation, also referred to as vibrotactile feedback. The system receives input by push buttons. It is nothing more than a mechanical switch with a on and off logic. One of two interpretations occurs when the button is pressed: "Logic 1" or "Logic 0," and vice versa. For example, in accordance with the Standard Braille Format, the system will recognize the entered pattern as B if push buttons 1 and 2 are pressed simultaneously. The braille pattern will be recognized by the system as A if push button 1 is pressed. All of the braille dot pattern's push buttons need to be depressed simultaneously, or at the same time, in order for the system to recognize the character.

One can build a whole word or sentence in this way. Every alphanumeric character's Braille code combination is kept in the program. For example, there are 10 Braille combination codes for integers and 26 Braille combination codes for alphabets. The matching letters will be recognized if the precise keys are touched at the same time.

This text to braille converter project is processed and implemented using the TTGO T-CALL V1.4 ESP32 SIM800L WIRELESS COMMUNICATION MODULE. By examining the push button state, it ascertains the character's representation and, depending on that state, sends the message to the specified mobile number.

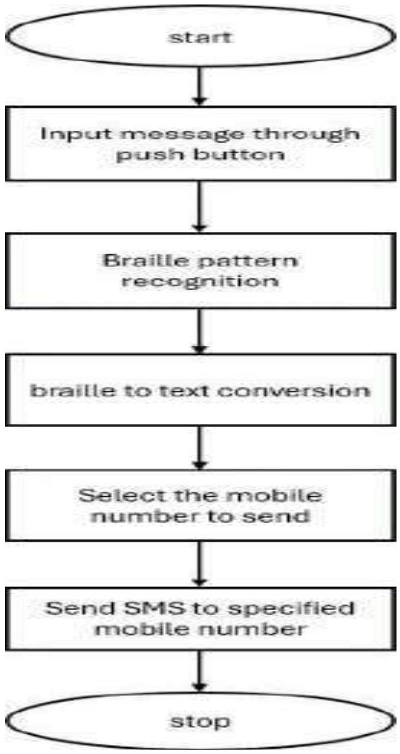

Figure 5. Braille to text conversion

The disabled individual must choose the recipient's mobile number and hit the send push button in order to send an SMS following message construction. This would enable the communication device's GSM module to transmit the message sequence as an SMS to a designated mobile number.

V. RESULTS

Figure 6. Prototype of The System

When interacting with a cell phone, our glove prototype's input and output modules both functions well for all allowed characters. Different motor vibrations can be clearly distinguished from one another since they are all felt locally at the palmer side position that corresponds to their respective Braille cells.

VI. CONCLUSION

Through the successful development of a promising prototype, this initiative has enabled deaf-blind people to freely communicate through text messaging using Braille. The glove has a built-in SIM card for SMS capabilities, enables two-way Braille input and output, and can even translate text messages into Braille code that users can understand through vibrations.

By making it easier for deaf-blind people to interact and share information, this cutting-edge technology has the potential to greatly increase their independence and communication skills.

To improve security features, provide customization options, and investigate multi-language support for Braille patterns, more development is necessary.

By taking care of these issues, the project can develop into a more reliable, approachable, and broadly useful communication tool with even more uses, which will eventually improve the quality of life for those who are deaf-blind.

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Design of H-Shape Microstrip Patch Antenna forThyroid Gland Cancer Cells Detection

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Abstract - This paper presents the design of an H-shaped microstrip patch antenna to evaluate the SAR (Specific Absorption Rate) for thyroid gland cancer cell detection. This antenna is flexible and appropriate for wearable applications. The performance can be varied when the antenna is placed on the thyroid gland of humans. The parameters like return loss, gain, VSWR are measured. There are different varieties of the antenna but microstrip patch antenna provides low cost, low volume, lightweight etc. FR-4 (lossy) is used as a substrate to overcome low gain and high return loss. The patch conductor is made up of copper material to form aflexible antenna. The proposed antenna design providesa high SAR value of 0.0199W/Kg for 1g of tissue with a tumor. Since cancer cells contain more water content the performance of various parameters can be changed in the proposed antenna design. The gain value of the proposed antenna is 2.77 dB at 5.244 GHz. The thyroid gland model of proposed H-shaped and H-shapedvertical slot antennas are designed using CST (Computer Simulation Technology) microwave studio tool.

Keywords: Voltage Standing Wave Ratio, Return Loss, Gain, Specific Absorption Rate

I INTRODUCTION

The thyroid gland is situated in the neck just below the larynx and is often referred to as the voice box. With a butterfly-shaped structure, it comprises two lobes known as the isthmus. Thyroid cancer originates in this gland, manifesting when healthy cells undergo changes, forming a mass termed a tumor [8]. This type of cancer can easily spread throughout the neck and other parts of the body. Under a microscope, normal cells differ from thyroid cells [4].In the realm of cancer detection, a wearable microwave imaging device utilizes a flexible antenna [3]. The Metal Composite Embroidery Yarn (MCEY), a polyester substrate,is employed for detecting FM signals. This involves attaching the MCEY-embroidered Multi Resonant Folded Dipole (MRFD) to a jacket, creating a wearable antenna. However, proximity to the human body can reduce the antenna's efficiency and frequency due to the body's high permittivity [6]. Textile antennas exhibit lower return loss atlower frequencies. For protection, flexible foam, offering excellent thickness and stability, is used [1] [10].Specific Absorption Rate (SAR) quantifies the power absorbed by human tissue, determined by placing the antenna at different positions [7].SAR value assessment is typically conducted over a sample volume (1g or 10g of tissue) using the formula:

$$SAR=(\sigma E2)/(2\rho)$$

where σ is tissue conductivity (S/m), E is electric field strength (V/m), and ρ is mass density (Kg/m³).Antennas designed with polydimethylsiloxane, adaptable by dielectric permittivity, and sealed antennas are manufactured to integrate the substrate. This enhances radiation features as the antenna remains soft and flexible [6].Wearable antennas for fabric substrates employ a microstrip patch radiator to measure the dielectric constant. Microstrip antennas are well-suited for various wearable applications. A multilayer weaving technique, utilizing a cotton substrate, involves weaving multiple layers of yarn. This process allows for variations in skin, fat, and muscle thickness based on different body parts [3].

II Design of H Shaped antenna

The H-shaped microstrip patch antenna is designed with a frequency range of 5.244GHz.In this particular configuration, copper (annealed) is utilized as the material for both the ground and patch elements. The substrate, facilitating communication between the ground and patch, is constructed using FR-4 (Flame Retardant), a composite material comprising fiberglass and epoxy resin. The patch is positioned on top of the substrate, crafted from copper (annealed). To enhance performance, slots are designated, and specific portions are delineated and subsequently removed using nickel (lossy) material.

Width of Rectangular Patch is calculated using equation

$$w = \frac{c_0}{2f_r}\sqrt{\frac{2}{\varepsilon_r+1}} \tag{1}$$

Where w and f are width and resonant frequency.

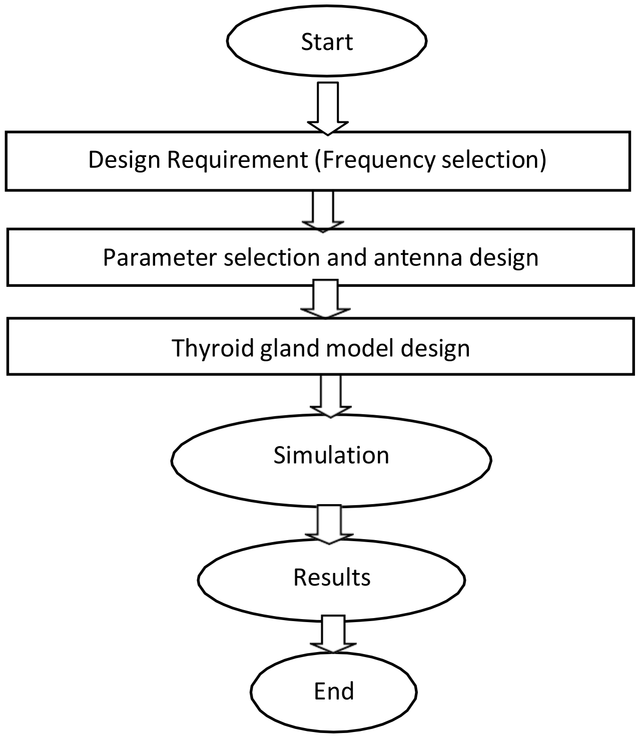

Fig. 1 Flow diagram

The effective dielectric constant is used to describe the fringing effect. The dielectric constant (εreff)is explained by the following equations

$$\epsilon_{reff} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2}\left(1 + \frac{12h}{W}\right)^{-\frac{1}{2}} \tag{2}$$

And Fringing effect of patch

$$\Delta L = 0.412h\frac{(\varepsilon_{reff}+0.3)\left(\frac{w}{h}+0.264\right)}{(\varepsilon_{reff}-0.258)\left(\frac{w}{h}+0.8\right)} \tag{3}$$

And rectangular patch length is

$$L = L_{eff} - 2\Delta \tag{4}$$

Where l and leff are rectangular patch length and effective

III Microstrip design configuration

The configuration of the proposed microstrip H-shaped patch antenna is projected in Fig. 2. The patch view and ground view of the antenna is depicted in Fig. 2. The overall width and length of the proposed antenna is of 16x18mm. Whereas, the height and relative permittivity of the substrate is h=1.6mm εr=4.2. The H-Shaped microstrip patch antenna dimensions is listed in Table 1

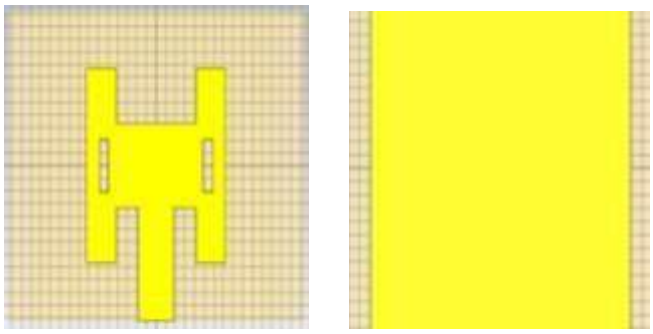

Fig. 2 Configuration of H-Shaped antenna

Table 1 Dimensions of the Microstrip antenna

keyword	Specification	Dimension(mm)
sw	Substrate width	30
sl	Substrate length	24
tu	Tumor thickness	18
th	Thyroidgland thickness	13
b	Bone thickness	9
m	Muscle thickness	6
f	Fat thickness	4
gw	Groundd width	25
gl	Ground length	24
s	Skin thickness	1
t	Copper thickness of Ground/ Patch	0.035
h	Substrate thickness	1.4
w	Width of Patch	8
l	Length of patch	6.5
fw	Feedwidth	3.5
S1	Slot 1 length	15
S2	Slot 2 length	6
S3	Slot 3 length	2
S4	Slot 4 length	4
m	Muscle thickness	6

From this, the design of H-shaped microstrip patch antennas is undertaken. The assessment involves evaluating parameters like gain, Voltage Standing Wave Ratio (VSWR), return loss, and Specific Absorption Rate (SAR) values. The evaluation is conducted on a thyroid gland length model, considering scenarios with and without tumors.

IV Result and Discussion

The proposed antenna is obtained by optimizing the patch and ground plane using CST 3D simulation software. So the gain of the H-Shaped microstrip with and without tumor is calculated. And also the return loss, directivity andVSWR of H-Shaped microstrip patch antenna with and without tumor is calculated at the frequency of 5.233 GHz and 5.244 GHz.

The gain for H-Shaped Microstrip patch antenna with tumor is 2.77dB at the frequency of 5.244 GHz

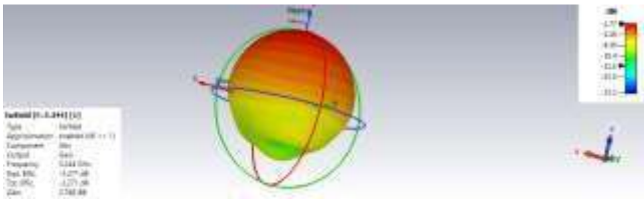

Fig.3. Gain for H-shape MPA with tumor at 5.244GHz

The gain for H-Shaped Microstrip patch antenna without tumor is 3.31dB at the frequency of 5.233 GHz

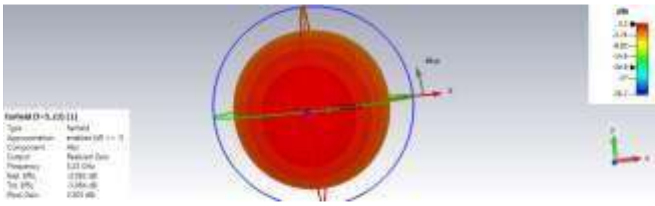

Fig.4. Gain for H-shape MPA without tumor at 5.244GHz

The return loss for H-Shaped Microstrip patch antenna with tumor is -39dB at the frequency of 5.244 GHz

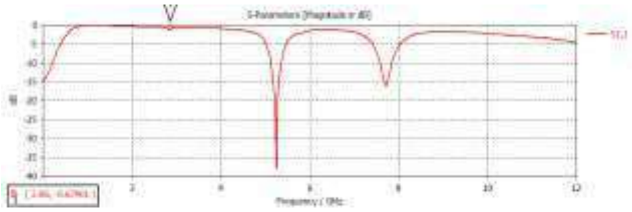

Fig.5. return loss for H-shape MPA with tumor at 5.244GHz

The return loss for H-Shaped Microstrip patch antenna without tumor is -36dB at the frequency of 5.233 GHz

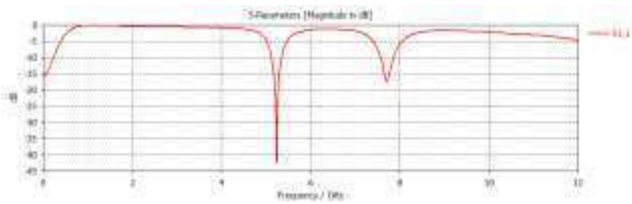

Fig.6. return loss for H-shape MPA without tumor at 5.233GHz

The VSWR for H-Shaped Microstrip patch antenna with tumor is 1.02 at the frequency of 5.244 GHz

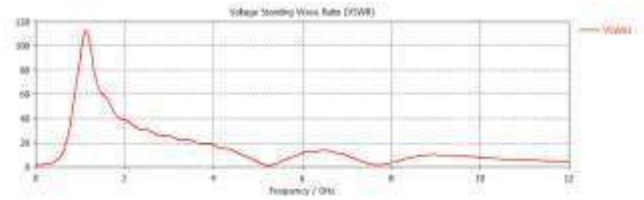

Fig.7. VSWR for H-shape MPA with tumor at 5.244GHz

The VSWR for H-Shaped Microstrip patch antenna without tumor is 1.02 at the frequency of 5.233 GHz

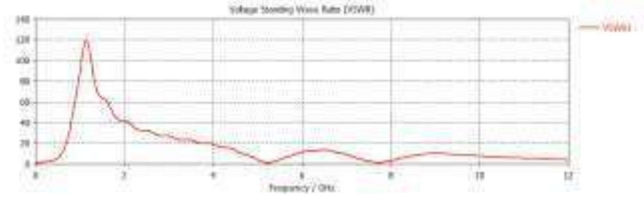

Fig.8. VSWR for H-shape MPA without tumor at 5.244GHz

From overall, the result of the H-Shaped microstrip patch antenna with tumor and without tumor will be

With Tumor:

Frequency: 5.244 GHz

Gain (dB)	Return loss (dB)	Directivity (dB)	VSWR
2.77	-39	6.03	1.02

Without Tumor:

Frequency: 5.233 GHz

Gain (dB)	Return loss (dB)	Directivity (dB)	VSWR
3.31	-36	6.36	1.02

V CONCLUSION

This Paper introduces the design and evaluation of H-shaped microstrip patch antennas specifically aiming at assessing Specific Absorption Rate (SAR) for the detection of thyroid gland cancer cells. The simulation is carried out using the CST tool. The choice of the H-shape microstrip patch antenna design is motivated by the anatomical resemblance of the human thyroid gland to this configuration. The human thyroid gland model incorporates six layers: skin, fat, muscle, bone, thyroid, and tumor, allowing for performance variation in the presence or absence of a tumor in the thyroid gland.

The H-shaped microstrip patch antenna, particularly when integrated with a tumor, exhibits notable performance, achieving a high gain of 2.77 dB at 5.244 GHz. The Specific Absorption Rate (SAR) is computed for 1g of tissue in both scenarios, with and without a tumor. Notably, this proposed design surpasses other configurations in terms of results. Future advancements may explore extending the application of the antenna to identify tumors in various body parts, potentially experimenting with different antenna shapes and frequencies to enhance overall performance.

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Design Of Miniature Smart Patch Antenna

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ABSTRACT: Wearable and portable technology has been the subject of much research in recent years due to its many benefits, including the ability to function as a personal digital assistant and offer multimedia and internet access. Examples of wearable technology that are presently the subject of extensive research are smart watches and rings. Wearable and flexible antennas have caught the attention of numerous companies working on wireless body area networks because of the significant role that antennas play in these wearable devices. Designing a miniature smart patch antenna necessitates a nuanced approach that harmonizes the constraints of size, performance, and intelligent functionalities. This paper outlines an exhaustive methodology for crafting a miniaturized smart patch antenna, tailored for scenarios where spatial constraints are critical and adaptability is pivotal. The design methodology integrates cutting-edge materials, sophisticated RF modeling techniques, and astute tuning mechanisms to attain elevated efficiency, multi-band versatility, and instantaneous environmental adaptiveness.

KEYWORDS: Patch Antenna, Cutting Techniques, Efficiency, Gain, bandwidth, CST.

I.INTRODUCTION:-

Plant leaf diseases are closely related to people's daily life. Due to the wide variety of diseases, it is not only time-consuming and labor-intensive to identify and classify diseases by artificial eyes, but also easy to be misidentified with having a high error rate. Therefore, we proposed a deep learning-based method to identify and classify plant leaf diseases. The following section contains literature survey, proposed system, control system, module description, conclusion and future work.

II. LITERATURE SURVEY:-

In the crop protection from animal attack based system, [1] animal intrusion detection based on Because it is one of the three main food crops and a significant source of revenue for many farmers cross the world, maize, which has a high nutritional value, continues to play a significant role in addressing the issue of human food supply today [1]. Data show that 60% of maize in China is used as feed for livestock and poultry industries, 30% is used for industrial purposes, such as chemical, pharmaceutical, and paper making, and the remaining 10% is used for direct consumption by people. Mazie occupies an important position in the agricultural production and economic development of China. It is evident that, together with rice and wheat, maize will be the food crop with the largest production demand in the future. Therefore, increasing maize production and maintaining high quality is important to China's agricultural industry. Among the many factors affecting maize production, the problem of maize pests and diseases has the greatest negative impact on its production and quality, and once maize pests and diseases occur, they can cause varying degrees of yield reduction and quality decline, seriously affecting the economic benefits of producers and the industry as a whole [2].

At present, the category identification of maize diseases in China is based on the empirical judgment of crop pathologist experts in the field and technicians specialized in plant protection; therefore, technicians need to have good observation skills and rich experience to accurately identify the category of diseases [3].

This traditional disease identification method, which relies on individual experience, has a large limitation. Additionally, when there are too many samples to test with many different disease types, subsequently, there is a higher chance of inaccuracy in the identification process due to human errors. Recent years, with the high-speed development of big data analysis technology and

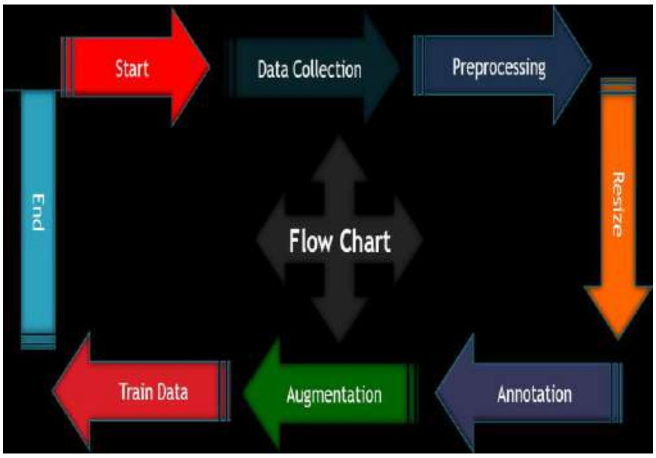
GPUs (Graphics Processing Units), the computing power of computers has been improved, and deep learning techniques have been developed rapidly and have been used in many applications such as agricultural pests and diseases [4]. Yinglai Huang et al. [5] replaced convolutional kernels in the first convolutional layer of the conventional ResNet-50 model with three 3 _ 3 convolutional kernels; they used the LeakyReLU activation function instead of the ReLU activation function and changed the order of the batch normalization layer, activation function, and convolutional layer in the residual block. The improved network obtained a 98.3% correct rate in maize leaf disease image classification. Haoyu Wu [6] proposed to construct a two-channel convolutional neural network based on VGG and ResNet. By adjusting the parameters of the two-channel convolutional neural network, the accuracy of identifying maize leaf disease types in the validation set can reach 98.33%, while the VGG model can reach 93.33%. Chao Wang et al. [7] proposed a method based on ResNet (Residual Neural Network) deep learning network for maize disease recognition, using ResNet as the main model for maize disease recognition, and found that the highest classification accuracy of 92.82% was obtained with ResNet50 at a batch size of 32 and epoch number of 16. Azlah, M.A.F. et al. [8] mainly reviewed the advantages of each classifier and compared their compatibility with different leaf features recognition process. Koklu, M. et al. [9] conducted a deep learning-based classification by using images of grapevine leaves. The most successful method was obtained by extracting features from the Logits layer and reducing the feature with the chi-squares method. The most successful SVM kernel was Cubic. The classification success of the system has been determined as 97.60%. Argüeso, D. et al. [10] introduced Few-Shot Learning (FSL) algorithms for plant leaf classification using deep learning with small datasets. The FSL method outperformed the classical fine-tuning transfer learning, which had accuracies of 18.0 (16.0–24.0)% and 72.0 (68.0–77.3)% for 1 and 80 images per class, respectively.

Although there are many recognition techniques based on deep learning technology and all of them work well, there are some problems among them, such as less small scale target data, larger memory consumption of the model, and being unsuitable for mobile deployment. This paper, therefore, investigates the problem of disease in maize leaves, applying the current deep learning technology to design an experimental study in the hope that farmers will be able to rely on their mobile phones in the field to identify diseases on maize in a timely and effective manner, thus alleviating the problems of reduced yields and reduced quality of maize. As the ultimate goal of our research is to help farmers to identify maize diseases in real-time in the field with a mobile device on their person, the light weight and high accuracy of the model is the focus of this paper. Currently, the commonly used target detection networks include Faster R-CNN [11], SSD [12], YOLO series [13–16], etc. Among them, the YOLO network model belongs to a one-stage target detection algorithm with a simple structure, small computation, and fast operation speed, which is widely used in crop disease identification research. Among them, YOLOv5n is the latest model of the YOLOv5 series network, which has the advantages of high detection accuracy, fast inference speed, and small storage space, and is suitable for deployment in mobile for real-time detection. In this paper, we propose a regional detection model for maize leaf diseases based on YOLOv5n: CTR_YOLOv5n, which accelerates the model convergence speed, improves the model generalization ability, and enhances the recognition accuracy and detection speed of the model, taking three common leaf diseases, blotch disease, gray spot, and rust, as the research objects.

III. Materials and methods

The method of research work preparation consists of six steps:

1) Data collection,
2) Data prepossessing,
3) Data resize,
4) Data annotation,
5) Data augmentation and
6) Data train

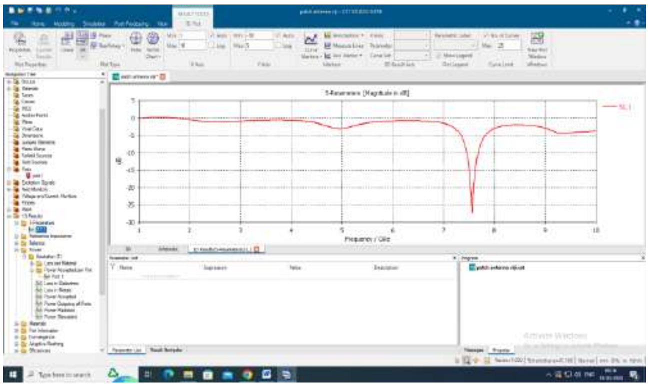


IV.YOLOv5 architecture

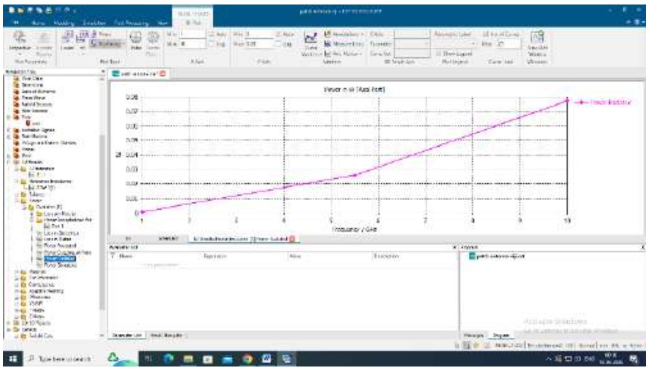
The architecture of Yolov5 is separated into three sections, as shown in Fig. 14: (a) the backbone; (b) the neck; and (c) the output.

1. Backbone: An input image is utilized to identify significant details using the Model Backbone. CSP (Cross Stage Partial Networks) are the framework used in YOLOv5 to extract valuable, useful attributes from an input picture. By conducting feature extraction on the feature map, the Bottleneck CSP module primarily obtains rich data from the picture. Compared to other large-scale convolutional neural networks, the Bottleneck CSP structure can reduce the duplication of gradient information during the optimization of convolutional neural networks. Its parameter amount makes up the bulk of the network's total parameter quantity. The SPP module adds functionality of various sizes and largely increases the network's receptive area. 2. Neck: Feature pyramids are frequently created by the model's neck. When object scaling is involved, feature pyramids help models generalize to a wider range of situations. It assists in locating an analogous object in different scales and sizes. Other models, including the FPN, BiFPN, and PANet, employ other feature pyramid strategies. PANet is used by YOLO v5 as a neck to obtain a feature pyramid.

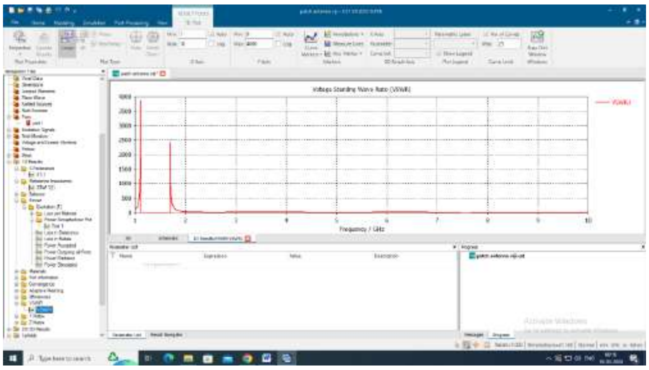
RESULT



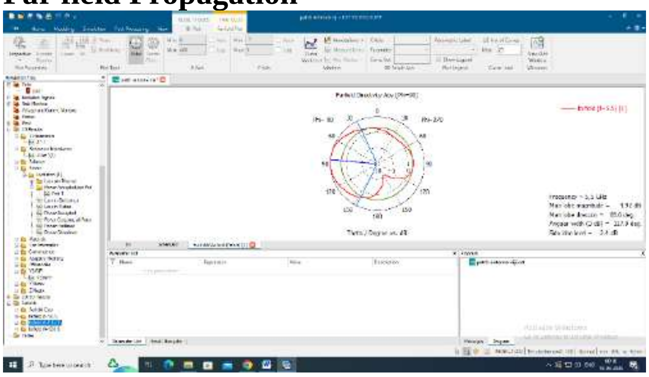
Power Radiated



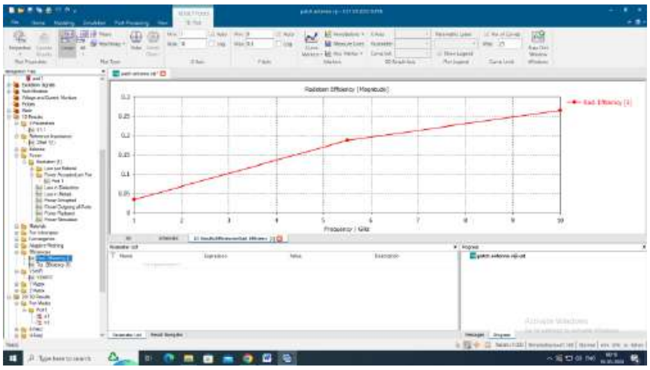
VSWR



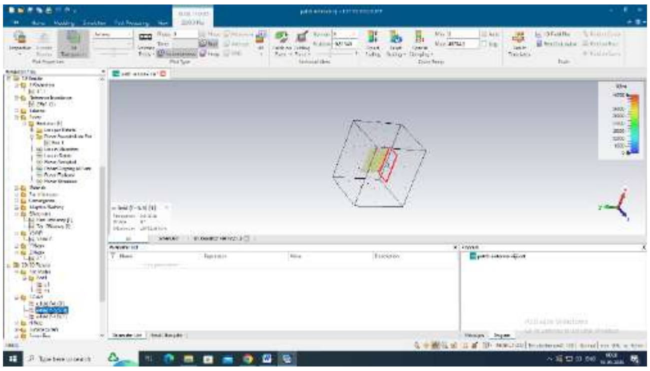
Far field Propagation



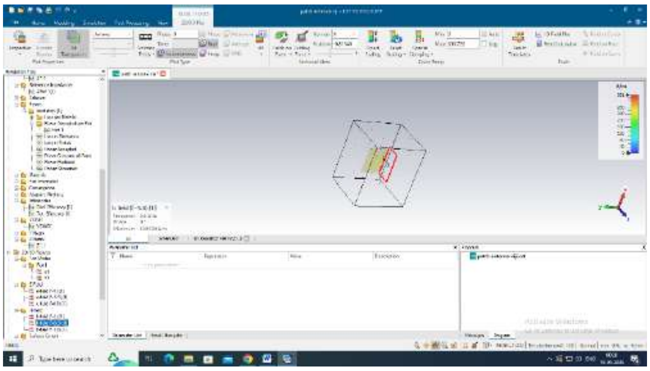
Radiation Efficiency



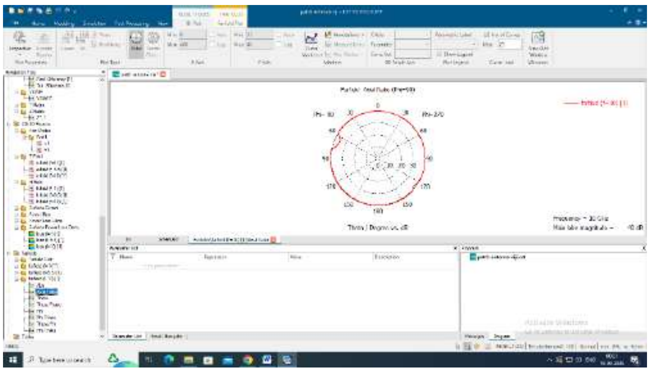
E-field



H-field



Far-field Axial Ratio



V.CONCLUSION:-

In rustic part of India, farmers meeting Spartan threats such as destruction done by animals. Hence, to overcome this concern we have designed a system which will monitor the land using sensors, camera and buzzer sound is produced to divert the animals. So that wild animals will not enter into the field. It will absconder. GSM module sends the alert SMS to the farmer and call to the forest department.From this it is concluded that the design system is very beneficial and reasonable to the farmer. This system will not be harmful to wild animals and human being.

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Design and Development of a Covert Quadcopter for Confidential Meeting Surveillance

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Abstract – This project presents the design and development of a cutting-edge covert quadcopter tailored specifically for conducting surveillance in confidential meetings. In today's digital age, ensuring the privacy and security of sensitive discussions is paramount, necessitating innovative solutions that surpass conventional surveillance systems. Our quadcopter integrates state-of-the-art technology to offer superior performance, discretion, and data collection capabilities. Compared to existing surveillance systems, our quadcopter offers several advantages, including enhanced maneuverability, real-time monitoring capabilities, and increases the accurate risk detection. Furthermore, its discreet nature minimizes the likelihood of arousing suspicion, ensuring uninterrupted surveillance throughout the duration of confidential meetings.

Keywords: quadcopter, surveillance systems

I. INTRODUCTION

Surveillance quadcopters represent a revolutionary advancement in the field of aerial surveillance, leveraging cutting-edge technology to enhance monitoring, reconnaissance, and security capabilities.

The history of Surveillance quadcopters or Unmanned Aerial Vehicles (UAVs), began in the early 20th century with concepts like the Kettering Bug. However, it wasn't until the Cold War and the Vietnam War that serious development took place. The 1980s and 1990s saw the rise of UAVs like the Predator, gaining prominence during the War on Terror. Technological advancements in the 2010s led to the integration of drones into civilian life. As drones became more widespread, concerns about privacy and ethics emerged. Today, surveillance drones continue to evolve with ongoing advancements, playing significant roles in military, law enforcement, and civilian applications while sparking debates on the balance between security and individual rights.

These unmanned aerial vehicles (UAVs) are equipped with sophisticated sensors, cameras, and communication systems, enabling them to gather real-time data, monitor vast areas, and respond rapidly to emerging situations. Surveillance quadcopters, commonly known as drones, are compact, remotely piloted aircraft equipped with multiple rotors for stable and agile flight. Unlike traditional surveillance methods, quadcopters offer a dynamic and versatile approach to monitoring various environments. They have gained widespread popularity across industries due to their ability to access hard-to-reach areas, capture high-resolution imagery, and provide rapid deployment for time-sensitive situations.

Fig 1.1
(General Surveillance system used across the globe)

In Fig 1.1 we can see the traditional surveillance system which is being used across the globe, Traditional surveillance methods often face limitations in terms of coverage, response time, and adaptability to diverse environments. Implementing physical security measures such as secure meeting room access, surveillance cameras (used responsibly and in compliance with privacy laws), and visitor logs. Providing training to employees on security awareness and the importance of maintaining confidentiality. Which creates complexity and challenging to process and so to address these challenges, we have developed a security surveillance drone system with the use of machine learning.

II RELATED WORK

There are two base paper we referred, where one is about drone building while other one gives us a base idea about software we built.

Coming to first paper which presents a brief idea about drones, their technology, the process to make that technology energy-efficient and can be used for different purposes. Major aim of their prototype is for surveillance of terrifying notions and hidden activities which can be captured in the camera which gives us an aerial view of objects. Our major aim is to increase the flight time of the drone as much as possible so to get more time for surveillance and to reduce the noise produced by cloaking it. An additional feature which is added to the prototype is transmission of video in FPV goggles. Our aim is making it available at an affordable rate for the private agencies, institutions and governmental bodies for efficient surveillance. There is lot of hidden observations and development for this prototype in future. Quad copters are types of drone which have four wings attached to them. Depending upon the criteria different feature can be added. "FPV drone with GPS used for surveillance in remote areas," 2017,Third International Conference on Research in Computational Intelligence and Communication Networks, published by A. Saha, A. Kumar and A. K. Sahu.

Moving to second paper which is about face recognition software, During the spread of the Corona epidemic, everyone started wearing masks as protection in public places. Therefore, this causes a major challenge in authentication and safety systems, such as face recognition systems in railway stations, airports, and payment systems based on facial recognition technologies. Face recognition systems are safer than touch-based biometric systems. However, the face recognition systems are ineffective in the presence of a face with a mask. Therefore, we developed an efficient algorithm using the MTCNN and VGGF model to improve the efficacy of face recognition systems in partially occluded face images. The proposed approach produced 90% accuracy in the top half of the facial images. "Face Recognition from Partial Face Data," 2021 International Conference in Advances in Power, Signal, and Information Technology (APSIT), Bhubaneswar, India, 2021, published by S. Alfattama, P. Kanungo and S. K. Bisoy.

III PROPOSED SYSTEM

This proposed Surveillance Quadcopter is designed based on the basic principles for UAVs to ascertain the better stability of the drone.

This project entails the development of a stealthy surveillance Quadcopter using an F450 frame which provides real time monitoring and rapid response. The primary objective is to create an aerial platform for discreetly observing confidential meetings without any blind spots which are caused by traditional surveillance. The drone will send monitoring video data to the ground system in which the system will use face recognition software using machine learning to process and detects the unknown face and alerts the security. This system contains a Quadcopter with mounted camera where it will be operated from ground using Radio Transmitter, undergoes a cycle of surveillance in a closed space (The closed place must be huge as an auditorium where it will have lesser interference after a certain height). The Live monitoring data will be transmitted by cam to the ground unit, which will be further used to processing. The software system is comprised using pycharm and vscode, where it uses pre taken data sets from the client to process (These data sets are 1000 of pictures of face of a particular person attending the respective meeting). Later, The system will determine the unknown face using machine learning and alerts the security system. A prototype has been built with available and capable of accessing.

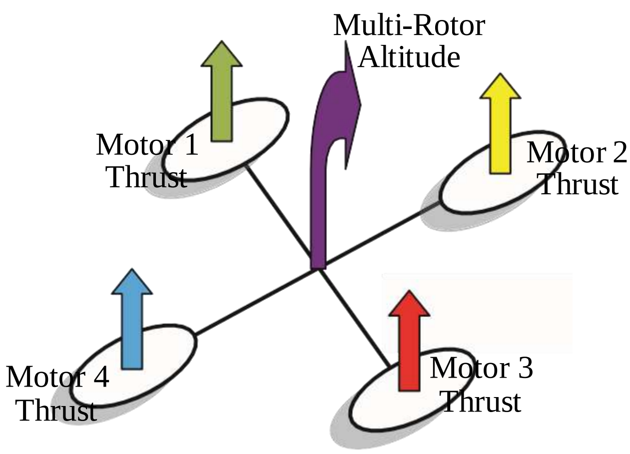


Fig 1.2

(Basic principle behind the stable fly of the quadcopter)

As shown in Fig 1.2, Our prototype is build using this base principle. Each motor is attached to a propeller that spins rapidly to generate upward thrust. The faster the propeller spins, the more thrust it generates.Lift and Stability is attained by varying the speed of the motors, the quadcopter can control the amount of thrust produced by each rotor. To ascend, all motors increase thrust evenly. To descend, they reduce thrust in unison. By adjusting the thrust of opposing motors (e.g., front and back, left and right), the quadcopter can tilt and move in different directions.

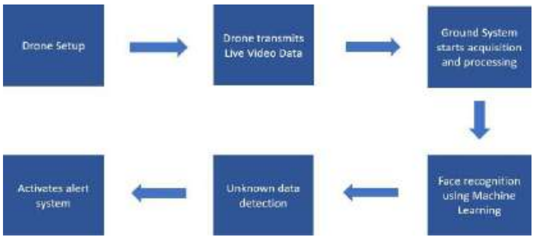
Fig1.3 (APM 2.8 flight controller)

To control this quadcopter we have used APM 2.8 flight controller which is shown in Fig 1.3. The flight controller is the central control unit of the quadcopter, responsible for stabilizing the aircraft, processing sensor data, and executing control commands. It contains sensors such as gyroscopes, accelerometers, and magnetometers to measure the quadcopter's orientation, acceleration, and magnetic heading. Using algorithms and feedback loops, the flight controller just adjusts the speed of each motor to maintain stability and control during flight. Below table 1.1 shows the overall weight displacement of our prototype.

Sr.No.	Components	Weight(gm)
1.	APM 2.8 controller	50
2.	GPS module	25
3.	BLDC motors (920kv)	235
4.	Electronic speed Controller(ESC)	100
5.	Propeller (1045)	45
6.	Li-Po battery	265
7.	Landing frame	75
8.	Cam module	200
	Total Weight	**995 (Approx.1kg)**

Table 1.1(prototype's weight)

Fig 1.4 (Top view of the prototype)



Block Diagram 1.1
(Prototype's working process)

Block diagram 1.1 shows the working process of the whole project. At first manually the quadcopter will be set at a particular height where the object interference is very less, then it will be set into auto pilot mode where it will circulate the space accordingly and send the monitored video data to ground system rapidly. The received data will be processed using face recognition software installed at ground system, If it recognise an unknown face it will alert the security officers.
(The face recognition software needs participants database to process which should be collected before the entry.)

IV RESULTS AND DISCUSSIONS

Fig 1.5
(Prototype's flying picture)

Here Fig 1.5 showcase the stable fly of our quadcopter. The overall system monitoring is done at the base ground setup, we have used mission planner to monitor the quadcopter's stability and pycharm software to process the realtime visual data captured by the drone.

Mission Planner plays a crucial role in the setup, configuration, monitoring, and analysis of drones equipped with APM 2.8 flight controllers The software provides a user-friendly graphical interface that displays real-time telemetry data such as altitude, speed, GPS position, battery voltage, and more. Users can monitor these parameters during flight for situational awareness and troubleshooting.

Fig 1.6(Mission planner software's output)

Fig 1.6 shows the mission planner software's realtime display which shows the directional, speed and required monitoring data to fly the quadcopter stably.

As the live visual data has been transmitted by the prototype will be processed using the methodology Convolutional Neural Networks (CNNs), which have emerged as the state-of-the-art approach for face recognition, especially in recent years. CNNs automatically learn hierarchical representations of faces from raw pixel values by stacking the multiple convolutional layers, pooling layers, and fully connected layers. CNNs have demonstrated superior performance in handling complex variations in pose, expression, lighting conditions, and occlusions, making them highly effective for face recognition tasks, particularly in large-scale datasets .This process is done using pycharm software and machine leaning basic libraries. The image below represent the final output which will be displayed in real time monitor.

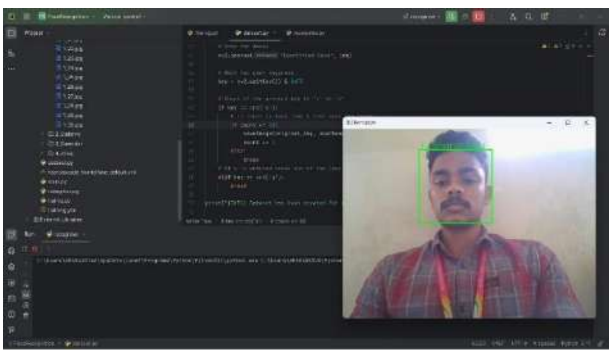


Fig 1.7 (Final Output)

As you can see in Fig 1.7, the final output showcase the detected face data(Here person's name) which can be monitored by the officals and safeguard the meeting frequently and incase of unknown face detection it alerts the officials. And you can also see the python program which we formulated to train and process the visual data as it receives from the drone.

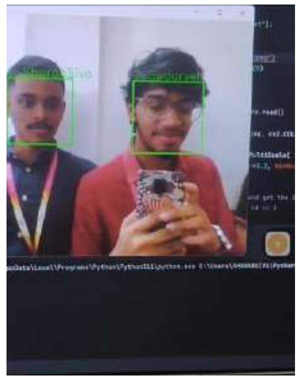


Fig 1.8
(Multiple Face detection)

Fig 1.8 showcase that our software model can handle multiple face detection at time. We see that this system can detect and alert and By this system we can provide safe and secure surveillance rapidly with an fast and effective alert system. Thus this the overall information about our proposed model and prototype .

V CONCLUSION AND FUTURE WORK

The findings demonstrate the effectiveness of our design in achieving quiet and high-quality surveillance. We see that this system can detect and alert, whereas the updated future version can follow the suspect using advanced machine learning and AI. We are also aiming to make this system fully autonomous where it will not need any human interventions. We also trying to employ silent propellers to minimize acoustic emissions.

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A Smart Portable Braille System for Text and VoiceConversion

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Abstract* - *One of the most widely used educational tools for the visually impaired is BRAILLE. But it takes a lot of practice and training to become proficient in BRAILLE. Furthermore, the degree of tactile sensitivity at the fingertips varies throughout individuals. Our solution consists of a single-cell BRAILLE display equipped with six electromechanical flapper actuators that are specially built. Standard BRAILLE cell dimensions and elevation can also be obtained with this equipment. The purpose of the Braille cells is to assist users in manually identifying the printed Braille. This device interprets speech and text signals to create a Braille code that is readable for visually impaired people.

Keywords* - *Visually impaired, Braille, Tactile sensitivity, Braille cell, Electromechanical flapper actuators.

I. INTRODUCTION

People who are visually challenged use the tactile writing technique known as Braille. The 19th century saw the invention of it by French educator Louis Braille. Braille represents letters, numbers, punctuation, and other symbols with a grid of raised dots that is 2 by 3. Different combinations of dots are used to represent different characters. Six dots altogether, placed in two columns of three dots each, make up a basic Braille cell. A particular letter, number, or symbol is represented by each dot or set of dots. Readers with low vision or blindness can read Braille by tracing over the raised dots with their fingers.

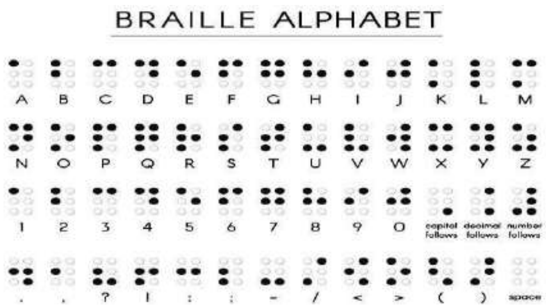

Fig. 1 Braille representation of alphabets.

The purpose of this project is to develop a portable Braille system that will enable blind people to acknowledge some printed characters without the need for any kind of assistance. This is an Arduino-controlled system that can provide blind individuals with directions. The system primarily serves as a guide for blind people, providing a specific virtual environment for those who are visually impaired and fostering a positive outlook comparable to that of the public worldwide. This compact technology can let blind people read withoutassistance and protect them from just receiving partial support.As a result, blind people can experience a significant decrease in everyday inconvenience and continue to engage in a certaindegree of independence and activities

II. LITERATURE REVIEW

The project described in the paper "*Speech to Braille Conversion Using Python"* by Gousiya Begum, N. Musrat Sultana, and D. Hinduja (2023) focuses on creating a system that will translate speech into Braille writing for people who are blind or visually impaired. The initiative intends to improve communication and accessibility for the blind by offering an easy-to-use way to translate spoken words into Braille text. The conversion process makes use of the file-handling functions and built-in modules of Python. Through the usage of this device, visually challenged people can type on their own without aid from a caretaker.

The goal of Himanshu Gautam and Prerna Gaur's project *"DRISHYAM: Real-Time Text to Braille Conversion and Realization"* (2020) is to create a portable, reasonably priced Braille cell that costs less than $50 to help those who are blind or visually challenged read text. 'Eyes of DRISHYAM' is a mobile application that the gadget uses to take pictures, translate text to Braille, and send orders over Bluetooth to the Braille cell. Servo motors for movement, HC-05 Bluetooth modules for communication, and an Arduino Uno microcontroller for driving the Braille cell are among the hardware components. In comparison to alternative designs, the rack and pinion mechanism design improves portability, economy, and power efficiency. The project intends to close the accessibility gap by offering visually impaired people an affordable tool for successful communication.

The project titled *"Developing of Text Translation and Display Devices via Braille Module"* by Dong-Hun Yoo and Soo-Whang Baek is aimed to develop a Braille output device for visually impaired individuals using a Raspberry Pi and 3D printing technology. The device captures images of documents using a camera module, extracts text through OCR, and translates it into Braille information. The Braille output is achieved through Braille cells, providing accurate information to users. The device allows users to read 20 characters at a time and navigate through text using a next button. The study emphasizes the use of hard materials like ABS resin for Braille cells to enhance recognition accuracy. Future plans include optimizing the device for improved information delivery and exploring IoT integration. The project was supported by the National Research Foundation of Korea.

The paper titled *"voice activated portable Braille with audio feedback"* by Fahad Faisal, Mehedi Hasan, et al., (2021) discusses the development of a Voice-Activated Portable Braille device with Audio Feedback to assist individuals with visual impairments. The device utilizes Arduino UNO to receive voice commands via Bluetooth and convert them into Braille language displayed by electromagnetic solenoids. The system aims to provide a cost-effective and efficient solution for the blind population, enhancing their independence and accessibility to information. The design includes a prototype Braille typewriter that incorporates feedback from blind users to ensure usability. The estimated cost and feasibility analysis highlight the device's affordability and potential for mass production. Overall, the technology offers a promising solution to improve the lives of visually impaired individuals by providing a portable and user-friendly Braille interface with audio feedback.

The research paper titled "*Voice to Braille Converter Using Arduino Mega"* by Shoba Krishnan, Fiza Khan, et al., (2021) presents the development of a voice-to-Braille converter using Arduino Mega, designed to aid visually and hearing-impaired individuals in communication. The system consists of a mobile application for voice input, an Arduino Mega for processing and displaying Braille output on a Push-Pull solenoid, and a Braille to Voice Converter using keypads for input and an LCD screen for output. The project aims to address the challenges faced by individuals with dual sensory impairments by providing a means for independent communication without the need for assistance. The successful implementation of the converters and the mobile application demonstrates the feasibility of the system, which can potentially benefit the visually and hearing-impaired community on a larger scale. The project was also simulated using Proteus software and developed with MIT App Inventor. Overall, the research paper highlights the importance of assistive technologies in enhancing the quality of life for individuals with sensory impairments.

III. EXISTING MODEL

A. Text to Braille Conversion

The project focuses on the development of a Braille output device for visually impaired individuals. The device utilizing a Raspberry Pi camera module to capture images of physical documents. Processing the captured images through OCR (Optical Character Recognition) to extract text information. Converting the extracted text into Braille information using a code-table. Outputting the Braille information through the Braille output device, which comprises 20 Braille cells. Designing the Braille cells with ABS resin material for improved recognition accuracy and user experience. Implementing a next button for users to navigate through the text, allowing them to read 20 characters at a time. Verifying the accuracy of text extraction through OCR by varying conditions during document photography. Conducting experiments to validate the feasibility and effectiveness of the proposed Braille output device. Demonstrating the device's ability to replicate the tactile experience of reading a Braille book and providing a tangible means for visually impaired individuals to access printed information.

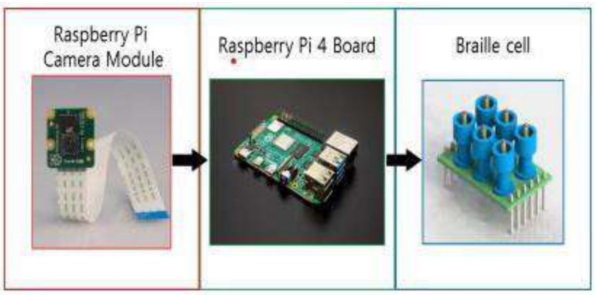

Fig. 2 Existing model that converts text to braille.

B. Voice to Braille Conversion

The method focuses on enabling visually impaired individuals to convert speech into Braille script using Python. The methodology for the "Speech to Braille Conversion Using Python" project involves importing key libraries like Matplotlib, Numpy, PyAudio, and PyTorch. The implementation includes running the codein visual studio code, incorporating speech recognition functionality, and developing code for braille conversion using Python's libraries. The system converts speech to text and then to braille script, allowing visually impaired users to independently engage in typing. The results are verified by comparing the converted text with a braille database. Overall, the methodology focuses on using Python libraries, speech recognition, and code development to facilitate braille conversion for visually impaired individuals

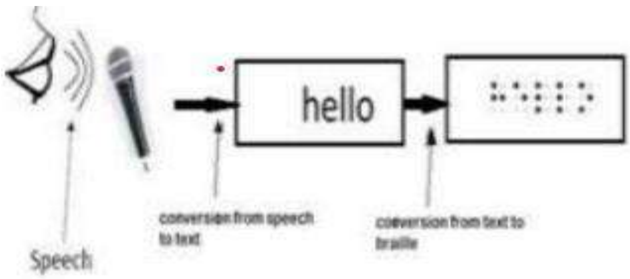

Fig. 3 Existing model that converts voice to braille.

C. Disadvantages of Existing Method

All the available methods can either convert text into Braille code or voice into a Braille a system cannot simultaneously do both. Certain existing method does not have a proper output device to display the Braille language.

Our project is aimed to create an integrated system that can convert both text and speech signals into Braille code.

D. Problem Statement

Some of the foremost limitations that persons with visual impairments face are:

- To access written information,
- To control devices with complicated user interfaces.
- To induce orientation and quality support

Lack of perceived purpose. Late Braille learners usually have lower proficiency levels and don't perceive the aim of up its broadcastings, movies, live performances or shows.

Lack of interactivity. All participants took or presently teach categories in tiny teams (2-4); however, the interactivity among students is incredibly restricted

IV. PROPOSED MODEL

This project presents the look associated implementation of a device which will convert the input voice from mobile application to Braille code and show it on liquid crystal display. This device is often a media for learning to youngsters with disablement or blind folks will able to write it severally while not facilitate of something. Blind folks will browse, speak and listen to simply however they can't write. Therefore, this device can facilitate them to jot down terribly simply by spoken communication the words in mobile.

A. Components Required

Utilitarian prerequisites are highlights that the framework will require so as to convey or work. Right now, was imperative to accumulate a few prerequisites that will be expected to accomplish the goals set out already. The practical necessities have been accumulated are plot here. Capture text images via camera, the miniature TTL serial JPEG camera is pointed to the book or magazines to capture image, these images are used to detect text by tesseract. The detected text is then used to convert into audio by Google text-to-speech convertor and then by Arduino to convert into Braille. The images are stored in server or directly transmitted to devices for conversions. The visually impaired people can hear or run their hand on the Braille to hear and read the content respectively

1) Hardware Components:

The goal of this project is to create a Braille system as a portable device that will help individuals who are visually impaired withoutany partial help to recognize certain written characters. To achieve these goals, specific hardware components required are Arduino Uno, ESP32-CAM, Solenoids (6), Power supply, Toggle switch (2), LCD, Bluetooth module HC-05.

2) Software Components:

The software components required to develop the entire system are Arduino IDE (Integrated Development Environment) and Embedded C.

B. Block Diagram

The system utilizes an ARDUINO UNO microcontroller as its central processing unit and stores the entire program. In the Voice to Braille converter, the required information can be sent as a spoken note via a mobile device. The Bluetooth module helps the Adriano receive the input and the input is processed by the Arduino, which will then be displayed on the LCD screen and convert it into Braille code, which will be displayed on the Braille cell. The system uses OpenCV to identify words in the text. The system can determine the message being conveyed by examining the Open CV readings, and those texts are then translated into Braille code. The system's toggle switch allows users to choose between several modes. Depending on their needs, users can move between different functionalities or settings based on their own requirements.

The block diagram of the developed braille system is shown below;

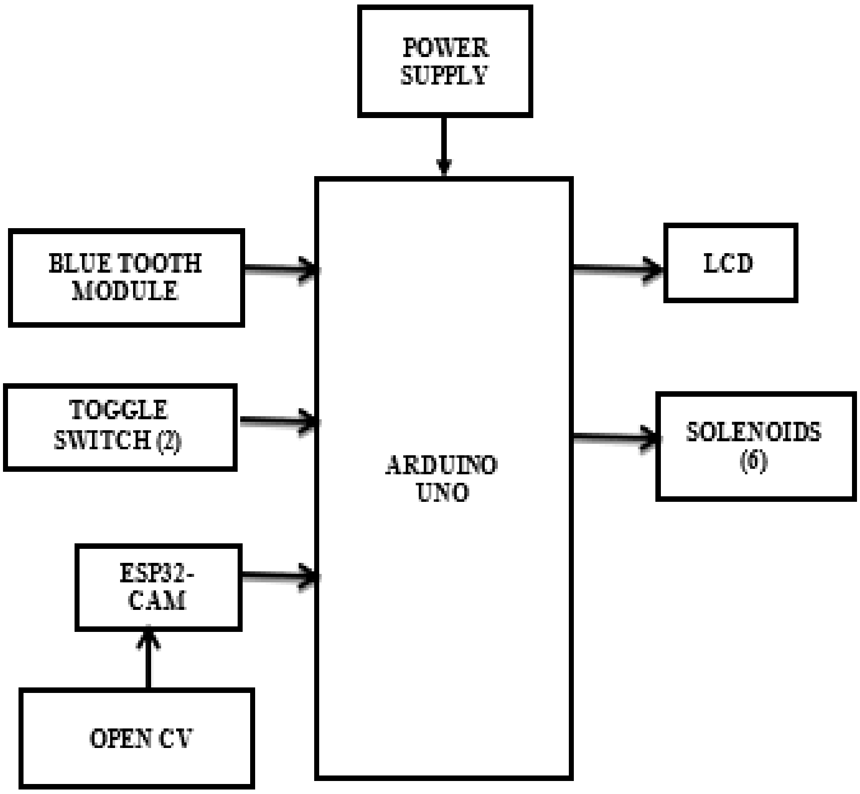

Fig. 4 Block Diagram of Proposed Model.

V. RESULT AND DISCUSSION

Our research is focused mainly on the developing a system that reduces the difficulty in writing a document and introducing a cognitive system which can give the visually impaired people a sense of haptic feeling. This system cost effective and the satisfaction of the user is tremendous. However, this can be the ultimate solution for the blind people for an effective interaction with writing a document, book or article. The importance of Braille to the blind community cannot be undermined. It has significantly contributed to individuals, who have this type of disability, functioning normally world and has provided them with the opportunity to make their society better, through their very valuable contributions in many different areas of everyday life. Now those people can learn themselves using this standalone kit. It is easy one to use.

ACKNOWLEDGMENT

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Transmission line break detection

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***Abstract*—This paper proposes the line break detection in transmission line. Distributed transmission lines typically carry nearly 100 A of current from Substations to home If a transmission line is not properly insulated and falls into rainwater, it could lead to a hazardous situation. This could result 5 or even 10 times more current into the water , which can pose a serious threat to human beings. The solution can be of placing Current sensors such as Hall sensors in the Transmission lines setting an average value of its current as a threshold if it increased more than 2 times of the threshold then an alarm is sent to near substation and the subsequent line is cutoff thus preventing people from the threat. This is achieved using a parallel circuit with a lower resistance on the same transmission line, if current is increased hall sensor detects and current is made to flow in this circuit. Cloud is used to continuously monitor the flow.**

Keywords: Hall sensor, Distributed transmission Lines ,Parallel circuit, Cloud.

I. INTRODUCTION

Electricity transmission lines play a critical role in delivering power from generation plants to consumers, forming the backbone of power distribution networks. However, these transmission lines are susceptible to various hazards, including line breaks, which can lead to severe electrical accidents, property damage, and disruption of services. Rapid detection of line breaks is essential to mitigate these risks and ensure the safety of personnel and the public.

Traditionally, monitoring and detecting line breaks in transmission lines have relied on manual inspections or periodic maintenance checks, which are time-consuming, costly, and often insufficient for timely detection. To address these limitations, advancements in Internet of Things (IoT) technology offer promising solutions by enabling real-time monitoring and automated detection of line breaks.

In this project, we propose an innovative approach to detect line breaks in transmission lines using IoT technology and cloud platforms. The system utilizes a Hall sensor installed along the transmission line to continuously monitor the flow of electrical current. Data from the sensor is wirelessly transmitted to a centralized cloud platform for analysis.

By employing sophisticated algorithms, anomalies indicative of a line break can be detected promptly. Upon detection, the system triggers an alert mechanism to notify the relevant power station, enabling swift response and preventive measures to be taken This proactive approach not only enhances electrical safety but also minimizes downtime and potential damages associated with line breaks.

Overall, this project aims to leverage IoT and cloud technologies to revolutionize the way line breaks are detected and managed in electrical transmission systems, ultimately enhancing operational efficiency, safety, and reliability in power distribution networks.

Moreover, with the advent of the Internet of Things (IoT) and cloud computing, the scalability and accessibility of these solutions have further increased, enabling utilities to deploy comprehensive monitoring and diagnostic systems across their entire transmission network.

II. PREVIOUS WORK

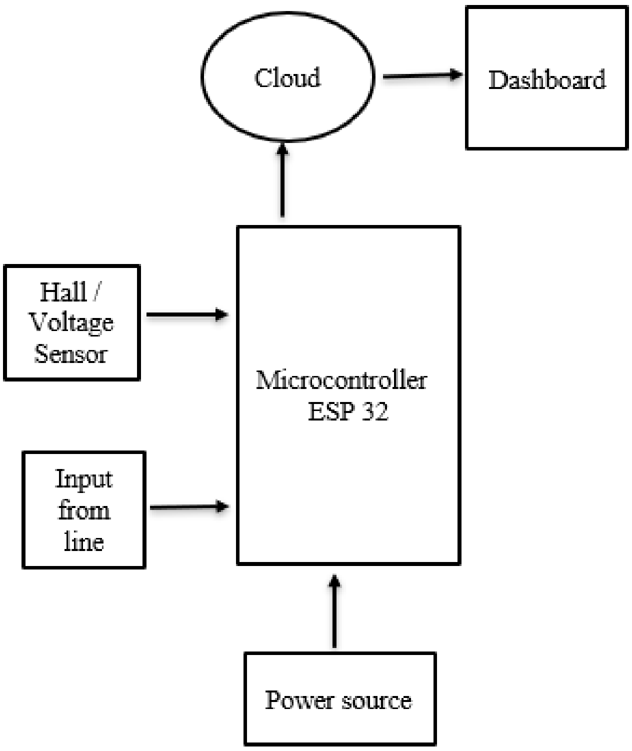
[1] S. Saravanan, Mohammed Sameer, Neemmani Deekshith, Pamballa Parthasardhi, D. Gireesh Kumar, M. Prameela, This paper presents a novel approach for identifying and detecting faults in distribution systems utilizing Arduino UNO microcontroller. The authors propose a system that integrates Arduino UNO with sensors and actuators to monitor the distribution system's parameters in real-time. Through experimental validation, the effectiveness of the proposed system in identifying and detecting faults such as short circuits and overloads is demonstrated. The research highlights the potential of Arduino UNO-based solutions in enhancing fault detection capabilities in distribution systems, contributing to improved reliability and efficiency in power distribution networks.

[2] Swapnil C. Naghate, Saurabh M. Dhuldhar and Ashvini B. Nagdewate, "Transmission Line Fault Analysis by Using Matlab Simulation", International Journal Of Engineering Sciences Research Technology, February 2015,explores fault analysis in transmission lines using MATLAB simulation. It focuses on detecting and analyzing faults like short circuits or line breaks crucial for power grid reliability. MATLAB simulation enables modeling and studying various fault scenarios, evaluating protective devices' effectiveness, and enhancing power system resilience. The paper provides insights into fault detection and protection strategies, aiding power system engineers and researchers..

[3] A. M. Pasdar and Y. Sozer, "Smart high voltage circuit breaker in overhead power lines for smart grid applications," 2013 IEEE Energy Conversion Congress and Exposition, Denver, CO, USA, 2013,explore the concept of employing intelligent circuit breakers to enhance the functionality and efficiency of power distribution systems within the context of smart grids. The study likely entails detailed discussions on the design, implementation, and potential benefits of these smart circuit breakers, including improved fault detection, remote operation capabilities, and enhanced grid stability. This research provides valuable insights into the development and deployment of advanced technologies aimed at modernizing power infrastructure and optimizing grid performance, offering practical implications for power engineers and researchers in the field of smart grid development

[4] S. Bagchi, S. Goswami, B. Ghosh, M. Dutta and R. Bhaduri, "Symmetrical and Asymmetrical Fault Analysis of Transmission Line with Circuit Breaker Operation," 2019 1st International Conference on Advanced Technologies in Intelligent Control, Environment, Computing & Communication Engineering (ICATIECE), Bangalore, India, 2019, it scrutinizes both symmetrical and asymmetrical faults while examining the efficacy of circuit breakers in managing these faults. Likely including in-depth fault scenario analyses, circuit breaker performance evaluations, and discussions on enhancing transmission line reliability, this research contributes crucial insights for power system engineers and researchers striving to optimize fault management strategies.

III. BLOCK DIAGRAM



IV. COMPONENTS USED

A. Arduino ESP-32

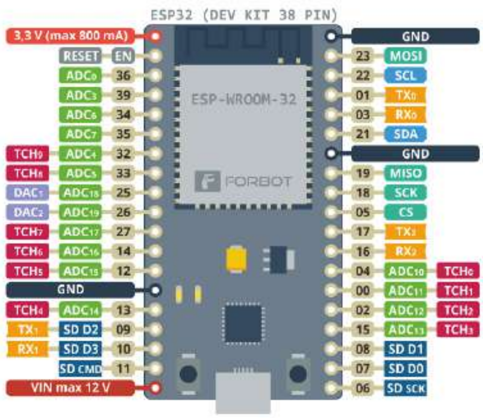
In the implementation of the IoT-based line break detection system, the ESP32 microcontroller can serve as a highly capable and versatile platform for integrating the Hall sensor and facilitating wireless communication. The ESP32 offers a wide array of features, including dual-core processing, built-in Wi-Fi and Bluetooth connectivity, and ample GPIO pins, making it well-suited for this application.

With the ESP32 serving as the central processing unit, the Hall sensor can be interfaced directly to one of its GPIO pins, allowing for seamless data acquisition. The ESP32's dual-core architecture enables efficient handling of sensor data processing tasks while simultaneously managing communication with the IoT module.

For wireless communication, the ESP32's built-in Wi-Fi capabilities provide a convenient means of transmitting sensor data to the cloud platform. Alternatively, if a cellular network-based communication is preferred, the ESP32 can interface with a GSM/GPRS module for transmitting data over cellular networks. Once the sensor data is collected and processed by the ESP32, it can be packaged and sent to the cloud platform for further analysis. The ESP32 can utilize protocols such as MQTT or HTTP to securely transmit data to cloud services like AWS IoT, Google Cloud IoT, or Microsoft Azure IoT.

The cloud platform serves as the centralized hub for receiving, analyzing, and storing sensor data. Here, sophisticated algorithms can be deployed to detect anomalies indicative of a line break, leveraging the processing power and scalability of cloud computing resources.

Upon detection of a line break, the cloud platform can trigger alerts to notify relevant stakeholders or power station operators. This alert mechanism can be customized to send notifications via email, SMS, or push notifications, ensuring timely response and intervention. Throughout the implementation process, the ESP32 microcontroller offers a robust and reliable foundation for integrating the Hall sensor, facilitating wireless communication, and orchestrating the flow of data within the IoT-based line break detection system. Its versatility, coupled with the wealth of features it offers, makes the ESP32 an excellent choice for powering such innovative IoT applications.



B. Voltage sensor

AC Voltage Sensor Module ZMPT101B (Single Phase) is the best for the purpose of the DIY project, where we need to measure the accurate AC voltage with a voltage transformer. This is an ideal choice to measure the AC voltage using Arduino/ESP8266/Raspberry Pi like an opensource platform. The ZMPT101B voltage sensor module is a compact and versatile component designed for accurately measuring AC voltage in the range of 0 to 250V.

It operates on the principle of using a voltage transformer to step down the input AC voltage, with signal conditioning circuitry to provide a stable and precise analog output proportional to the input voltage. This output signal can be easily interfaced with microcontrollers or other digital devices for further processing and analysis. The module typically offers a frequency response covering standard AC power frequencies, making it suitable for various mains power applications worldwide. Some versions may include built-in protection features like overvoltage protection or transient voltage suppression for added reliability. Users may need to calibrate or adjust the module according to application requirements, with calibration procedures typically outlined in the datasheet. Available from various electronic component suppliers, the ZMPT101B module is a reliable choice for projects requiring accurate AC voltage measurement and monitoring, offering ease of integration and high performance in a wide range of environments.

C. Hall sensor

Hall sensors, utilizing the Hall effect , are transducers that alter their output voltage in response to fluctuations in magnetic field strength. They are instrumental in a variety of applications such as proximity sensing, speed detection, position sensing, and current sensing. These sensors come in diverse types, including analog, digital, linear, and switch Hall sensors. Analog Hall sensors yield a continuous output voltage in direct proportion to the magnetic field's intensity, while digital ones produce a digital output signal that toggles between high and low states contingent on the presence of the magnetic field. Linear Hall sensors offer an output that linearly shifts with variations in magnetic field strength, whereas switch Hall sensors furnish a digital output indicative of the magnetic field's presence or absence.

These sensors find extensive use across automotive systems, industrial machinery, consumer electronics, and more, owing to their reliability, precision, and resilience in harsh environmental conditions. Hall sensors are crucial components in electronic systems, providing non-contact detection of magnetic fields, which is particularly advantageous in applications where physical contact is not feasible or desirable. They operate based on semiconductor technology and can detect a wide range of magnetic field strengths, making them versatile for various sensing tasks. Additionally, Hall sensors exhibit fast response times and low power consumption, further enhancing their suitability for battery-operated and portable devices. With ongoing advancements in sensor technology, Hall sensors continue to play a vital role in enabling innovative solutions across numerous industries,

contributing to the development of smarter and more efficient electronic systems..

V. WORKING

The implementation of the IoT-based line break detection system is a comprehensive process that encompasses several crucial components and steps. At the outset, meticulous attention is given to the installation of the Hall sensor along the transmission line. Positioned strategically, this sensor serves as the frontline data collector, meticulously monitoring the flow of electrical current with precision. Its placement is pivotal, ensuring it can capture subtle variations in current flow that may signal a potential line break.

Once installed, the Hall sensor is seamlessly integrated with a microcontroller, which acts as the central processing unit of the system. Arduino ESP 32is utilized for their versatility and reliability. Through this integration, the microcontroller orchestrates the collection, processing, and transmission of data generated by the Hall sensor.

The IoT module plays a pivotal role in enabling wireless communication capabilities within the system. This connectivity allows for the seamless transmission of sensor data to a centralized cloud platform, irrespective of geographical constraints.

The cloud platform serves as the nerve center of the system, where incoming data is meticulously analyzed, processed, and stored. Here, sophisticated algorithms are deployed to interpret the raw sensor data and discern patterns indicative of a potential line break. Leveraging advanced statistical methods or cutting-edge machine learning techniques, these algorithms continuously refine their analysis, ensuring accurate and timely detection of anomalies.

Upon detecting a potential line break, the system swiftly triggers an alert mechanism to notify relevant stakeholders or power station operators. This alert mechanism is carefully designed to deliver notifications through dashboard, ensuring rapid dissemination of critical information.The system is deployed along transmission lines at transformer locations. Integration with existing power distribution infrastructure is seamlessly executed, fostering interoperability and data exchange. This integration empowers power distribution companies with real-time monitoring capabilities, enabling proactive intervention and mitigation strategies in the event of a line break.

In essence, the implementation of the IoT-based line break detection system embodies a meticulous and iterative process, driven by innovation and a steadfast commitment to enhancing electrical safety within power distribution networks. Through the seamless integration of cutting-edge technologies and rigorous testing protocols, this system stands poised to revolutionize the detection and response

mechanisms for line breaks, safeguarding lives, property, and critical infrastructure alike.

VI. CONCLUSION

In conclusion, the IoT-based line break detection project represents a significant advancement in enhancing electrical safety within power distribution networks. By leveraging cutting-edge technologies such as the ESP32 microcontroller, Hall sensor, and cloud platforms, the system offers a proactive approach to detecting line breaks in transmission lines.

Through meticulous implementation and rigorous testing, the system demonstrates its capability to monitor current flow, analyze data in real-time, and promptly detect anomalies indicative of a line break. The seamless integration of components, coupled with efficient wireless communication, enables the system to deliver accurate and timely alerts to relevant stakeholders, empowering them to take swift action to mitigate risks and ensure the safety of personnel and the public.

Moreover, the scalability and flexibility of the system allow for its deployment across diverse operational environments, offering a cost-effective solution for power distribution companies to enhance operational efficiency and reliability. By embracing innovation and harnessing the power of IoT technology, the project sets a new standard for proactive line break detection, paving the way for a safer and more resilient electrical infrastructure.

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Analysis of Methodology to Detect Autism Spectrum Disorder using Machine Learning

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Abstract-ASD (Autism Spectrum Disorder) consists of wide range of symptoms and can often go unnoticed. These also relate to other mental disorders. The cause may be linked to genetics, lower weight at birth, having old parents etc. The symptoms includes, difficulty when interacting with someone or a group of people, improper communication skills, repetitive behaviors, difficulty dealing with change, sensitive to light and other stimuli, fixated interests, inability to understand others, difficulty in organization, delay in speech development. Early diagnosis is necessary to ensure quality life. The symptoms are primarily observed when a child attends school. Diagnosis in adults can be difficult as they can present other mental disorder symptoms also.

INTRODUCTION

This information aids healthcare providers in making diagnostic decisions based on DSM-5/ICD-10 criteria (World Health Organization, 2004). Providers use a range of methods, from subjective (e.g., rating scales) to objective (e.g., direct observations), to gather this data. Autism Spectrum Disorder (ASD) and Attention-Deficit/Hyperactivity Disorder (ADHD) are common brain conditions, often persisting from childhood into adult. ASD is a neurodevelopmental illness categorized by message, behavior, and social interaction deficits (Maenner et al., 2020). Since DSM-5, ASD encompasses a broader diagnostic category (Eslami et al., Kogan et al., 2009), ASD affects behavior and communication, emerging at any stage of life with evolving symptoms. It significantly impacts an individual's quality of life. Confused with Typically Developing (TD), which lacks a neurodevelopmental basis, ASD diagnosis relies on factors like the functional connectome pattern, patient phenotypic data, and blood oxygen level-dependent (BOLD) signals. The commonly used brain atlases are Automated Anatomical Labeling 116 (AAL116), Craddock 200 (CC200), and Harvard-Oxford Atlas 110 (HO110). Promising ASD detection results include 70% accuracy with a simple deep convolutional neural network (CNN) [14]. The ASD detection results are achieved as 71.98% with classical ridge regression [15], and for multi-layer perceptron model it is achieved as 75.27% [16], using input as Connectivity Maps as input.

We present a thorough analysis of ML techniques for ASD and ADHD diagnosis in this survey. In addition to (f) MRI, research on ADHD and ASD also makes use of other forms of brain data produced by technologies like positron emission tomography (PET) and electroencephalogram (EEG). Eye tracking data and Facial expressions are used to assess the usefulness of machine learning methods in reliably determining the people with ASD and also without ASD.

To understand the ADHD, graph theoretical and community detection algorithms are used. Literature reveals that combined data of Personal Characteristic Data (PCD) with MRI data gives better classification results for both ASD and ADHD data sets (Brown et al., 2012; Ghiassian et al., 2016; Parikh et al., 2019).

The authors Vaishali R, et al., suggested optimal behavior method for determining Autism. The characteristics selected were 21 from the UCI machine learning repository and utilized a swarm intelligence-based characteristic selection on the ASD diagnosis dataset. The outcomes revealed that 10 out of the 21 features were sufficient to distinguish between ASD and non-ASD patients. This method resulted in precision ranging from 92.12% to 97.95%. Fadi Thabtah et al. discussed a model using Machine Learning Adaption and DSM-5. They discussed the arrangement of ASD using machine learning and related the pros and cons of various methods. The paper highlighted the limitations of prevailing ASD screening methods and the significance of reliability. M. S. Mythili, et al., a study on Autism

Spectrum Disorder (ASD) conducted by focused on employing grouping methods to detect autism and categorize its severity levels. They utilized Neural Network, SVM, and Fuzzy techniques with WEKA tools to detect student behavior and social interaction. Another method proposed by J. A. Kosmicki1, V. Sochat, M. Duda, and D.P. Wall et al., aimed to identify a minimal set of traits for autism detection using a machine learning approach based on clinical assessments. With data from 4540 individuals, they applied eight different machine learning algorithms to pinpoint a subset of behaviors from the ADOS modules, achieving an overall accuracy of 98.27% and 97.66%.

Li B, A. Sharma, et al., employed ML methods to detect autism in adults through an imitation method. Their investigation focused on categorization test conditions and kinematic parameters, analyzing hand movements in 16 ASC participants. Machine learning methods were then used to extract 40 kinematic constraints from 8 imitation conditions. The study illustrated the potential of machine learning methods for the diagnostic classification of autism.

METHODOLOGY

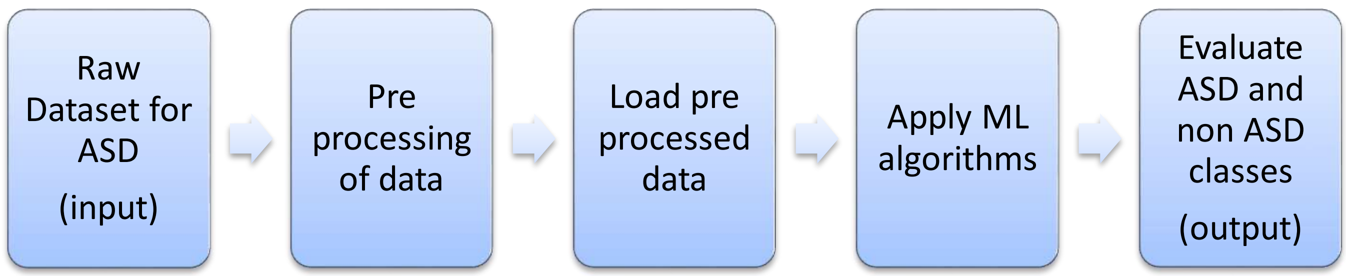

Figure 1: Block Diagram to determine ASD Patients

DATA PRE PROCESSING

This technique involves converting raw data into a format that the system can comprehend. Its purpose is to avoid errors such as missing values, data reduction, and numerical value reduction. Here the problem of missing values is handled by imputation method.

TRAINING AND TESTING MODEL

In this model, the dataset is divided into double parts: one is training set and other is testing set. The ratio is set to 80:20. For cross validation, training set is further divided to training set and validation set

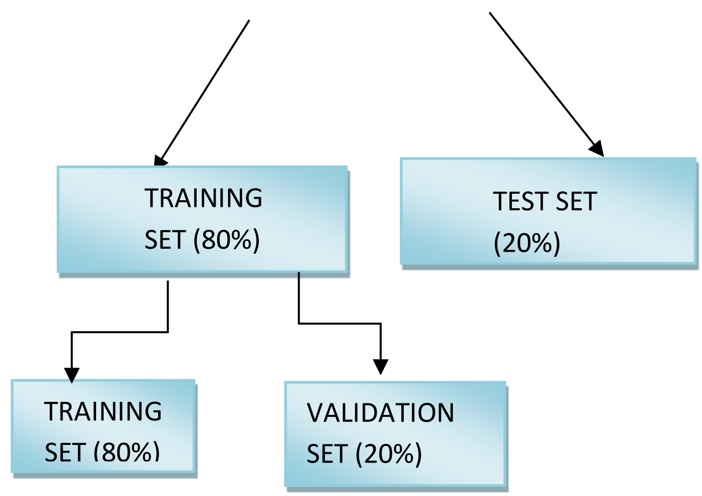

Figure 2: Methodology to apply ML Algorithms

According to Heinsfeld et al. (2018), ABIDE I/II data sets are frequently used by machine learning techniques to assess the categorization accuracy of their approaches. Chen et al. (2016) employed support vector machines (SVM) to categorize data based on attributes derived from brain functional connectivity across several frequency bands. Kernel support vector machine (MK-SVM) was applied to static and

dynamic functional connectivity characteristics created by a sliding window mechanism in a different study (Price et al., 2014).
The author Ghiassian et al. (2013), applied SVM to a histogram of oriented gradients (HOG) characteristics of fMRI data. The research performed by Katuwal et al. (2015) used three different categorization algorithms Random Forest (RF), SVM and Gradient Boosting Machine (GBM) using sMRI. The efficiency obtained was 67%.

RESULTS

The outcome is evaluated using specificity, sensitivity, and accuracy, which are determined through the confusion matrix and reported according to the model's accuracy.

PERFORMANCE EVALUATION METRICS

Assessing performance is crucial for examining the functionality of a classification model. Evaluation metrics are utilized to determine the effectiveness and performance of classifying a specific dataset. It is crucial to choose the correct metrics to evaluate the model performance like accuracy, specificity, sensitivity etc.

	PREDICTIVE ASD VALUES	
ACTUAL ASD VALUES	True Positive (TP)	False Positive (FP)
	False Negative (FN)	True Negative (TN)

Specificity = TN/TN+TP
True Positive Rate or Sensitivity = TN/ (TN+FN)
Accuracy = TP+TN/ (TN+TP+FP+FN)

CONCLUSION

Deep learning and machine learning methods were used to identify ASD. A range of features were employed to examine the non-clinical dataset comprising three groups: children, adolescents, and adults. After verifying the missing values, the CNN classifier SVM with all of its features produced better results. About 98.30% of the predictions are shown by both SVM and CNN based models. The model based on CNN obtained the best accuracy result.

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Automated fault discernmentsystem with data provision viacloud in thermal powerhouse

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Abstract* – In this proposed system, microcontroller which acts as heart of the system, controls the turbine based on the output values of sensors incorporated in every section of power plant. Sensors used here are temperature sensor,oil level sensor, oil conditioning sensor, vibration sensor and voltage and current sensors. Temperature sensor measures heat produced in power plant, oil level sensor formeasuring quantity of oil which acts as lubricant. Oil conditioning sensor detects the nature of oil and vibrationsensor is used to measure the friction level in shaft while spinning. Voltage and current sensors are incorporated toquantify the amount of current produced from turbine. Ifoutput value from any of the sensors becomes abnormal, an alert system will be activated by controller to intimate the occurrence of fault. Simultaneously, output values from these sensors are updated in web server to monitoring section of power plant.

I. INTRODUCTION

In recent years, the integration of Internet of Things (IoT) technology has revolutionized various industries, and the energy sector is no exception. One area where IoT holds significant promise is in the monitoring and management of thermal power plants. Thermal power plants play a critical role in generating electricity by converting heat energy into electrical energy through the combustion of fossil fuels such as coal, natural gas, or oil. However, the efficient operation of these plants requires continuous monitoring of various parameters to ensure optimal performance, safety, and environmental compliance.

Traditional monitoring systems in thermal power plants often rely on manual inspections and periodic checks, which can be labour-intensive, time-consuming, and prone to human error. Moreover, these systems may not provide real-time insights into the plant's operational status, making it challenging to detect and address issues promptly. This is where IoT-based smart monitoring solutions come into play.

By leveraging IoT technology, thermal power plants can collect, analyse, and visualize data from a multitude of sensors and devices installed throughout the plant. These sensors can monitor critical parameters such as temperature, pressure, humidity, flow rates, and emissions in real-time. The data gathered from these sensors can then be transmitted to a central monitoring system or cloud- based platform for analysis and decision-making.

Key Benefits of IoT-enabled Smart Monitoring in Thermal Power Plants:

1. *Real-time Monitoring*: IoT enables continuous monitoring of key parameters, providing plant operators with real-time insights into the plant's performance and condition. This allows for proactive maintenance and troubleshooting, reducing downtime and enhancing overall efficiency.

2. *Predictive Maintenance*: By analyzing historical data and employing predictive analytics algorithms, IoT systems can anticipate potential equipment failures or malfunctions before they occur. This enables predictive

maintenance strategies, wherein maintenance activities are scheduled based on actual equipment condition rather than predetermined schedules, minimizing unplanned downtime and reducing maintenance costs.

3. *Optimized Performance*: IoT-based smart monitoring allows for optimization of plant operations by identifying opportunities for efficiency improvements and process optimization. By analyzing data from various sensors, plant operators can fine-tune equipment settings, adjust operating parameters, and implement energy-saving strategies to maximize output while minimizing fuel consumption and emissions.

4. *Enhanced Safety and Compliance*: Continuous monitoring of critical parameters ensures compliance with safety regulations and environmental standards. IoT systems can detect deviations from predefined thresholds and alert operators to potential safety hazards or environmental violations, allowing for timely intervention and mitigation measures.

5. *Remote Monitoring and Control*: IoT technology enables remote monitoring and control of thermal power plants, allowing operators to access real-time data and manage plant operations from anywhere with an internet connection. This facilitates centralized management of multiple plants, improving overall operational efficiency and responsiveness

II. RELATED WORK

Temperature logger for electrical equipment's thermal stress monitoring. 2023 Alin Dragomir; Maricel Adam; Mihai Andruşcă ; Cosmin Nistor Deaca Anamaria Iamandi.This paper aims to present the importance of the electrical equipment's temperature monitoring by highlighting how its thermal stresses can indicate a malfunction of equipment. When defective electrical equipment or improper electric loading or damaged metallic or non-metallic components occur, they are usually due to abnormal temperature models. Also the paper presents the development and manufacturing of a temperature logger that can successfully monitor the thermal stress of electrical equipment in multiple independent points.

Intelligent Multi-point Sampling System of SCR Denigration Optimizing Ammonia Injection Control Technology in Thermal Power Unit, 2022 Deng Yue, Huang Xin, Jia Xibu. Aiming at the problem that the measured data of CEMS for denigration in coal-fired power plant can not reflect the real concentration of NOx, an intelligent multi-point sampling system is designed to make the sampling data of NOx at denigration outlet representative. The test results show that the average cross-section concentration measured by SCR intelligent multi-point sampling system can meet the accuracy requirements of operation monitoring and environmental protection monitoring, ensure the timeliness and accuracy of the measurement data, and feed back the SCR outlet NOx concentration signal to the ammonia injection operation control in advance, so as to maintain the safe and stable operation of the unit.

A Wireless System for Monitoring Leakage Current in Thermal power plant, 2024 Michael Wang, Lisa Chen**.** In this paper, the design and the development of a remote system for continuous monitoring of leakage currents and ground currents in high voltage electrical substations are proposed. Based on wireless local area network technology, the system can be used to monitor continuously a variety of plants within the substation and has low power consumption with inbuilt overvoltage protection. It consists of a transmitter module equipped with a data acquisition (DAQ) system connected to leakage current and voltage sensors, and a receiver module connected to a remote controller for data processing and storage.

Improving the Information Reliability of Industrial and Environmental Monitoring of the Burning Fuel Process in Thermal Power Plants. 2023, Ya.A. Tynchenko, I.V. Kovalev, V.S. Tynchenko. One of the most significant technological processes implemented at thermal power plants and having the greatest impact on the environment and, therefore, requiring monitoring of production and environmental indicators is the burning of prepared fuel. As a result of the study, a model of the fuel burning production process from a thermal power plant was developed, which is able to give an estimate of the generalized criterion for the quality of the technological process by n-1 inputs and evaluate the allowable range of values of the n-th parameter. At the same time, for the formation of the process parameters (oxygen content and temperature) measured values, a multisession approach is used, based on obtaining the N-th amount of measured data. The resulting value is obtained by voting. The proposed approach will improve the information reliability of thermal power plants industrial and environmental monitoring, which is especially relevant for the industrially developed Krasnoyarsk Territory and other industrial regions of the Russian Federation.

III. PROPOSED SYSTEM

In a thermal power plant, the process of coal combustion in the boiler results in the conversion of water into high-pressure steam within the boiler tubes. This steam, characterized by its high pressure and temperature, is then directed into the turbine, causing it to rotate. The turbine shaft is linked to the generator shaft, enabling power generation. Ensuring the operational parameters of the power system is crucial to maintain the health of the power generation equipment and the efficient operation of equipment utilized by the power plant and end users. Continuous monitoring and frequent inspection are essential to this end. In the power plant setting, the main parameters that require constant monitoring include temperature, vibration, and level. Excessive steam temperature can lead to the puncturing of boiler tubes, while elevated bearing temperatures may cause the fans to trip.

So, temperature of steam should be monitored. Turbine shaft will be damage if vibration increases. So, vibration should be monitored. The timely information about the variation in parameters like boiler drum level, turbine vibration and steam temperature can be received from various devices by using embedded system. If the values of the parameters are increased or decreased than the reference value, Arduino will intimate the higher officials about the values of the parameter varied from set values through Internet of Things.

IV. BLOCK DIAGRAM

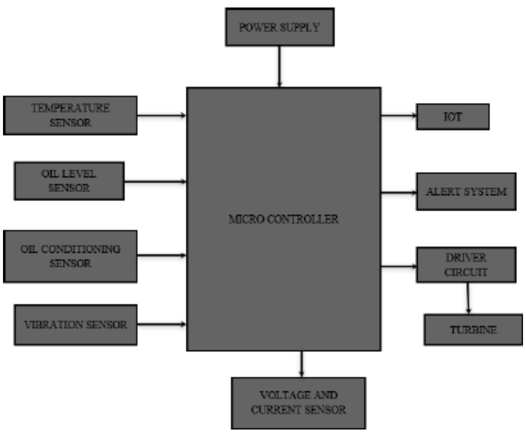

Fig. 1 System Block Diagram

V. RESULTS AND DISCUSSIONS

Fig. 2 Real Time Sensor Values

Temperature Sensor: The temperature sensor serves to monitor the heat generated within the power plant. High temperatures can indicate potential issues such as overheating, which could lead to equipment damage or failure. By continuously monitoring temperature levels, the system can implement necessary adjustments to maintain optimal operating conditions and prevent overheating-related failures.
Oil Level Sensor: Monitoring the quantity of oil, which acts as a lubricant within the power plant machinery, is critical for ensuring smooth and efficient operation. The oil level sensor enables the system to detect any deviations from the desired oil level, thereby facilitating timely refilling or maintenance activities to prevent equipment damage due to insufficient lubrication.

Oil Conditioning Sensor: The nature and condition of the oil used in the power plant machinery significantly impact its performance and longevity. The oil conditioning sensor allows for real-time monitoring of the oil's quality, detecting contaminants, degradation, or other factors that may compromise its effectiveness as a lubricant. This information enables proactive maintenance interventions, such as oil replacement or filtration, to uphold optimal operating conditions and prevent equipment wear.

Vibration Sensor: Monitoring the vibration levels in the shaft while spinning provides insights into the friction and mechanical stresses experienced by the turbine components. Excessive vibration can indicate misalignment, imbalance, or wear within the machinery, posing a risk of equipment failure or reduced efficiency. By detecting abnormal vibration patterns, the system can trigger corrective actions or maintenance procedures to mitigate potential damage and ensure smooth operation.

Voltage and Current Sensors: Quantifying the electrical output of the turbine through voltage and current sensors is essential for assessing its performance and efficiency. Deviations from expected voltage and current levels may indicate electrical faults, system inefficiencies, or load imbalances, which could affect overall power generation capabilities. Continuous monitoring of these parameters allows for prompt identification and resolution of electrical issues, optimizing the power plant's output and reliability.

Alert System and Web Server Integration: The microcontroller orchestrates an alert system that activates in response to abnormal sensor readings, promptly notifying operators of potential faults or deviations from optimal operating conditions. Additionally, the system updates the output values from the sensors to a web server accessible to the monitoring section of the power plant. This real-time data transmission enables remote monitoring and analysis, empowering operators to make informed decisions and take timely corrective actions to ensure uninterrupted operation and maximize plant efficiency.

VI. CONCLUSION

In IoT-based smart monitoring holds immense potential for transforming the way thermal power plants are operated and managed. By leveraging real-time data analytics, predictive maintenance, and remote monitoring capabilities, these systems can enhance efficiency, reliability, and safety while reducing operational costs and environmental impact. As the energy industry continues to evolve, embracing IoT technology will be essential for staying competitive and sustainable in the increasingly complex and dynamic energy landscape.

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Robust Key derivation in Mining for Blockchain Network Using Cryptographic Hash Functions and Voting Based Algorithm

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Abstract—In distributed systems, two or more nodes work together to accomplish a common objective. Users perceive the systems as a single physical platform due to their design. The two most difficult issues in distributed system design are fault tolerance and node collaboration. Blockchain is essentially a peer-to-peer distributed ledger that can only be updated by peer consensus, is append-only, immutable, and cryptographically secure. Since consensus algorithms are necessary for the proper operation of a blockchain network, choosing the right ones is crucial for achieving the highest levels of efficiency and security. Numerous consensus algorithms with distinct performance and security features have been put forth in the literature. Not every application can be satisfied by a single consensus algorithm. To illustrate the advantages, disadvantages, and use cases of the various consensus algorithms, a technical comparison is essential. The purpose of this research is to compare and evaluate various consensus algorithms based on how well they mine blocks using various cryptography hash functions and consensus algorithms.

Keywords— Distributed System, Cryptography, Blockchain, Consensus Algorithm and Hash Functions

1. INTRODUCTION

Blockchains were first introduced in 2008. Blockchain technology was developed to address the inefficiencies and hazards associated with corporate transactions. It has completely changed how businesses and industries are structured. However, blockchain technologies are now moving beyond cryptocurrency to have an impact on how businesses are conducted across many industries. Database, or distributed ledger, is secure using cryptography. This means that in order to read or write data from the database, you need the appropriate cryptographic keys: a private key, which is your unique key and acts as true security to keep others from updating the data until they have the correct key. The public key is essentially the address and database where information is stored. Transactional data is stored in blocks linked to each other forming a chain. It makes asset tracking in a company easier. Any valuable object, whether tangible or intangible, can be considered an asset. A car, land, house, and money are a few examples of tangible assets. Intellectual assets like copyrights, real estate, patents, and brands are examples of intangible assets. Depending on the specified block size, transactions are clustered together in a block. Using a timestamp, Block verifies the order of transactions. Every block keeps note of a previous block's hash, which facilitates retracing steps during the validation of new blocks. Because no one can insert a malicious or tainted block between genuine blocks, this increases the security of the blockchain as a whole. This is referred to as immutability in which no existing block can be altered. Whenever a transaction occurs, every node updates the ledger. Every node stores the copy of whole ledger. On top of the internet, blockchain can be viewed as a layer of a distributed peer-to-peer network. From a commercial perspective, a blockchain is a system that allows peers to use transactions to trade values without having to rely on a central authority. As a result, blockchain can function as a decentralized consensus method without a single authority controlling the database. A block is just a grouping of transactions that have been rationally arranged. It consists of transactions and varies in size based on the kind and layout of the blockchain that is being used. If the block isn't a genesis block, it additionally contains a reference to a prior block. A genesis block is the initial block in the blockchain that was per-programmed at the moment the network was established. Consensus algorithm plays an important role in blockchain. Consensus meant for group of people agree on a single state of the network or data value. In recent years, blockchain consensus algorithm are used to provide immutable, decentralized decision making and trusted data in various sectors like healthcare, real estate and banking system etc. Consensus algorithms facilitate confidence and agreement among network users, which is necessary for blockchain-based applications.

II. CRYPTOGRAPHIC PRIMITIVES

Third parties or governments are not involved in blockchains. Many transactions take place in these networks, which are completely decentralized. In Blockchain, security is therefore crucial. To construct cryptographic protocols for a robustly secured network, one uses cryptography primitives. When building algorithms, these low-level algorithms are employed. These are the cryptosystem's fundamental building components. The fundamental building blocks of cryptography are combined by cryptographic designers to create robust security protocols. For instance, having a security mechanism that can both find and fix problems is always useful. In the blockchain, data is encrypted using a public key algorithm in conjunction with a hashing technique called SHA-256. One way hash function, Symmetric key, Asymmetric key, Randomized algorithm, Mix network, Retrieval of Private information and Initialization are some of the common cryptographic primitives.

A. HASHING

Hashing is a fundamental component of blockchain technology that serves a number of important functions in preserving the security and integrity of the network. The hash, or digital fingerprint of the input, is the result of the hashing algorithm. The block contains the hash, which functions as a digital signature. It functions as a digital signature that attests to the data's integrity and is stored in the block with the data. The hash can be recalculated when the data is needed later, and if it agrees with the hash that has been saved, it is verified that the data has not been altered. In order to link blocks together, safeguard data stored in the blockchain, confirm data integrity, and function as a component of the consensus process, hashing is essential to blockchain technology. The blockchain would not be able to operate as a safe, unchangeable, decentralised ledger without hashing. SHA 256, Scrypt, Ethash and Equihash are some hashing algorithms used in blockchain network.

B. MINING

In the context of blockchain technology, solving a hash usually refers to mining—the process of generating new blocks and appending them to the network. Miners carry out this procedure by solving the hash function through sophisticated mathematical computations using specialised hardware and software.

Steps for Solving Hash in Blockchain:

1.With a number of outstanding transactions, a new block is produced.

2.The hash function is applied to the data by the miner using the hash of the previous block and the data from the current block.

3.Until the block's hash satisfies a set of requirements, the miner keeps altering a little bit of information known as a nonce.

4.Miner sends the block data and the solution to the network for validation.

5.The new block is put to the blockchain and the miner is rewarded with a specific amount of cryptocurrency once the network has validated the solution.

III. LITERAURE SURVEY

A. SECURE HASH ALGORITHM 256

The Ethereum network and Bitcoin both use SHA 256 and SHA 3. The input message size for SHA-256 is less than 2^64 bits. Word size is 32 bits, while block size is 512 bits. It produces a 256-bit digest. A 256-bit intermediate hash value and a 512-bit message block are processed by the compression function. The compression function and a message scheduling are the two primary parts of this function.SHA-256 is applied to a blockchain at different phases. In order to determine the hash of newly produced blocks using SHA-256, miners adjust the nonce value in a bitcoin block until they obtain a hash that is below the threshold. After that, the ledger can accept that block. Every block in the ledger has a hash produced by SHA-256 that is related to the block before it on the chain. Digital signatures are used in transactions to ensure their integrity. The data involved in the transaction is first hashed using SHA-256 and then encrypted using the sender's private key to produce a signature. Next, in order to confirm the transaction, the miner checks this signature.

Cryptocurrency mining is the main application of SHA-256 and other hash algorithms in blockchains. The process of adding new transactions to the blockchain, and specifically the creation of new Bitcoins, is called mining. Mining is the process of allocating computer processing power to the validation of new transactions. When the Bitcoin being sent has not been sent by the same person previously, a transaction is considered lawful; this is referred to as "double-spending." To make sure someone isn't "double-spending," the whole blockchain must be checked for duplicate transactions. Several computers calculate hashes using random data, called the nonce, in an effort to predict the correct value. The first person to guess the correct hash wins Bitcoin. This process is known as verification. We refer to this authentication procedure as "Proof-of-Work." A hash in Bitcoin that is less than or equal to the value determined by the network is considered correct.

B. SCRYPT ALGORITHM:

The cryptocurrency Litecoin (LTC) initially employed Scrypt as a hash algorithm in place of the more well-known SHA-256 hash function. The mining algorithms employed by the Litecoin and Bitcoin (BTC) protocols are Scrypt and SHA-256, respectively. Both use the proof-of-work consensus mechanism, in which adding a block to the blockchain requires a miner to solve a hash function.In order to add the next block and get paid for it, a cryptocurrency miner needs to solve the Scrypt hash function on the Litecoin protocol.Given that they both need massive amounts of processing power to produce a wide range of potential solutions for their respective purposes, hash functions are both computationally demanding.

But the Scrypt function is also memory-intensive, which sets it apart from the SHA-256 algorithm. Because Scrypt generates numbers quickly and stores them in the processor's Random Access Memory (RAM), which must be continuously read until a result is sent, Scrypt requires a large amount of memory.Protocols based on Scrypt have a lower hash rate overall than protocols based on SHA-256.

The Litecoin development team first introduced the Scrypt hash function to prevent ASICs from being able to mine the cryptocurrency (users usually have the choice of using a CPU, GPU, or ASIC miner when mining cryptocurrencies). Because ASICs can produce more hashes per second than CPUs and GPUs, they are computationally superior to them. As a result, miners that mine for cryptocurrencies using any other equipment than an ASIC are at a disadvantage. The memory-intensive Scrypt mining algorithm, on the other hand, was designed to stop this from happening. Because ASIC miners were ill-suited to mine Scrypt, miners using CPUs and GPUs were able to maintain their competitiveness.

C. ETHASH

An Ethereum proof-of-work algorithm for mining is called Ethash. With memory hardness and ease of verification, Ethash has been engineered to withstand ASIC attacks.The Ethereum network and its cryptocurrency counterparts use the proof-of-work mining algorithm known as Ethash. The Ethereum algorithm that came before it, known as Dagger-Hashimoto, was improved upon by Ethash. But at this point in their evolution, both algorithms are sufficiently dissimilar to be regarded as the same algorithm. The fact that Ethash employs the "Keccak-256" and "Keccak-512" hash algorithms causes some confusion because SHA-3 (Secure Hash Algorithm 3) cryptographic standards are being developed concurrently with Ethash.The SHA-3 standard is a member of the larger Keccak cryptographic primitive family, which is also known as a synonym for SHA-3. Although the hash algorithms used by Ethash are sometimes referred to as "sha3_256" and "sha3_512," the Keccak variant of Ethereum does not use the conventional SHA-3 hash technique.Although the primary Ethash-based cryptocurrency, Ethereum, has gained immense popularity, ASIC developers are now more interested in producing miners that are compatible with Ethash due to the fact that Ethash was designed with protection against ASIC (Application Specific Integrated Circuits) miners in mind. Both the CPU and the GPU can be used for Ethash mining.

Due to GPU miners' nearly two times more efficient mining capabilities, CPU mining of Ethash-based cryptocurrencies is no longer economical. Nonetheless, CPU mining can be used to test out cryptocurrency transactions inside a network, generate a small number of coins to power smart contracts, or make initial mining attempts. The ETH client, geth, is used to mine Ethereum CPUs. Geth is an application that links the miner's equipment and the Ethereum network. Within a network, coins that are mined will be transferred straight to the miners' coinbase address.

For Ethash, GPU mining is the best choice. But it's crucial to keep in mind that Ethash is memory-intensive and requires one to two gigabytes of RAM for every GPU it uses. The community and developers discourage the use of ASICs and FPGAs (Field-Programmable Gate Arrays), which are now capable of mining ethers, as they are less efficient than GPUs. AMD GPUs, on the other hand, typically outperform NVidia devices in the same category. To begin GPU mining, download Ethminer, an Ethash miner created by the Ethereum team that can be used with any Ethash-based cryptocurrency that hasn't blocked this possibility directly. AlethZero, the GUI, and EthMiner, the standalone miner, are the three versions of Ethminer that are available.

IV. HASHING ALGOIRTHMS IN BLOCKCHAIN MINING

Robust Key Derivation in Hash Algorithm for Mining Process:

Hash algorithms can encounter a number of issues for a variety of causes, the most significant of which is collisions.

To ensure that algorithms are resilient to any issues they face, it is essential to increase their power.

The hash method was created using logic, buffers, and chaos theory (1D and 2D), incorporating a new structure based on Merkle-Damgård construction. When dealing with variable-length communications, the Chaos Buffer Hash technique transforms them into fixed-length output.

The steps listed below demonstrate how to solve the hash:

1. Data is passed through to the updated ETHASH algorithm
2. Transforming data into a message digest or hashed value and ensure it must always have a specific amount of zeros
3. The node determines if a hash satisfies the difficulty requirements.
4. A broadcast is sent to all other miners on the network if the hash satisfies the difficulty requirements.
5. The block is validated into a new block by the first miner to discover a valid hash, and they are rewarded with block rewards and Bitcoin fees.
6. Another nonce is chosen and hashed if the hash does not satisfy the network difficulty requirements.
7. Miners probably have to generate many hashes with many nonce's until they find a nonce that meets the difficulty.

For every example, some numbers of measurements were taken, and an average value was determined. There are one million calculations in one millisecond. The system has 16GB of RAM, 1 core Intel i7 2.60GHz, and 64 bits of Windows 10.

TABLE 4.1: COMPARISON OF VARIOUS HASHING ALGORITHMS

Hash	#1 (ms)	Avg per 1M (ms)
MD5	1652.9	0.564
SHA- 256	2248.3	0.541
ROBUST HASH	5343.06	156.64

Generic approach to estimating the hash rate for "Robust Hash" algorithm:

```
import time
# Define the hypothetical Robust Hash function
def robust_hash(data):
    # Example: return hash_function(data)
    pass
# Benchmark function
def benchmark_robust_hash(iterations):
    start_time = time.time()
    for _ in range(iterations):
        input_data = bytes(str(_), 'utf-8')
        robust_hash(input_data)
    end_time = time.time()
    elapsed_time_ms = (end_time - start_time) * 1000
    return iterations / elapsed_time_ms
 # Hashes per millisecond
# Adjust this based on your system and desired precision

iterations = 1000
hashes_per_ms = benchmark_robust_hash(iterations)


print("Robust Hashes per millisecond:", hashes_per_ms)
```

TABLE 4.2: COMPARING THE USAGE OF VARIOUS PARAMETERS FOR DIFFERENT ALGORITHMS

Algorithms	CPU usage	Memory Usage	Network Usage
SHA 256	Low	Low	Low
SCRYPT	High	High	Low
ETHASH	High	High	High
Robust Key Derivation Hash	Moderate	Moderate	Low

V. DISCUSSION AND CHALLENGES

SHA-256 produces a fixed-size 256-bit (32-byte) hash value and it is widely used in various security applications, including digital signatures, SSL/TLS certificates, and blockchain. As a cryptographic hash function, SHA-256 is designed to be fast and efficient. However, it's vulnerable to brute-force attacks using specialized hardware like ASICs and Length extension attacks can also be a concern if SHA-256 is used improperly.

Scrypt's memory-hardness can make it less suitable for environments with limited memory. Determining optimal parameters for Scrypt can be challenging, as they directly affect its memory and CPU requirements. Implementing Scrypt efficiently can be complex, and incorrect implementations may compromise security. Scrypt's memory-hardness can make it less suitable for environments with limited memory. Determining optimal parameters for Scrypt can be challenging, as they directly affect its memory and CPU requirements. Implementing Scrypt efficiently can be complex, and incorrect implementations may compromise security.

Ethash is the proof-of-work algorithm used in Ethereum mining. It's designed to be ASIC-resistant and memory-hard, aiming to ensure a fairer distribution of mining rewards and it requires a large amount of memory during the mining process. Ethash's memory-hardness presents a challenge for hardware optimization, as it requires a significant amount of memory.The DAG (Directed Acyclic Graph) size grows over time, increasing the memory requirements for mining. Ethash's resistance to ASICs may diminish over time as hardware evolves, requiring constant algorithm adjustments.

Robust Key Derivation Hash is a hypothetical hash function with characteristics tailored for key derivation. Its design may focus on factors like resistance to side-channel attacks, scalability, and performance. It may involve a balance between computational complexity, memory requirements, and security. Defining the properties and design principles of RKDH would require careful consideration of various factors, including security, performance, and usability.

VI. CONCLUSION

In conclusion, each of these hashing algorithms presents unique characteristics, challenges, and considerations. SHA-256 is widely used and well-understood but vulnerable to brute-force attacks. Scrypt and Ethash aim to address ASIC vulnerabilities by incorporating memory-hardness but introduce their own challenges in terms of parameter tuning and memory requirements. Robust Key Derivation Hash, as a hypothetical algorithm, would need careful design to balance security, efficiency, and usability. Achieving a balance between security and efficiency is a challenge, as increasing security measures (such as increased iterations or memory requirements) can impact performance. Implementing and standardizing RKDH would require rigorous cryptographic analysis and community consensus.

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LIVER COMPUTED TOMOGRAPHY IMAGE ANALYSIS AND ABNORMALITY CLASSIFICATION IN MACHINE LEARNING

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Abstract

Background and objective: Acute liver failure occurs when liver cells are damaged significantly and are no longer able to function. The causes may include Hepatitis and other viruses, Toxins, Autoimmune disease, Diseases of the veins in the liver, Metabolic disease, Cancer, Overwhelming infection etc. The liver diseases are asymptomatic and do not show any significant symptoms at its initial stage. Therefore, diagnosing the liver diseases at their earlier stage is required to prevent the loss of liver function and liver failure.

Method: This paper proposes a diagnosis system for detecting liver abnormalities from Computed tomography images. Computed tomography images usually get affected by noise and contrast reduction that degrades the image quality and performance of the system. Hence, it is necessary to remove speckle noise and enhance contrast of the Computed tomography images. The proposed model consists of several stages where the image is first normalized and pre-processed using a Median filter and Adaptive equalization of histogram with limited contrast (AEHLC) to remove noise and enhance contrast in the image. Thus the proposed system helps the physician to diagnose the abnormalities with ease. Finally, liver abnormalities are classified implementing support vector machine (SVM) .The software used here is MATLAB.

Result: To validate the proposed system performance, the experiments have been carried out in the noisy liver Computed tomography images. The designed system framework using a linear SVM requires less computation but exhibits a very good accuracy

Keywords: Liver abnormality, median filter, Contrast limited adaptive histogram equalization, Computed tomography image, SVM classifier

1. Introduction

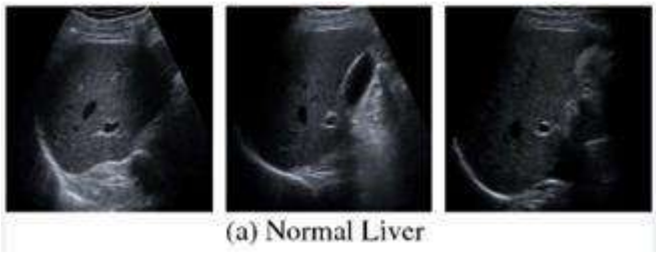
The liver is an organ about the size of a football. It sits just under our rib cage on the right side of our abdomen. The liver is essential for digesting food and ridding your body of toxic substances. Liver disease can be inherited (genetic). Liver problems can also be caused by a variety of factors that damage the liver, such as viruses, alcohol use and obesity. The term “liver abnormality” refers to any of several conditions that can affect and damage your liver. Over time, liver disease can cause cirrhosis (scarring). As more scar tissue replaces healthy liver tissue, the liver can no longer function properly. Left untreated, liver disease can lead to liver failure and liver cancer. But early treatment may give the liver time to heal.

The chronic infection by hepatitis B virus (HBV) and hepatitisC virus (HCV) are the traditional risk factors that are associated with (Hepatocellular carcinoma) HCC. The virus-associated mechanisms driving hepatocarcinogenesis are complex and cause liver cirrhosis, which progresses to HCC in about 80–90% of the cases. According to the latest WHO data published in 2020 Liver Disease Deaths in India reached 2,68,580 or 3.17% of total deaths.

Computed tomography is excellent at showing normal anatomy and the presence of abnormalities in the liver. It is particularly excellent for differentiating cysts from solid masses. Simple cysts have a thin wall and contain fluid, which shows up as a darker center than solid masses have on Computed tomography . Complex cysts may have associated lumps (nodules), calcifications, or multiple tissue bands. Solid masses can even be evaluated for blood flow by a technique called Doppler Computed tomography , and cystic areas within masses can be distinguished from the solid parts.

Computed tomography can also evaluate diffuse liver diseases, such as **fatty liver, hepatitis, and cirrhosis**. For example, a fatty liver (steatosis) is typically brighter (more “echogenic” or “hyperechoic”) on a liver Computed tomography than normal liver, while hepatitis may be less bright (“hypoechoic”). A cirrhotic liver often looks shrunken and lumpy. A special technique called elastography can be added to an Computed tomography study to help measure the elasticity of the liver and assess the severity of fibrosis.Dilated bile ducts and any fluid near the liver (ascites, fluid collections) will also typically show up on a liver Computed tomography . Other organs, including the gallbladder, right kidney, and at least a portion of the pancreas are often seen as well.

Computed tomography can detect many cancerous (malignant) and non-cancerous (benign) liver masses. A mass is generally more easily seen by Computed tomography the more it differs in appearance, and therefore stands out, from background tissue. Although not a hard-fast rule, in many cases a larger mass is more easily detected than a smaller mass. But the detection of any mass is only possible if there is a good Computed tomography “window.” Unfortunately, bone, calcification, and gas act as barriers to a liver Computed tomography beam. Fatty tissue in front of or within the liver also reduces the penetration of the beam and the visibility of masses. In addition the combined speckle noise and contrast reduced images also serves as an obstacle for the doctors or radiologists to diagnose accurately and classification accuracy also get reduced due to such noisy images which may delay the treatment procedure further. These drawbacks can be overcome by a CAD system with appropriate noise reduction filter and classifier techniques.



Cysts and tumor abnormalities progresses to liver function loss and may be a contributing factor for the development of serious liver complications like Hemangioma, focal fatty infiltration, focal fatty sparing, cyst, HCC etc. To prevent such serious complications, it is essential to detect liver abnormalities at their early stage. Therefore, a computer-aided diagnosis (CAD) system is proposed to detect liver abnormalities from the Computed tomography images. By detecting liver abnormalities in their initial stage, complicated liver diseases such as hemangioma, focal fatty infiltration, focal fatty sparing, cyst, HCC etc., can be prevented. The Computed tomography image- based diagnosis system has been extensively used for detecting liver abnormalities such as cyst and tumor. Based on the echogenicity liver abnormality appears during the Computed tomography diagnosis, the liver abnormalities are classified into different categories like normal, cyst, fatty, HCC and tumor. The sample Computed tomography images with different liver diseases are shown in Fig. 2. The cysts in the livers are fluid-filled tissue with irregular structures. They appear dark or hypoechoic in Computed tomography imaging because larger part of waves goes through them and does not get reflected to the transducer. The tumors are irregular in shape composed of solid tissues and they appear hyperechoic. The radiologists and nephrologists observe the echogenicity of liver abnormality, and diagnose various

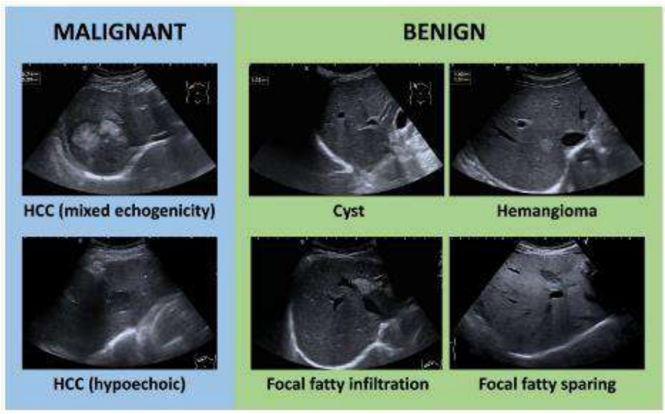


Fig 2 : Liver Abnormalities

conditions of liver. However, the number of nephrologists is inadequate and owing to this, many people may never seen nephrologist. The Computed tomography imaging may be visualized differently by the radiologists depending on their clinical experience. The radiologists manually analyze the Computed tomography images and each accurate diagnosis may take observations from several liver images. Speckle noise in the Computed tomography image may degrade the image quality as they have low contrast. This makes the Computed tomography diagnosis challenging and may alter the diagnosis results. The manual examination of each image for accurate diagnosis of the abnormality is a burden to the radiologists and nephrologists. Therefore, to overcome this, an automatic diagnosis system for identifying the liver abnormalities will be of high practical use.

In the present study, an automated computer-aided diagnosis (CAD) system is developed to detect multiple liver abnormalities. The designed CAD system comprises a pre-processing module which helps to reduce the speckle noise from the Computed tomography images. The CAD system uses the Co-occurrence matrix with grey level (CMGL) features of a recurrent neural network with pre trained logical pool (RNNPLP) and the extracted features are given to the soft max layer for classification. The feature extraction using CMGL helps toextract minute details from the image, which will be helpful in accurate prediction of disease. The different Computed tomography images are acquired from various datasets and radiologists. The different types of liver images collected are presented in Fig. 2. The primary step in the proposed CAD system is to reduce speckle noise. Hence, the CAD system is designed with the integrated despeckling contrast enhanced module using a integrated LPRNN and Contrast limited adaptive histogram equalization (N-AEHLC)[3] model. As a result, the Computed tomography image quality gets improved, which will enhance the performance of the CAD system. The motivation of the proposed CAD system is to effectively classify the liver abnormalities from the noisy Computed tomography images. This automated diagnosis system will mitigate the issue of insufficient nephrologists and acts as a supporting tool for the preliminary diagnosis of liver diseases. The CAD system will also reduce the burden of experienced radiologists and nephrologists in their diagnostic procedures. In addition to that, CAD system helps to mitigate the discrepancy among doctors in diagnosing the disease. The proposed CAD system consists of despeckling and classification module. The despeckling module [4] in the CAD system reduces the speckle noise, which will be helpful in the precise diagnosis of disease. After the despeckling process, the CAD system classifies the liver Computed tomography images into normal, cyst, fatty, and tumor categories.

The paper is organized as: In Section 2, the overview of various deep learning technique for speckle noise removal. The methodology part is described in Section 3, Extensive experimental results and discussions are presented in Section 4. The conclusion is given in Section 5.

II Related works

Catalin Daniel et al uses a DL/DNN approach for CEUS FLLs diagnosis.DNN architectures available through Keras Applications. 88% accuracy reported against a higher number of liver lesion types: hepatocellular carcinomas (HCC), hypervascular metastases (HYPERM), hypovascular metastases (HYPOM), hemangiomas (HEM), and focal nodular hyperplasia (FNH).

Ademola Enitan Ilesanmi et al resized and then enhanced with the contrast limited adaptive histogram equalization method (CLAHE) and segmentation procedure for BUS images using the VEU-Net method is obtained with segment tumors (VE block and a concatenated convolution). Proposed method achieves high DM with 89.73% for malignant and 89.62% for benign BUSs.

Onur Karaoglu, Hasan Şakir Bilge et al uses five different deep learning networks and compares the output obtained to find out the best results Dilated Convolution Autoencoder_Denoising Network (Di-Conv-AE-Net), Denoising U-Shaped Net/D-U-Net, BatchRenormalization U-Net/Br-U-Net, Generative Adversarial Denoising Network/DGan-Net, CNN Residual Network/DeRNet. These methods are compared with block matching and 3D filtering and other deep neural networks and proved to be outperformed when compared. Parameters for evaluation peak signal-to-noise ratio (PSNR), structural similarity index (SSIM) and runtime criteria

Baiju Babu Vimala et al uses image enhancement methods like contrast enhance method by logarithmic and exponential transforms and enhance the details of the glandular Computed tomography breast images by guided filter algorithms and using spatial high-pass filtering algorithms to remove the extreme sharpening and to remove speckle noise without sacrificing the image edges, edge-sensitive terms were eventually added to the Logical-Pool Recurrent Neural Network

(LPRNN). The time required to destroy local speckle noise is low, edge information is preserved, and image features are brought into sharp focus.

Kaizhi Wu et al in their paper Deep learning based classification of focal liver lesions with contrast-enhanced Computed tomography were first Dynamic CEUS videos of hepatic perfusion was retrieved. Secondly time intensity curves (TICs) are extracted from the dynamic CEUS videos using sparse non-negative matrix factorizations. Finally deeplearning is employed to classify benign and malignant focal liver lesions based on these TICs. Quantitative comparisons demonstrate that the proposed method outperforms the compared classification methods in accuracy, sensitivity and specificity

Hameedur Rahman et al in their paper, A Deep Learning Approach for Liver and Tumor Segmentation in CT Images Using ResUNet proposed an hybrid ResUNet model an efficient method for segmenting liver and tumors from CT image volumes and obtained the true value accuracy for liver segmentation as 99.55%, 97.85%, and 98.16%, the authentication rate of the dice coefficient also increased

Tarek M. Hassan et al in their paper, Diagnosis of Focal Liver Diseases Based on Deep Learning Technique for Computed tomography Images uses a pre processing stage and a Segmentation done using level set method and Fuzzy c-means clustering algorithm, softmax layer classifies the different focal liver diseases and a stacked sparse auto-encoder extracts the high-level features representation from pixels of the segmented images, which are considered as the inputs for the classifier. The experimental results show that the accuracy of classification of our proposed system outperforms the three state-of-the-art techniques with classification accuracy 97.2%

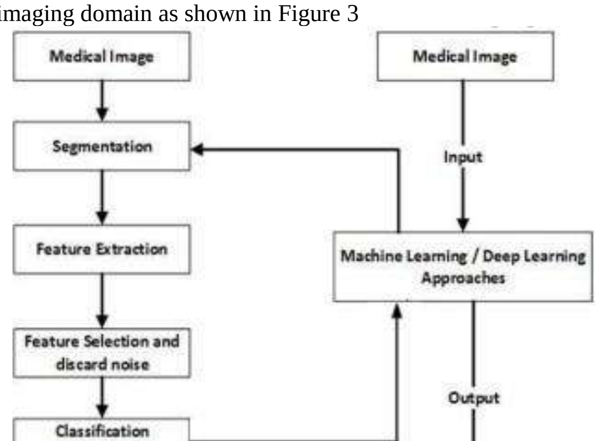
Rayyan Azam Khan et al in their paper Machine learning based liver disease diagnosis: A systematic review uses a Preprocessing method denoising, deblurring and segmentation methods and classification of Hepatocellular carcinoma (HCC), Cholangiocarcinoma (CR), Angiosarcoma and Hepatoblastoma using support vector machine method

LiDandan et al in their work Classification of diffuse liver diseases based on Computed tomography images with multimodal features uses CNN network-Multi-scale Co-occurrence Matrix with grey level (MCMGL) and Wavelet Multi-sub-bands Co-occurrence Matrix with multilevel subband (CMWMS) for extract image texture features and lightGBM classifier classifies liver abnormalities

In recent years, deep learning technology has been increasingly developing; one of the most well known CNNs has attained great achievements in text processing, voiceprint recognition, and image classification. Image enhancement using CNN method, effectively enhanced the image quality. But still there is scope for medical image processing using various methods of machine learning and deep learning.

III METHODOLOGY

There are different steps of machine learning and deep learning algorithms which are used in the medical imaging domain as shown in Figure 3



Input image

The input images of patients Liver retrieved from Computed tomography scan will be taken in, Computed tomography imaging procedures have no known risk factors to patients because they use echo technology as opposed to radiation or magnetic force. MRIs, on the other hand, can pose risks to those with implanted metal objects due to its use of magnets. As well, when a CT scan is performed some radiation takes place. In existing system we used scanned images in which we can find the max and min values by threshold values implemented and for extracting the image using Discrete Fourier transform and classified by Support vector machine.

Segmentation

Implementing Region difference filter gives a difference in image based on the region. This image is then converted into binary image and operated for segmenting the desired lesion from the Computed tomography image.

Preimaging

(a) Contrast enhancement

Contrast enhanced adaptive equalization of histogram (AEH) [3] is an image pre-processing technique used to improve contrast in images. It computes several histograms, each corresponding to a distinct section of the image, and uses them to redistribute the luminance values of the image.

(b) Median filter

The Median filter [1] is the popular known order-statistic filter in digital image processing. Median filter is very popular technique for the removal of impulse noise because of its good de-noising power and mathematical accuracy. The value of a pixel is replaced by a median of the intensity levels in the neighborhood of that pixel by the Median Filter. A fixed filtering window size is used for outcome of neighborhood pixels by the Median Filter. The median filters are implemented consistently across the image and therefore tends to modify both noisy and noise free pixels present in the image. Relation to this, there is always a chance of replacement of good pixels by some corrupted ones. Therefore, de-noising is often accomplished at the expense of blurred and distorted features thus removing fine details present in the image.

Feature extraction

co-occurrence matrix with grey level (CMGL) [8] is a popular texture-based feature extraction method. The CMGL determines the textural relationship between pixels by performing an operation according to the second-order statistics in the images. Usually two pixels are used for this operation. It examines the spatial relationship among pixels and defines how frequently a combination of pixels are present in an image in a given direction and distance.

Classification

The feature extracted in the previous step is taken and is utilized in training the classifier. The classifier used for the classification of these features is SVM classifier. Support vector machines (SVMs) [7] are a set of supervised learning methods used for classification, regression and outliers detection. The advantages of support vector machines are: Effective in high dimensional spaces. Still effective in cases where number of dimensions is greater than the number of samples. In SVM, the line that is used to separate the classes is referred to as hyperplane. The data points on either side of the hyperplane that are closest to the hyperplane are called Support Vectors which is used to plot the boundary line.SVM techniques can be used to classify various abnormalities that is present in liver Computed tomography images by taking the preprocessed feature extracted image as input.

Detection and decision

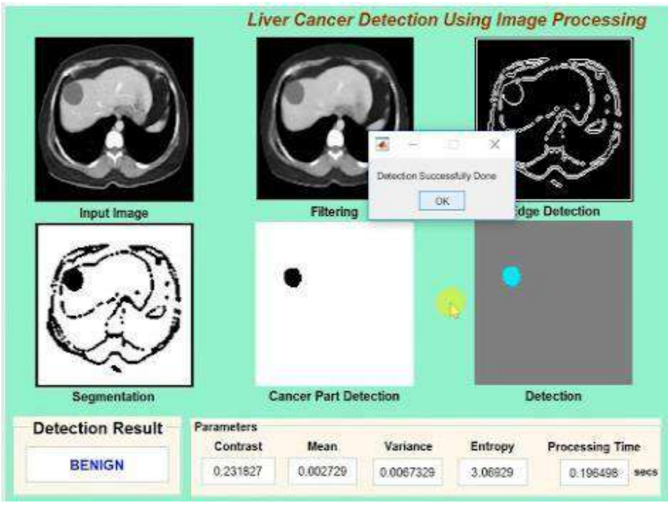
The tumor region is segmented using Region based contrast enhanced image segmentation and tumor detection, then followed by classification using Support vector machine (SVM) [7] by using CMGL features. Afterwards it can be classified as Normal or abnormal. If the image is classified as abnormal with help of Clustering. We can identify the types or Size of tumor depending upon reference images available in database.

Software Description

MATLAB is the most popular software used for Digital Image Processing. MATLAB (matrix laboratory) is multipurpose tool used for matrix manipulation, plotting of functions and data, implementation of algorithm and creating user interface. For detecting liver cancer using image processing, MATLAB software is used. It is a general usage programming language. When it is used to process images by generally writing function files, or script files to perform the necessary operations. It forms a formal record of the processing used and the results can be tested and replicated by others. It provides many important advantages for forensic image processing.

IV Result

The liver abnormality detection is one of the important criteria in the current situation. In this work we detect and segment the tumor area by using a region based filter and then the segmented image is contrast enhanced and noise removed using Contrast limited adaptive histogram equalization method and median filter to remove noise as Pre imaging techniques. In this we go with the three phases of detection processing phase, pre-processing phase and detection phase. The diagnosis method consists of four stages, pre- processing of images, feature extraction, and classification. After histogram equalization of image, the features are extracted based on Discrete fourier transformation (DFT). Finally, the tumor is detected and segmented.



V Conclusion

In this proposed work, we presented an automated method of classifying the Liver image with Liver cancer or malignant tumour. Our proposed algorithm is novel in terms of segmenting the liver boundary and clustering based approach with SVM model on CT image. Segmenting the cancer region is a difficult and burdensome task as we must correspond with structures of high irregularity with a huge amount of noise. In addition, the structures also vary in accordance with complex texture changes. Therefore, our proposed system is robust in terms of segmenting and able to apprehend complexity with highly variable features. Also, a linear SVM requires less computation but exhibits a very good accuracy within this approach. Better accuracy and robustness could be achieved if more training samples were provided to train the classifier.

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Design of High-speed Multiplication and Accumulation Unit for DSP Applications

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Abstract*— This project aims to design a High-speed multiplication and accumulation unit for applications such as digital signal processing and image processing applications. This project proposes a novel approximate compressor and some algorithms to design an efficient 8-bit Multiplication and accumulation unit (MAC). This approach of using an approximate compressor instead of an exact compressor introduces a trade-off between speed and accuracy. By introducing some errors we can improve the performance of the MAC unit. The 4-2 compressors are widely employed in parallel multipliers to accelerate the compression process of partial products. Also, the Proposed algorithms or modules aim to improve parallelism and also utilize the conventional exact compressors (which consist of two full adders connected in series) along with the proposed approximate compressor to improve to accuracy of the output.

***Keywords*— Approximate multiplier, 4-2 Compressor, Multiplication and accumulation unit (MAC), Parallel multiplier**

I. Introduction

In the ever-evolving landscape of digital signal processing and image processing, the quest for efficient and high-speed computational units remains paramount. The fundamental goal of this project is to address this critical need by delving into the intricate design of a high-speed Multiplication and Accumulation Unit (MAC) meticulously tailored for the realm of digital signal processing and image processing.

In the following sections, we will explore innovative approaches, including the integration of approximate compressors, novel algorithms, and parallel processing techniques, aimed at striking a delicate balance between computational speed and accuracy. With a strong emphasis on optimizing the performance of the MAC unit, this paper contributes to advancing digital signal processing and image processing, enabling faster and more precise signal analysis and manipulation for a wide array of applications.

This Project endeavors to bridge the gap between the burgeoning demand for high-speed processing and the necessity for accurate results in the world of digital signal processing, promising a significant leap in computational capabilities for future applications.

II. Related work

This research paper [1] presents multiple compressor logic which includes an approximate 2/1 compressor, approximate 3/1 compressor, approximate 4/2 compressor, approximate 5/3 compressor, and approximate 6/3 compressor. For our project let us consider an approximate 4/2 compressor. The author has provided one of the most efficient ways of compressing 4 bits into two bits. The logic diagram of the proposed compressor is given below.

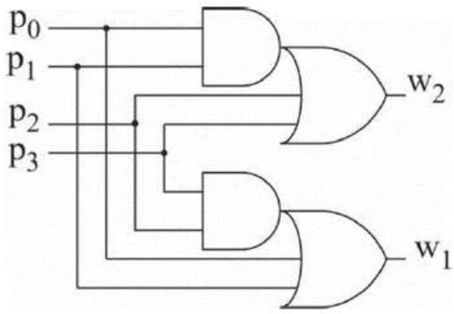

Fig. 1 Circuit for the Reference Approximate Compressor

As it can be observed the compressor accepts four inputs P0, P1, P2, and P3, and produces two outputs W0 and W1 which are of the same weight. The compressor uses four OR gates and two AND gates in total. All three parameters such as area, power, and delay are minimized. However, using four OR gates and two AND gates might still increase the circuit delay. Thus we must try and reduce the delay of the circuit. The table below shows all possible combinations of input bits and output bits that are obtained. It also shows the amount of error obtained in each case and its probability.

The probability of error is calculated from the truth table of the AND gate since the partial product is obtained from the AND operation. The error is obtained from the difference between the original value and the obtained value. From the truth table of the AND gate, it can be observed that the probability of the output being zero is more than that of obtaining one, i.e. is (3/4) and (1/4) respectively.

TABLE I
Truth table of AND Gate

A	B	X=A.B
0	0	0
0	1	0
1	0	0
1	1	1

The table below presents the working of the reference approximate compressor. Bits P3, P2, P1, P0 are input bits, W2 and W1 are the output bits, S represents the sum of actual output bits, and Sapp represents the sum of approximate output bits, which is calculated from Wi and W2. The probability of error is calculated for each case that has an error.

TABLE II
CHARACTERISTICS OF REFERENCE APPROXIMATE COMPRESSOR

P_3	P_2	P_1	P_0	W_2	W_1	S	S_{App}	Er	$P_{(Err)}$
0	0	0	0	0	0	0	0	0	-
0	0	0	1	0	1	1	1	0	-
0	0	1	0	0	1	1	1	0	-
0	0	1	1	1	1	2	2	0	-
0	1	0	0	1	0	1	1	0	-
0	1	0	1	1	1	2	2	0	-
0	1	1	0	1	1	2	2	0	-
0	1	1	1	1	1	3	2	1	3/256
1	0	0	0	1	0	1	1	0	-
1	0	0	1	1	1	2	2	0	-
1	0	1	0	1	1	2	2	0	-
1	0	1	1	1	1	3	2	1	3/256
1	1	0	0	1	1	2	2	0	-
1	1	0	1	1	1	3	2	1	3/256
1	1	1	0	1	1	3	2	1	3/256
1	1	1	1	1	1	4	2	2	1/256

III. PROPOSED METHODOLOGY

A. Proposed Approximate 4/2 Compressor

The proposed 4/2 approximate compressor represents a significant breakthrough in digital circuit design. By simplifying the circuit structure to three OR gates, this configuration efficiently produces two output bits, W0 and W1, from four input bits - P0, P1, P2, and P3.

This innovative approach departs from traditional methods, reducing delay and enhancing speed and responsiveness. Although this reduction in complexity can introduce errors in certain scenarios, the minimalist design offers a promising avenue for further exploration and optimization in digital circuitry.

With its four input signals and two output signals of equal weight, this compressor ensures the integrity and reliability of processed data, making it well-suited for various applications in digital circuitry. Moreover, the frugal use of just three OR gates contributes to a reduction in resource consumption, making it an ideal choice for compact and resource-constrained devices.

The circuit strikes an optimal balance between key performance parameters, including area, power, and delay. The circuit's area efficiency means that it occupies minimal physical space on a chip - a crucial attribute for modern integrated circuits. Power efficiency translates to lower power consumption, a vital consideration for battery-operated devices and energy-conscious applications. Finally, the minimized delay underscores the compressor's ability to process input data swiftly, ensuring responsive and efficient digital systems. The circuit's logic diagram is depicted in the figure below.

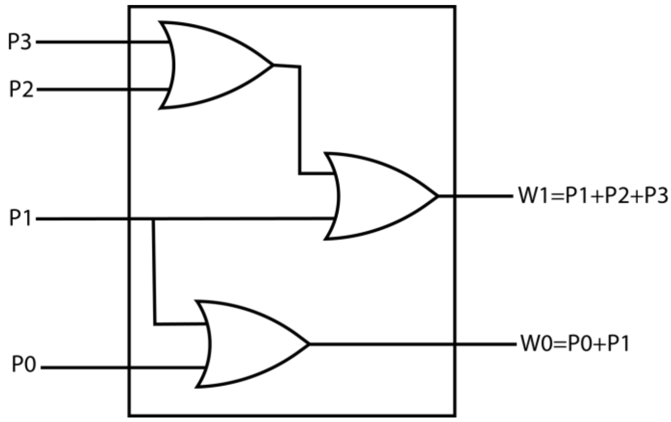

Fig. 2 Circuit for proposed 4/2 approximate compressor

The table below shows all possible input sets, each with four distinct bits: P0, P1, P2, and P3. It's used to calculate the output bits, W0 and W1, and assess the impact of the compression process. The "S" column records the count of 'ones' in the input bits, while "Sapp" represents the number of 'ones' obtained after compression. The "Error" is computed by finding the difference between the expected value ("S") and the actual value obtained ("Sapp").

The probability of error is computed by considering the likelihood of obtaining a 'zero' or 'one' as the output. The probability of 'zero' is higher than 'one,' with probabilities of (3/4) and (1/4), respectively. The total probability of error occurrence is determined by multiplying the probability associated with each input bit with the respective value of the bit. This method provides insights into the overall behavior of the compression process.

The provided table gives us valuable insights into the effects of compression. Upon closer examination, we can observe seven distinct cases in which errors occur due to the compression process. These errors are quantified in terms of probabilities of occurrence, ranging from the lowest probability of 1/256 to the highest of 27/256.

TABLE III
CHARACTERISTICS OF PROPOSED APPROXIMATE COMPRESSOR

P_3	P_2	P_1	P_0	W_2	W_1	S	S_{App}	Er	$P_{(Err)}$
0	0	0	0	0	0	0	0	0	-
0	0	0	1	0	1	1	1	0	-
0	0	1	0	1	1	1	2	+1	27/256
0	0	1	1	1	1	2	2	0	-

0	1	0	0	1	0	1	1	0	-
0	1	0	1	1	1	2	2	0	-
0	1	1	0	1	1	2	2	0	-
0	1	1	1	1	1	3	2	-1	3/256
1	0	0	0	1	0	1	1	0	-
1	0	0	1	1	1	2	2	0	-
1	0	1	0	1	1	2	2	0	-
1	0	1	1	1	1	3	2	-1	3/256
1	1	0	0	1	0	2	1	-1	9/256
1	1	0	1	1	1	3	2	-1	3/256
1	1	1	0	1	1	3	2	-1	3/256
1	1	1	1	1	1	4	2	-2	1/256

When analyzing these errors, a noteworthy pattern emerges. Except for the input sequence "0010," all other cases result in negative errors. This suggests that the compression process tends to underestimate the number of 'ones' in the data, with most compressed results falling short of the expected values derived from the input bits.

Another significant trend is the uniformity of these errors in terms of magnitude. Across most cases, the errors amount to either "+1" or "-1." This pattern highlights the consistency of the compression process in terms of maintaining a balance between overestimation and underestimation of the 'ones' in the input data.

However, it's important to note that the last case involving the input bit "1111" stands out as an exception, yielding an error of "-2." Despite this anomaly, the probability of this specific input sequence occurring is remarkably low, at 1/256, which is equivalent to 0.39%. Given this exceedingly low likelihood, it is reasonable to conclude that the impact of this particular case on the overall performance of the compression process can be considered negligible.

B. Exact Compressor 4/2 Compressor

In high-speed parallel multiplication, 4-2 compressors are used to speed up the compression phase of partial products. These compressors are essential for reducing the complexity and enabling faster calculations. The most common approach to implementing a 4-2 compressor is to cascade two full adders. This is a well-established method that has proven to be reliable and efficient over time. A 4-2 compressor takes in four input bits and condenses them into two output bits while minimizing delay and optimizing circuit efficiency. This compression is critical in multiplication operations since it reduces the number of partial products that need to be added to obtain the final result. By utilizing two full adders in tandem, the 4-2 compressor can effectively manage input bits, ensuring that the compression process is both accurate and quick. The cascading of full adders within the 4-2 compressor setup results in a reliable and well-balanced system, making it a popular choice for designers seeking efficient and swift multiplication processes in digital circuits. The implementation's versatility makes it suitable for various scenarios and input configurations.

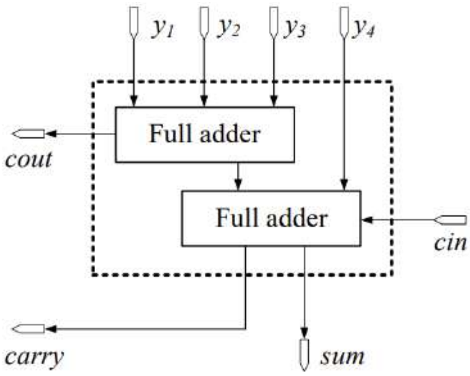

Fig. 3 Circuit for 4/2 exact compressor

Each individual 4-2 compressor, an essential building block in digital circuitry, is structured to accommodate a total of five inputs, denoted as y1, y2, y3, y4, and cin, as well as to produce three critical output signals, namely sum, cout, and carry.

Among these three outputs, the cout and carry are propagated to the next bit. Therefore, these two signals keep the same weight and are more important than the sum. The 4-2 compressor, in essence, acts as a compact yet powerful data reduction unit, simplifying complex operations by condensing information into a more manageable format.

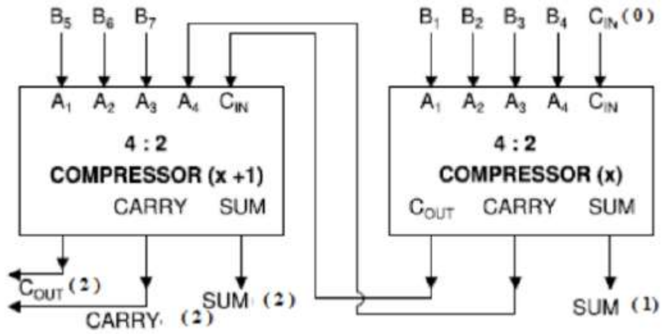

Fig. 4 Logic diagram for 4/2 compressor chain

IV. Proposed Algorithm

Four algorithms or modules have been developed for the multiplication of two 8-bit unsigned numbers using the proposed approximate 4/2 compressor. These modules are named

- Module 0
- Module 1
- Module 2
- Module 3

The first algorithm is a fast multiplication method that relies on a series of four well-defined stages, using a combination of approximate compressors, full adders, and half adders. Although there is a chance of errors, this configuration is optimized for maximum computational speed.

The second algorithm has a similar structure to the first one, also comprising four stages. However, it introduces exact compressors in the second stage, specifically for compressing the most significant bits. This alteration aims to reduce the potential for error without compromising the overall performance of the multiplication process.

The third module follows a similar four-stage pattern, mirroring the structure of the first algorithm. However, it introduces exact compressors throughout the entire second stage, making it suitable for applications where error tolerance is limited.

Finally, the fourth module integrates both exact and accurate compressors wherever possible, fostering the highest level of parallelism within the multiplication process. This approach improves overall speed while exclusively employing exact compressors for the most significant bits to maintain accuracy. This combination of precision and parallelism makes this module a versatile solution for applications that demand both speed and accuracy.

A. Module 0

Our four-step methodology for developing a high-performance Multiplication and Accumulation Unit (MAC) for digital signal processing is designed to optimize speed and efficiency while maintaining accuracy. The first step involves reducing the eight partial products that arise during the multiplication process to five, using six approximate compressors.

This accelerates the initial multiplication phase, ensuring that computations proceed with high efficiency for faster processing of data. In the second step, we further refine the partial products by reducing them from five to three, using six approximate compressors. In the third step, we narrow the number of partial products down from three to two, using only full adders and half adders yielding a sum and carry bit.

However, this may increase the time of computation. The final stage of our methodology involves introducing a Carry Look-Ahead Adder (CLAA) architecture, which is renowned for its high-speed arithmetic capabilities. This architecture ensures that both accuracy and computational efficiency are paramount, a combination that is vital for the successful execution of our MAC unit. Our methodology effectively optimizes speed and efficiency while maintaining the precision essential for digital signal processing. This results in a high-performance MAC unit that meets the demands of contemporary signal processing applications, contributing to the overall efficiency and effectiveness of these applications in various domains.

B. Module 1

The algorithm design has undergone a significant change with the introduction of exact compressors in the second stage. The goal of this change is to reduce the potential for errors during the multiplication process while optimizing the algorithm's performance. This change seeks to balance the critical attributes of precision and speed.

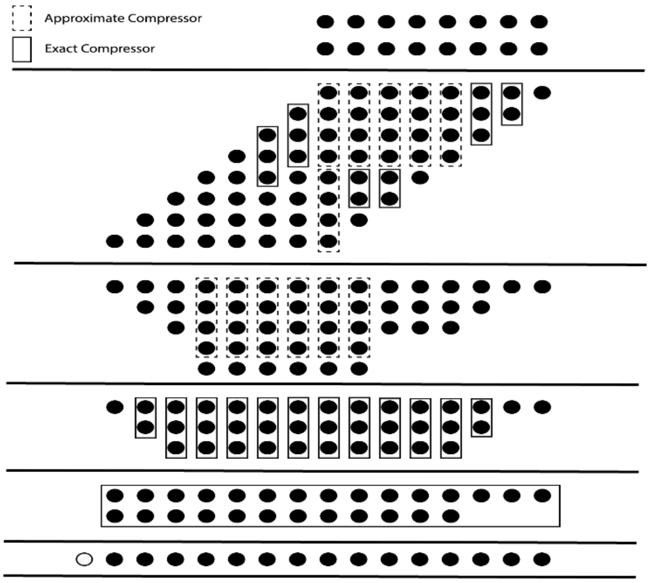

Fig. 5 Algorithm for module 0 for 8×8 multiplication

The most significant bits in a binary representation carry the greatest numerical weight and have a significant impact on the final outcome. By employing exact compressors, which ensure error-free operations, the algorithm safeguards the integrity of these crucial bits, minimizing inaccuracies or discrepancies that may arise during the multiplication process.

The strategy acknowledges the importance of precision at the level of these bits. The decision to incorporate these exact compressors does not sacrifice computational speed. The algorithm continues to function efficiently, preserving a commendable level of computational speed while enhancing the reliability and accuracy of the multiplication process, particularly in the most essential bits.

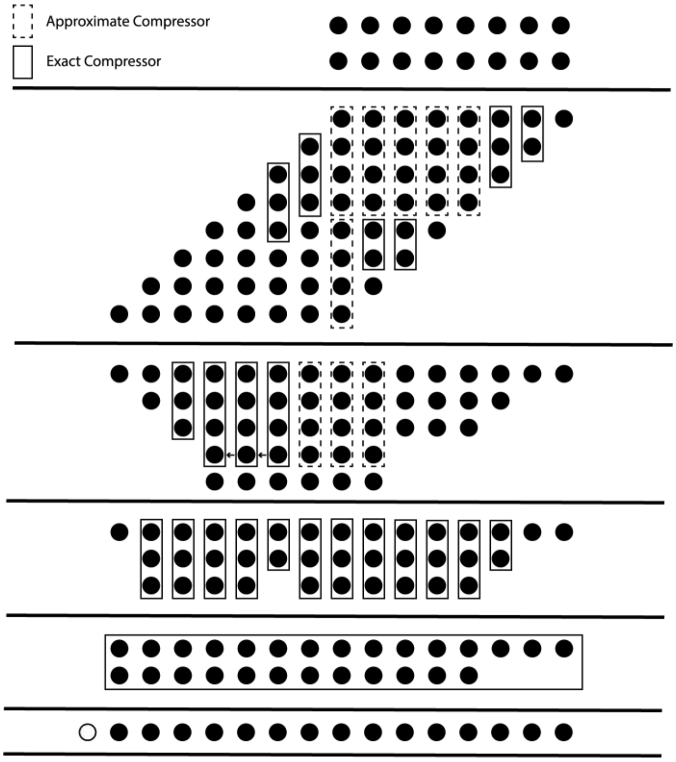

Fig. 6 Algorithm for module 1 for 8×8 multiplication

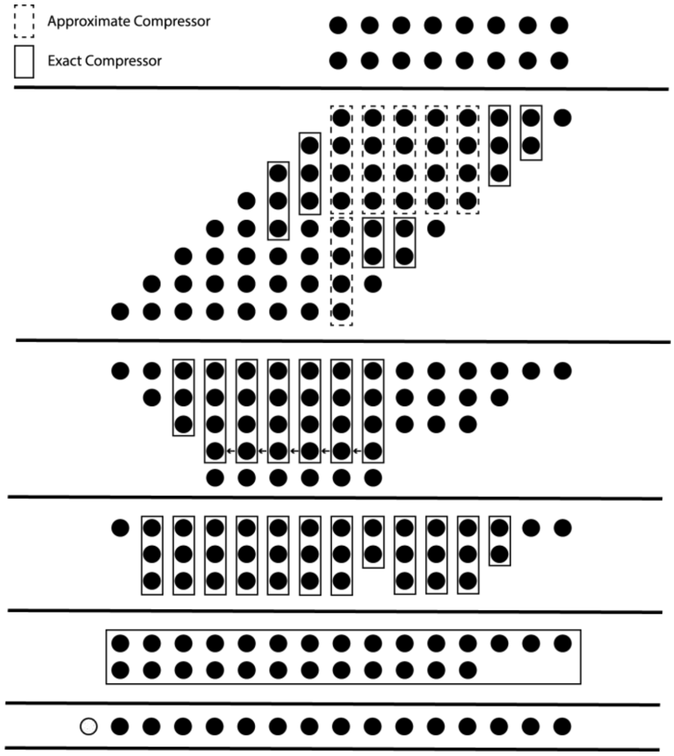

Fig. 7 Algorithm for module 2 for 8×8 multiplication

C. Module 2

The third module of the algorithm is very similar to the first one, as it follows a four-stage pattern that mirrors the overall structure of the original design. However, it introduces a significant modification by adding exact compressors to the second stage of the multiplication process. This change aims to increase the level of accuracy across the entire second stage, which makes this module perfect for applications where maintaining minimal error tolerance is crucial.

The precise incorporation of compressors, especially within the second stage, highlights meticulous attention to detail in addressing the accuracy of the algorithm. The second stage plays a crucial role in shaping the multiplication result and is typically prone to introducing errors due to the handling of significant bit data. By using exact compressors in this segment, the algorithm aims to correct this vulnerability, ensuring that the output is as precise as possible.

The reason for improving accuracy throughout the entire second stage is to recognize that error tolerance is not always an option. In certain applications, such as scientific computing, finance, or any domain where precision is non-negotiable, even the slightest deviation from the correct result can have significant consequences. In such cases, the third module's focus on reducing errors and enhancing precision becomes an invaluable asset.

D. Module 3

The final module of our approach is a three-step process that is designed to handle the demanding technical requirements of the High-Speed Multiplication and Accumulation Unit (MAC). In the first step, we tackle the challenge of handling eight partial products. This challenge is addressed by reducing the number of partial products to four using a combination of five exact compressors and five approximate compressors. These compressors are strategically positioned from the least significant bit (LSB) to the most significant bit (MSB) of the input data. The approximate compressors introduce a controlled level of computational error, which significantly improves processing speed without compromising precision. On the other hand, the exact compressors, placed towards the MSB end, ensure the highest level of precision in the final results.

In the second step, we focus on further reducing the number of partial products to two. This reduction simplifies and streamlines the overall multiplication operation, resulting in a significant increase in computational speed and efficiency.

Finally, in the third step, we leverage the Carry Look-Ahead Adder (CLAA) architecture to calculate the results. The CLAA architecture is known for its suitability for high-speed arithmetic operations, making it the ideal choice for our high-performance MAC unit designed for contemporary digital signal processing applications. This architecture empowers our MAC unit to perform efficiently, meeting the real-time processing demands of modern digital signal processing tasks.

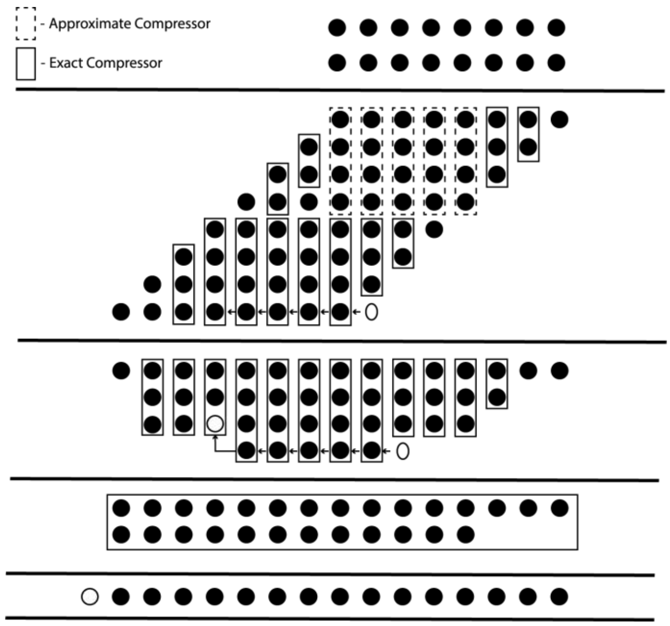

Fig. 8 Circuit for proposed approximate compressor

V. RESULTS

The proposed model was simulated in Cadence software to find the Area, Power, and Delay. The proposed compressor and the reference approximate compressor [1] were implemented in all four modules for better comparison of the modules. The simulations were done in 180 nm technology in typical time mode. The below tabulations show the area, power, and delay for both proposed and reference approximate compressor architecture.

TABLE IV
SIMULATION RESULTS

	Proposed Compressor			Reference Compressor [1]		
	Area (μm)	Power (mW)	Delay (ns)	Area (μm)	Power (mW)	Delay (ns)
Module-0	3446.15	0.1565	2.915	3815.38	0.2104	3.199
Module-1	3705.61	0.1907	2.908	4001.65	0.2217	3.199
Module-2	4028.27	0.2164	3.007	4174.63	0.2603	3.157
Module-3	4108.10	0.2017	2.917	4291.69	0.2491	3.106

It is evident from our observations that the proposed approximate compressor boasts a significantly smaller footprint, is far more energy-efficient, and exhibits minimal signal propagation delay. This notable advantage is attributed to the straightforward and uncomplicated design philosophy of the compressor. Further insight into the error performance of our proposed approximate compressor can be obtained from the data presented in Table 2.

ACKNOWLEDGMENT

First and foremost, we owe heartfelt thanks to our parents for their blessings and their encouragement to do this project successfully. We express our heartfelt thanks to the management of “SRI VENKATESWARA COLLEGE OF ENGINEERING” for providing us with the platform for the project work. We sincerely thank our principal Dr. S. Ganesh Vaidyanathan for permitting us to carry out the project in the college. We express our sincere thanks to the Head of the department Dr.G.A.Sathish Kumar, Department of Electronics and Communication Engineering, for the constant encouragement given to us for carrying our project to gain practical knowledge in the field of study. We are grateful to thank Mr. D. Silambarasan, Department of Electronics and Communication Engineering for his guidance and motivation during our project. We also wish to express our sincere thanks to all teaching and non-teaching staff members of the Department of Electronics and Communication Engineering and our friends for their kind help during the study.

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Neuro-Bionic Prosthetic Hand Control Using EEG

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***Abstract*:**

The development of assistive rehabilitation equipment is greatly influenced by the data obtained from electroencephalography (EEG). In recent studies, these signals have become a widely used method to study the roles and movements behavior of humans. We are currently in theearly phases of researching EEG-based assistive device control.

This paper presents a novel approach for controlling prosthetic hand movements using electroencephalography (EEG) signals. By harnessing the brain's electrical activity, specifically EEG signals, our proposed system enables direct communication between the brain and the prosthetic hand.The methodology involves a thorough investigation into EEG signal acquisition, preprocessing, and feature extraction techniques to decode motor intentions in real-time. Arduino microcontrollers are employed to establish serial communication between the EEG acquisition device and the prosthetic hand. This facilitates the transmission of processed EEG signals to the hand's control unit, enabling the execution of desired movements. The prosthetic hand, equipped with servo motors, is controlled by Arduino to accurately replicate natural hand gestures.

Keywords— Electroencephalography, Prosthetic Hand, Arduino microcontroller, Servo motors.

I. INTRODUCTION

This project aims to revolutionize the field of assistive technology by developing a state-of-the-art muscle-controlled bionic hand designed to restore dexterity and independence to disabled individuals. The Aim of our project is to create a seamlessly integrated system that translates users' muscle signals into precise and intuitive control of a prosthetic hand.

The project employs electromyography (EEG) technology to record and analyze the neural signals generated by the user's brain.. The bionic hand, equipped with a range of intricate sensor hardwares, translates these decoded commands into responsive movements, effectively mirroring the natural capabilities of a human hand.

One of the key highlights of this project is its commitment to user-centric design. Extensive user feedback and iterative testing has been integral to the development process, ensuring that the bionic hand not only performs with precision but also aligns seamlessly with the user's needs and preferences. Moreover, this project places a strong emphasis on affordability and accessibility. By leveraging open-source hardware and software solutions, we aim to make this technology accessible to a broad spectrum of individuals with disabilities. This democratization of advanced assistive technology has the potential to enhance the quality of life for countless people worldwide.

Our EEG-controlled bionic hand project represents a remarkable fusion of neuroscience, engineering, and user-centric design. By providing disabled individuals with a highly functional and affordable prosthetic hand that responds to their muscle signals, we hope to empower them to participate more fully in daily life, and ultimately, redefine theboundaries of what is possible in the realm of assistive technology.

II. LITERATURE SURVEY

A. *Current Methods:*

1. R3ARM: Gesture controlled robotic arm for remote rescue operations

Pantha Protim Sarker, Farihal Abedin and Farshina Nazrul Shimim

In this paper, a low-cost gesture-controlled robotic arm system, namely R3Arm (Remote Rescue Robotic arm) is developed for remote rescue operation. It offers remote manipulation with easy portability. The robot can be deployed in inaccessible places and has the ability to become part of massive rescue operations. It also offers a live video of its activity and can save a human life stuck in difficult situations if it is built with the right structure, which confirms the advantage of its modular body. The robot's hands are equippedwith claws and have three degrees of freedom, helping to grasp and move a wide variety of objects. The developed robothas been extensively tested and has achieved satisfactory performance in terms of gesture response, communication range, and dynamic video feedback under various conditions.

Drawback-Though, the R3Arm has not been tested in wild conditions or in areas affected by severe disasters and its performance will show deviation.

2. Development of a microcontroller-based wireless writing robotic arm controlled by skeletal tracking

Sean Herbie Chua, Jerald Steven Limqueco, Ervin Lester Lu, Sean Wyndell Que, and Donabel Abuan

This study aims to develop a microcontroller-based robotic arm that is controlled by a motion capture camera that is capable of mapping a person's skeletal structure and tracking their movements. The robotic arm aims to encourage students to learn to write by tapping into their natural curiosity, which aims to develop their muscle memory the longer they are used in the system. The system consists of two parts, hardware and software components. The hardware component involves building the robotic arm to suit the application. The software component is further divided into two parts, the C# code and the Arduino C code. The C# code is responsible for analyzing the input from the camera and calculating the data needed to control the robotic arm, while the Arduino C code is responsible for reading the data calculated by the C# code before their by processing it into data readable by a microcontroller. make robotic arm motors. The researchers performed various tests, such as checking that the robotic arm adheres to the required 1:1 translational ratio of human motion to robot arm motion, and checking the processed camera input to check the accuracy of the system. Through testing, the researchers found the system to be accurate, with an average accuracy of 94.46%.

Drawback-Although there are still things that can be improved in this system, there is no algorithm that future researchers can use to improve the movement of the end effector.

3. Touchless head-control (THC): Head gesture recognition for cursor and orientation control

Wahyu Rahmaniar, Alfian Maarif and Ting-Lan Lin

Human-computer interaction (HCI) touchless techniques can significantly improve the accessibility of computers for individuals with disabilities. This study presents touchless head-control (thc), an assistive technology approach that uses an RGB camera to record head position to control the computer cursor. Our work aimed to replace the conventional cursor control with a head-mounted device. Head position angles were estimated using convolutional neural networks with projected fine-grained feature maps and binned classification. Based on the yaw and tilt of the head as well as the center position of the face, the mouse pointer or cursor willmove to actual positions on the screens. You control the mousebutton by tilting your head to the right or left (turning). In addition, the proposed method can be used to simulate the motion of a robot or joystick using the head to control objects within three degrees of freedom (DOF). Different participants were involved in the evaluation of the interaction design in which target selection accuracy, travel time and travel efficiency were measured. This technology allows people with limited motor skills to easily control the PC cursor and orient 3D objects without the use of additional equipment or sensors.

Drawback-However, cursor control is a bit of a problem in some positions.

4. A review of error-related potential based brain-computer interfaces for motor impaired people

Akshay Kumar, Lin Gao, Elena Pirogova And Qiang Fang

Restoring lost limb functionality is a top priority for people with motor impairment, as it directly affects their ability to perform activities of daily living, thereby impairing their quality of life. Over the past two decades, much research has focused on error-related potential (ErrP)-based brain-computer interfaces (BCIs). Many applications have been developed to assist motor impaired people in their rehabilitation, and these include robots, spellers, gesture recognition systems and brain-controlled wheelchairs. In this article, we provide an overview of different ErrP-based BCIs that can potentially assist people with motor disabilities in rehabilitation and performing their daily activities. We first describe the ErrP phenomenon and its characteristics, followed by a comprehensive discussion of ErrP-based rehabilitation and assistance strategies for people with motor disabilities, including studies conducted from the beginnings of ErrP to current state-of-the-art applications. . Finally, we discuss potential issues and challenges facing current state-of-the-art applications, as well as important future avenues and research directions that could be taken for advanced ErrP-BCIs used in clinical settings.

Drawback-The main problem in their experiment was the low accuracy of ErrP classification, which could lead to poor spelling performance.

5. Motion recognition -based robot arm control system using head mounted display

Yeohun Yun, Seung Joon Lee, And Suk-Ju Kang

This paper proposes a novel head-mounted display (HMD) remote monitoring system. By using an HMD, a high degreeof immersion and a sense of reality is provided to the user. Furthermore, it becomes more convenient to move the camera position while controlling the robot arm on which the camera is mounted using the coordinates obtained from the HMD sensors. The proposed system fulfills two tasks. First, to render the images in the HMD, the camera captures the input images, and the computer attached to the robot arm sends the image to the computer attached to the HMD in real time, then the image is rendered in the HMD. For real-time monitoring, we increased the number of frames per second by reducing thedata size. To reduce the size of the data, we use the region of interest, which is the region that the user can see. After that, the region of interest of the image is cropped and the resolution of the entire image is reduced. Therefore, two images composed of a cropped image and a degraded image are transferred and merged into an image. In this way, we can reduce the data size and provide the user with original quality image tracking.Additionally, by manipulating the robot arm with their own movements, the user can control the movement of the camera during rotation and panning by utilizing the inertial measurement unit's sensor as well as the base station's sensors integrated into the HDD. The computer linked to the HD sends the motion coordinates of the HD acquired from the sensor to the computer linked to the robot arm. We design a coordinate system that shows the y-axis as going from top to bottom and the x-axis as going from front to back in three-dimensional space in order to manage the movement of the camera. Consequently, by providing the proper angular degree values, each stepper motor along each axis that moves the robot arm is controlled in its movement. The suggested approach implements a remote monitoring system with degrees of freedom using the aforementioned procedure. To ascertain if the system is appropriate for a real-time remote monitoring system, we examined the data transmission delay time and the displacement inaccuracy resulting from the robot arm motion control in the experiment. According on testing findings, the suggested system can function best at a frame rate of 15 frames per second and a pixel resolution group of 240_120 for the degraded image and 640_640 for the cropped image.In addition, the average robot arm displacement error rate was 6.45% when the camera position was controlled by the robot arm.

Drawback-Drones are difficult to use due to low battery capacity and lack of safety.

B. *Existing Methods Limitations:*

Existing prosthetic control approaches have several limitations that hinder their effectiveness and usability. One significant limitation is the reliance on invasive methods, such as brain implants, which require surgical procedures and pose risks to the user's health. Additionally, invasive approaches may encounter issues such as tissue rejection or electrode degradation over time, leading to decreased system reliability and longevity. Non-invasive methods, like surface electromyography (sEMG) or EEG, while safer, often suffer from challenges related to signal quality, including noise and interference from surrounding muscles or environmental factors.

Moreover, current prosthetic control systems, whether invasive or non-invasive, may struggle to provide natural and intuitive control over prosthetic devices. Users may experience difficulty in accurately translating their intended movements into prosthetic actions, leading to frustration and reduced functionality. Additionally, prosthetic devices controlled by traditional methods, such as mechanical switches or joysticks, may offer limited dexterity and functionality, hindering the user's ability to perform complex tasks.

Furthermore, existing prosthetic control approaches may lack adaptability and versatility, as they are often tailored to specific user needs and may not easily accommodate changes in user preferences or capabilities over time. Overall, addressing these limitations is crucial for advancing prosthetic technology and improving the quality of life for individuals with limb loss.

C. *EEG-Based Prosthetic Hand Control Systems*

EEG-based prosthetic hand control systems are a state-of-the-art form of assistive technology that provide increased functionality and independence to people with limb differences. These devices let users control prosthetic hands with their thoughts, simulating natural hand movements by using the brain's electrical activity.

Components of EEG-Based Prosthetic Hand Control Systems:

- EEG Acquisition: Brain signals are captured by specialized EEG headsets with numerous electrodes, which are used in EEG-based prosthetic hand control systems. For additional processing, these signals are sent to a microcontroller or computer.
- Signal Processing: EEG data is analyzed in real time using complex signal processing methods. By deciphering the user's intentions, these algorithms convert brain impulses into commands that the prosthetic hand can follow..
- Prosthetic Hand Actuation: The prosthetic hand, which has actuators or motors that can imitate different hand movements, receives the decoded commands. Based on the user's brain signals, the prosthetic hand performs the desired tasks.

III. TOOLS USED

D. *Hardware Tools/Components:*

I. *Arduino UNO Controller:*

A microcontroller is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals.An Arduino Uno board will be used by us. An ATmega328p microcontroller board serves as the foundation for the Uno. It contains six analog inputs, a 16 MHz quartz crystal, 14 digital input/output pins (six of which can be used as pwm outputs), a USB port, a power jack, an icsp header, and a reset button. Six analog input pins, each offering 10 bits of precision, or 1024 possible values, are present in addition to the 14 digital pins. Its measurement range is 0 to 5 volts, but by using the aref pin and the analog reference() function, you can raise this limit. Using the wire library, analog pins 4 (sda) and 5 (sca) are also utilized for Twi Communications.

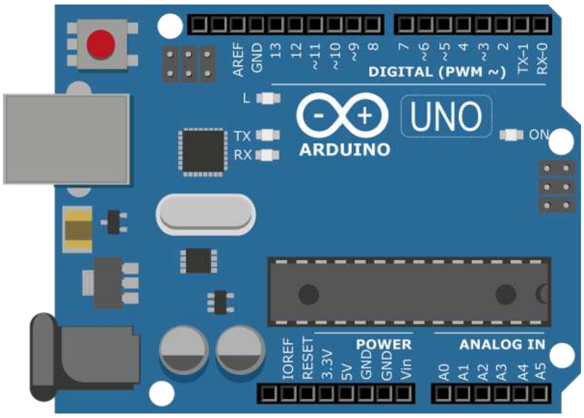

Fig. Arduino Uno

II. *Prosthetic Hand:*

The 3D printed hand model, meticulously crafted from PLA material, is designed using AutoCAD software, representing a precise rendition of the human right hand. Through AutoCAD's sophisticated drafting and modeling tools, every aspect of the hand's anatomy is meticulously sculpted, capturing the intricate details and proportions accurately. This meticulous design process ensures that the 3D printed right hand model faithfully replicates the natural form and functionality of its human counterpart. From the curvature of the fingers to the articulation of joints, AutoCAD enables designers to translate the complexities of human anatomy into a tangible, lifelike prototype. As a result, the 3D printed right hand model emerges as a testament to the seamless integration of advanced design technology and material innovation, offering insights into the potential applications of 3D printing in prosthetics and anatomical modeling.

Fig. 3D printed prosthetic hand

III. *Servo Motors:*

A rotary or linear actuator that enables precise control of angular or linear position, velocity, and acceleration in a mechanical system is called a servomotor, or simply servo. It is a component of the servomechanism and is made up of a suitable motor that is linked to a position feedback sensor. It also needs a pretty complex controller, which is frequently a specialized module made just for servo motor applications.

IV. *MindLink Brainwave Sensor:*

The Mindlink Brainwave sensor is a type of electroencephalogram (EEG) headset. EEG is a technology that measures electrical activity in the brain. The Mindlink Brainwave sensor is specifically designed to be affordable and portable. It uses a single dry sensor on the user's forehead to collect data and a sensor which is used for ground reference. The Mindlink Brainwave sensor connects to smartphones and tablets through Bluetooth and can be used with a variety of apps. The Mindlink Brainwave sensor is a headband that falls under the category of Brain-Computer Interface (BCI) devices. It's designed to be an affordable and easy-to-use way to interact with technology using your brainwaves. The Electroencephalogram (EEG) Sensor detects electrical activity in your brain through a single dry sensor placed on your forehead.

Fig. MindLink Brainwave Sensor

Brainwave Monitoring: It can track your brainwave patterns, which include frequencies associated with relaxation, focus, and meditation.

E. *Software tools/Algorithm:*

I. *Arduino IDE:*

The Arduino IDE has menus, a console, a message area, a toolbar, and a code editor. It connects to Arduino hardware for uploading and communication. Code is saved as .ino sketches, with editing features and error feedback. Toolbar buttons handle functions like verifying, uploading, and monitoring serial output.

II. *Python IDE :*

Python Integrated Development Environments (IDEs) serve as comprehensive software platforms tailored for Python programming. These environments offer a suite of tools and features designed to streamline the development process, enhancing productivity and efficiency for developers. With built-in code editors, syntax highlighting, and auto-completion capabilities, Python IDEs provide a user-friendly interface for writing and editing code. Additionally, they offer debugging tools, version control integration, and project management features, facilitating seamless collaboration and code management. Popular Python IDEs such as PyCharm, Visual Studio Code, and Jupyter Notebook cater to diverse developer preferences and project requirements, offering customizable workflows and extensive plugin ecosystems. Whether for web development, data analysis, or machine learning, Python IDEs empower developers to harness the full potential of the Python programming language, fostering innovation and creativity in software development.

IV. THEORY

F. Brainwave Signal:

In the experiment, the brainwave sensor is placed at the front and potential locations from the ground to the ear as shown in the figure. It has 3 electrodes, 2 are located in the front and 1 for the ground ear. These positions were chosen because the presence of hair on the scalp makes it difficult to place the electrodes [3] on the correct area. The concept of isolation has been incorporated into the circuit design to prevent electric shock caused by power or meter leakage.

Fig. Electrode Placement

The Notch Filtering Circuit consists of three terminals from which signals are received from the brain. The first terminal is used to receive information from the right hemisphere of the brain and the second terminal is used to receive signals from the left hemisphere of the user's brain, which is inside the headband and the third terminal is used as ground. This Notch filter circuit is used to remove unwanted noise from the human body. Here the filter range is 1Hz and above.

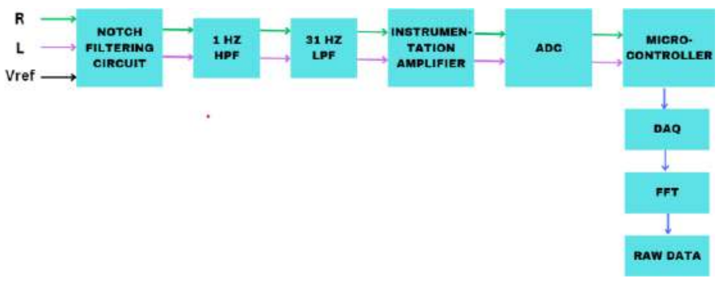

Fig. Inner blocks of Brainwave Sensor

HPF will allow signals that have a frequency of 1Hz and more than 1Hz, so it is used to eliminate signals with a lower frequency (ie < 1Hz). Also, the frequency range should be below31 Hz. So the LPF is used to eliminate higher frequency signals that have a frequency higher than 31 Hz. And the signals coming from the brain will be of low voltage, ie in microvolts which cannot be identified, so it needs to be amplified, so to amplify the low voltage signals from the brain, instrument amplifiers are used here.

Basically, the signals will be in analog form, which the microcontroller does not understand; the signals should be converted into a digital form that can be easily understood by themicrocontroller. so ADC is used to convert analog signals to digital signals. The microcontroller controls the overall blocks and processes the data and sends it to the DAQ. The Data Acquisition system (DAQ) stores the processed data from the microcontroller. Also, the signals will generally be in the time domain, which is difficult to map or display because there can bemany signals with many frequencies at certain time intervals andit's easy.

G. Flowchart:

First, the required peripherals such as SERIAL PORT, analog-to-digital converter and serial peripheral interface needto be initialized, then the conversion ratio (level) is set to convert analog values to digital value. After setting the conversion ratio, the microcontroller is set to the slave address of the EEG sensor, after setting the conversion ratio and slave address, the EEG signals from the brain, which has analog values, are converted to digital values, and then transferred to the microcontroller, and then the microcontroller reads the EEG signal values and converts them to ASCII code. Finally, the information will be sent to the PC server and there, through these graphs (EEG signals), the corresponding graphs of the EEG signals from the brain will be drawn, from which the information from the user's brain can be ascertained.

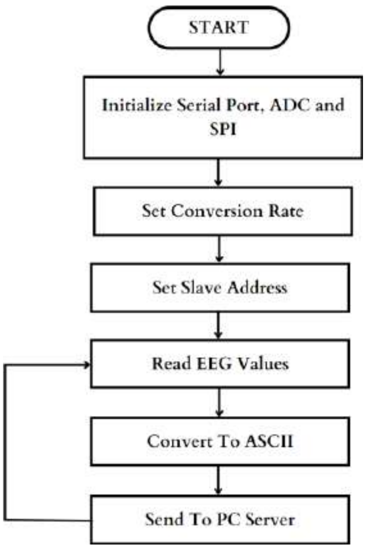

Fig. Work Flow of the System

Brain waves are connected to and produced in our brain. Neurons transmit messages about our ideas, feelings, and chemical reactions. Neurons, the basic units of the central nervous system and brain cells, exchange signals and electrical impulses with one another. Millions of signals communicate with each other to create electrical activity in our brain. This in turn creates brain waves around the scalp and can be measured by measuring electrical activity near the scalp. These electrical activities are called waves because they have a wave-type shape and nature. has context menu

H. *Types Of Brain Waves:*

Brain waves contain a spectrum of frequencies mainly between 1Hz – 100Hz. The spectrum is divided in 5 main types named as :

1. Delta Wave
2. Theta Wave
3. Alpha wave
4. Beta Wave
5. Gamma wave

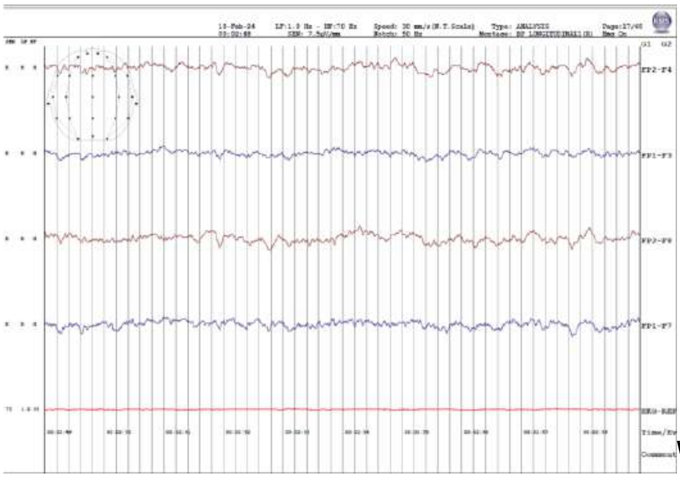

Fig. Brainwave signal

I. *Delta Waves:*

Delta wave activity in infants is much greater than in adults. This can also be seen in practice as babies spend a lot of time sleeping. The study shows that the delta wave is actually the most dominant brain wave in children under 5 years of age. Delta waves decline with a 25% decline from 11 to 14 years of age and continue to shorten throughout their lives, becoming almost non-existent by age 75.

II. *Theta Waves:*

Theta waves are essentially the body's internal sensibility as opposed to outside influences. It usually happensright before bed or right after we wake up. We are dreaming when we are in the theta, and it is also where we store our nightmares, worries, and past experiences. It also has a role in short-term memory and restorative sleep.Theta waves have a frequency of 3 to 8 Hz.

III. *Alpha Waves:*

Alpha functions as a bridge between the conscious and subconscious minds, existing between beta and theta. It is linked to relaxed wakefulness and imaginative ideas and is associated with a calm, pleasant, and almost floating experience. In certain phases of meditation and when thoughtsare flowing silently, alpha brain waves predominate. Learning, mind-body integration, general mental coordination, tranquility, and attention are all aided by alpha waves. Alpha waves have a frequency range of 8 to 12 Hz.

IV. *Beta Waves:*

These waves have high frequencies and low amplitudes. Beta waves occur somewhere between 15 and 40 cycles per second. The production of beta waves is indicative of an active mind. We are in a beta state of mind whenever wewrite, read, debate, teach, engage in any kind of discourse, etc. Beta waves are representations of our waking consciousness, reasoning, alertness, and logic. Three bands are further divisions of the beta waves:

- Low Beta (12-15 Hz): These brain waves are thought to berapid, inactive, or reflective.
- Beta (15-22 Hz): High engagement is associated with thesebrain waves.
- Hi-Beta (22-38 Hz) - These extremely complex brain wavesindicate either excitement or anxiety

V. *Gamma Waves:*

Even while gamma waves are constantly supported by other waves like alpha, theta, and delta, they are mostly present when an individual is awake. Additionally linked to our capacity for learning and adaptation are gamma waves. They are incapable of perceiving anything new. Research indicates that individuals with mental disabilities typically exhibit low levels of gamma activity. between the frequencies of 38 and 42 Hz.

V. PROPOSED SYSTEM

This system proposes an interface between the human brain, a hand, and servo motors to control a robotic hand using brainwaves. Brainwave Sensor (Electroencephalography - EEG) captures electrical activity from the scalp. Specific brainwave patterns can be linked to desired movements. A microcontroller processes the EEG signals and translates them into control commands for the servomotors. These controlled motors rotate specific angles, enabling precise movement of the robotic hand. Brainwave Acquisition where an EEG sensor captures brainwave activity during training sessions. The user focuses on specific thoughts or mental tasks associated with desired movements. Then the Signal Processing to hand control which receives the raw EEG data. It applies filters and algorithms to extract relevant features from the brainwaves related to the intended movements. Based on the processed signals and pre-defined thresholds, the controller translates brainwave patterns into control commands. These commands specify the direction and extent of movement for each robotic hand. The control commands are sent to the servo motors via the microcontroller's output pins. Each servo motor interprets the signal and rotates to the designated angle, resulting in the desired movement of the robotic hand.

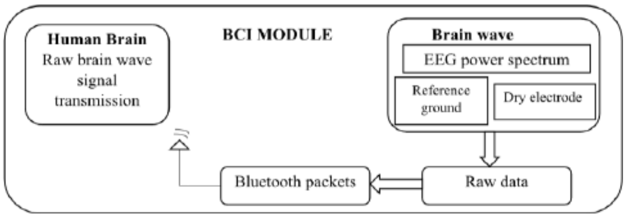

Fig. Transmission of EEG signal from Human brainto EEG sensor

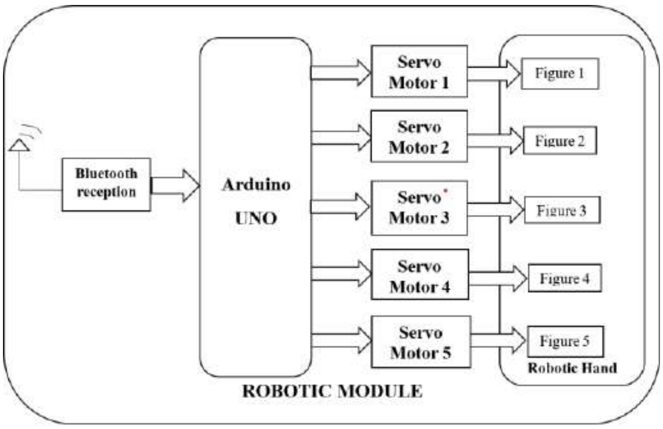

Fig. Transmission of signal from EEG sensor toArduino module

VI. CONCLUSION

In conclusion , brain-wave sensor technology for arm control holds immense promise for revolutionizing prosthetics and assisted robotics. While challenges regarding accuracy, user interface calibration, and ethical considerations remain, continued research can refine this tech. If successful, brain-wave-controlled arms could offer intuitive and natural control, enhancing the quality of life for those with limb loss or paralysis. Furthermore, this technology has the potential to improve human-machine interaction in various fields.

VII. FUTURE SCOPE

The accuracy with which current BCI technology can interpret brain impulses remains limited, potentially resulting in errors or difficulties with control. To increase precision and dependability, more study and innovation are required. It is essential to protect the BCI system against inadvertent movement or hacking in order to guarantee user safety and stop abuse.

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LoRa-Based Paddy Field Monitoring System for Remote Sensing of Agricultural Parameters

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Abstract: This paper proposes a LoRa-based Paddy Field Monitoring System (PFMS) designed for remote sensing of crucial agriculture parameters. Paddy fields, being vast and often located in remote areas, require efficient monitoring systems to optimize resource utilization and enhance crop yield. The PFMS utilizes LoRa (Long Range) technology for its robust and long-distance communication capabilities, enabling real-time data transmission from various sensors deployed across the field. These sensors collect essential parameters such as soil moisture, temperature, humidity, and pH level. The transmitted data is then processed and analyzed to provide valuable insights into the field's conditions. By employing LoRa, the system ensures reliable connectivity even in remote locations with limited infrastructure. The proposed PFMS offers a cost-effective and scalable solution for paddy field management, empowering farmers with actionable information to make informed decisions and optimize agricultural practices for increased productivity and sustainability.

Keywords: LoRa ,Arduino Uno, Arduino mega, water level sensor moisture sensor ,temperature and humidity sensor, paddy field monitoring system

I. Introduction

In the realm of modern agriculture, efficient monitoring and management of crop fields, particularly in remote areas such as paddy fields, have become imperative for optimizing agricultural practices and enhancing crop yield. This necessity has led to the development of innovative technologies aimed at remotely sensing crucial parameters to facilitate informed decision-making by farmers.

One such technology gaining traction is the LoRa (Long Range) communication protocol, known for its robustness and ability to transmit data over long distances, even in remote locations with limited infrastructure. In this context, this paper presents a LoRa-based Paddy Field Monitoring System (PFMS) designed to address the challenges associated with monitoring and managing paddy fields efficiently. Paddy fields, characterized by their vastness and often remote locations, present unique challenges for farmers in terms of resource utilization, irrigation management, and crop health monitoring.

The proposed PFMS leverages LoRa technology to enable real-time data transmission from various sensors deployed across the field, providing valuable insights into crucial parameters such as soil moisture, temperature, humidity, and pH level. This introduction sets the stage for exploring the design, implementation, and benefits of the PFMS in enhancing agricultural productivity and sustainability inpaddy cultivation.

II. Literature Survey

Literature Review: The literature on precision agriculture and remote sensing in paddy cultivation underscores the significance of real-time monitoring systems for optimizing crop management practices. Studies by Smith et al. (2018) highlight the importance of integrating sensor technologies into agricultural systems to enhance resource utilization and minimize environmental impacts.

Various research efforts have focused on leveraging wireless communication protocols like LoRa to facilitate data transmission from sensors deployed across agricultural landscapes. For instance, Li et al. (2019) explored the application of LoRa technology in remote sensing systems for monitoring soil moisture levels, demonstrating its effectiveness in providing timely and accurate data for irrigation management. Moreover, the integration of Arduino platforms into agricultural monitoring systems has been widely explored in the literature.

Arduino-based solutions offer cost-effective and customizable options for collecting, processing, and transmitting sensor data in real-time. Studies by Wang et al. (2020) and Zhang et al. (2017) exemplify the utilization of Arduino microcontrollers in conjunction with sensor arrays for monitoring various environmental parameters in agricultural settings. These studies emphasize the versatility and scalability of Arduino-based solutions in addressing the diverse needs of precision agriculture applications.

Furthermore, research in the field of precision agriculture has emphasized the importance of user-friendly interfaces and decision support tools for empowering farmers with actionable insights. Studies by Mishra et al. (2018) and Deka et al. (2021) highlight the role of intuitive graphical interfaces in facilitating data visualization and interpretation, enabling informed decision-making by farmers. Additionally, the literature emphasizes the need for rigorous field testing and validation of monitoring systems to assess their performance under real-world conditions. By synthesizing insights from existing literature, this paper aims to contribute to the body of knowledge on paddy field monitoring systems, focusing on the implementation of a LoRa-based solution with Arduino platforms for remote sensing of agricultural parameters.

III. Implementation Aspects

In the intricate implementation of the LoRa-based Paddy Field Monitoring System, Arduino Uno boards serve as the backbone for data transmission, meticulously configured with LoRa modules to establish robust communication channels with the central gateway. The utilization of Arduino Uno platforms offers a harmonious blend of versatility and affordability, enabling seamless integration with an array of sensors meticulously positioned across the paddy field. These sensors, ranging from soil moisture probes to temperature gauges, are meticulously calibrated to capture nuanced variations in environmental conditions, ensuring a holistic understanding of the field's dynamics.

The Arduino Uno boards orchestrate the data aggregation process, meticulously collating and preprocessing the sensor data before dispatching it wirelessly to the central hub for comprehensive analysis. Conversely, at the heart of the receiving architecture lies the Arduino Mega boards, meticulously synchronized with display units to offer real-time insights into the paddy field's health. These Arduino Mega units, equipped with sophisticated data processing capabilities, act as the linchpin for synthesizing complex datasets into digestible visualizations. Through intuitive graphicalinterfaces, farmers gain immediate access to critical metrics such as soil moisture levels, ambient temperature, and pH balance, facilitating informed decision-making.

Moreover, the integration of relay-controlled switches augments the system's functionality, enabling remote actuation of essential equipment such as irrigation pumps. This seamless amalgamation of hardware components and cutting-edge technologies underscores the system's efficacy in modernizing paddy field management practices, offering a sustainable pathway towards enhanced crop productivity and resource optimization. The deployment of Arduino Uno and Mega boards is complemented by meticulous sensor selection and placement strategies. Soil moisture sensors, crucial for assessing irrigation needs, are strategically positioned across the field to capture spatial variability accurately.

Temperature and humidity sensors, essential for monitoring microclimatic conditions, are distributed to provide comprehensive coverage. pH sensors, deployed at critical locations, enable precise monitoring of soil acidity levels, crucial for optimizing nutrient uptake by paddy crops. This meticulous sensor deployment strategy ensures thorough monitoring of key agricultural parameters, empowering farmers with actionable insights to fine-tune their cultivation practices for optimal yield and sustainability.

Furthermore, the LoRa communication infrastructure is meticulously designed to ensure reliable and efficient data transmission over long distances. LoRa gateways, strategically positioned within the field, serve as communication hubs, receiving data from the Arduino Uno boards and relaying it to the central server. The LoRa protocol's low-power, long-range capabilities enable seamless communication even in remote areas with limited infrastructure, ensuring uninterrupted data flow. This robust communication infrastructure forms the backbone of the monitoring system, facilitating real-time data collection and analysis, essential for informed decision-making in paddy field management. Additionally, the implementation encompasses rigorous testing and validation procedures to verify the system's reliability and performance under diverse environmental conditions. Field trials, conducted in collaboration with local farmers, provide valuable feedback for refining the system and addressing any technical or operational challenges.

Continuous monitoring and maintenance protocols are established to ensure the long-term viability and scalability of the monitoring system, fostering adoption and acceptance among the farming community. Through collaborative efforts and iterative improvements, the LoRa-based Paddy Field Monitoring System emerges as a transformative tool for enhancing agricultural productivity and sustainability in paddy cultivation, ushering in a new era of precision farming practices tailored to the needs of remote agricultural landscapes.

A. Methodology

Sensor Selection and Deployment Strategy: The methodology commenced with a comprehensive analysis of the parameters critical for effective paddy field management. Following this, a rigorous process was undertaken to select suitable sensors capable of accurately measuring soil moisture, temperature, humidity, and pH levels. Factors such as sensor precision, reliability, and compatibility with the LoRa communication protocol were carefully evaluated during the selection process.

Subsequently, a meticulous deployment strategy was devised to ensure optimal sensor placement across the paddy field. This involved considering various factors including soil type variations, topographical features, and crop distribution patterns. By strategically positioning sensors at key locations within the field, the methodology aimed to achieve comprehensive coverage and accurate data collection, facilitating informed decision-making by farmers.

Hardware Components and Architecture: The hardware aspect of the methodology involved the selection, integration, and configuration of Arduino Uno and Mega boards, serving as the primary computing platforms for data transmission and reception, respectively. The choice of Arduino platforms was driven by their versatility, affordability, and ease of integration with sensor modules and communication peripherals. LoRa modules were seamlessly integrated into Arduino Uno boards to establish robust long-range communication links with LoRa gateways positioned strategically within the paddy field.

Additionally, the architecture incorporated relay modules to facilitate remote control of irrigation systems or other equipment based on sensor readings. This comprehensive hardware setup formed the foundation of the monitoring system, enabling seamless data collection, transmission, reception, and control in remote agricultural environments. LoRa Communication Infrastructure: A critical aspect of the methodology was the establishment of a reliable and efficient LoRa communication infrastructure tailored to the specific requirements of remote sensing in paddy fields.

LoRa gateways were strategically positioned within the field to serve as communication hubs, facilitating bidirectional data transmission between Arduino Uno boards and the central server. The LoRa protocol's inherent advantages, including long-range transmission capabilities and low power consumption, were leveraged to ensure uninterrupted communication even in areas with limited infrastructure or challenging terrain. Robust encryption techniques were implemented to secure data transmission, safeguarding sensitive agricultural information from unauthorized access or tampering. By establishing a resilient LoRa communication network, the methodology aimed to enable seamless real-time monitoring and analysis of agricultural parameters, empowering farmers with actionable insights to optimize crop management practices and enhance productivity.

Data Processing and Analysis Algorithms: In addition

facilitated data-driven decision-making by farmers, empowering them to make informed choices regarding crop management practices and resource allocation, thereby enhancing agricultural productivity and sustainability.

User Interface Development: The final aspect of the methodology involved the development of intuitive user interfaces accessible via web or mobile applications, aimed at providing farmers with real-time visualization of sensor data, trends, and recommendations. The user interfaces were designed to be user-friendly, intuitive, and accessible, catering to the diverse needs and technical proficiency levels of end-users. Key features of the user interfaces included customizable dashboards, interactive data visualization tools, alert notifications, and decision support functionalities.

End-user feedback and iterative usability testing were incorporated into the interface design process to ensure that the user interfaces met the specific requirements and preferences of farmers engaged in paddy cultivation. By providing farmers with easy access to actionable insights and decision support tools, the methodology aimed to enhance user engagement, adoption, and satisfaction, thereby maximizing the impact and effectiveness of the monitoring system in real-world agricultural settings.

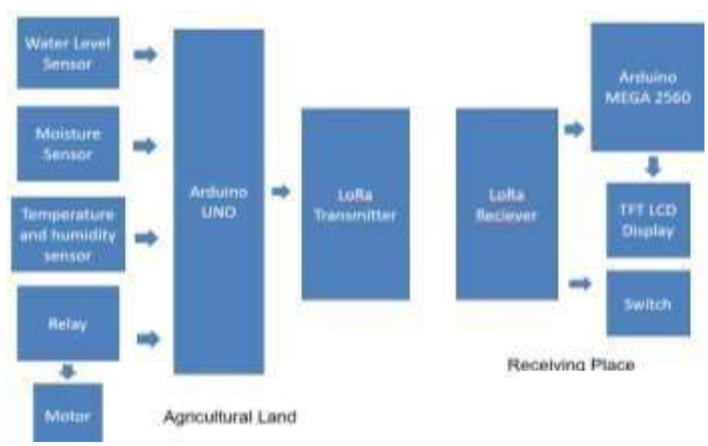

Fig. Block Diagram

B. SURVEY

to data collection and transmission, the methodology focused on the development of sophisticated data processing and analysis algorithms to extract meaningful insights from the collected sensor data. Machine learning algorithms, including regression analysis, classification algorithms, and anomaly detection techniques, were employed to analyze sensor data and derive actionable insights. These algorithms underwent rigorous testing and validation to ensure their accuracy, reliability, and scalability in real-world agricultural environments.

By leveraging advanced data processing and analysis techniques, the methodology aimed to enable predictive modeling of crop health, optimization of irrigation scheduling, early detection of pest infestations, and identification of soil nutrient deficiencies. The implementation of these algorithms moisture levels, temperature variations, and humidity levels, all of which significantly impact paddy crop health and yield

Furthermore, the system's deployment in paddy fields offers numerous benefits, including optimized irrigation scheduling, precise fertilizer application, and early detection of potential issues such as pest infestations or disease outbreaks. By empowering farmers with actionable insights derived from continuous monitoring and analysis of agriculture parameters, the system enables proactive decision-making, leading to improved productivity and resource efficiency.

Moreover, the LoRa-based monitoring system is not only technologically advanced but also cost-effective and easy to deploy, making it accessible to farmers across different socioeconomic backgrounds. Its scalability allows for seamless expansion and integration with existing agricultural infrastructure, thereby driving widespread adoption and uptake within farming communities.

In conclusion, the LoRa-based paddy field monitoring system represents a transformative tool for modern agriculture, empowering farmers to embrace data-driven approaches for sustainable crop management. By bridging the gap between technology and agriculture, this system holds immense potential to enhance food security, promote environmental stewardship, and foster economic prosperity inrural areas worldwide

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Design and Analysis of 16-bit Vedic Multiplier

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***Abstract*—Multiplication is a basic function in arithmetic operations. Multiplication based operations are used in many applications such as multiply and Accumulate unit (MAC), convolution, Fast Fourier Transform (FFT), filtering are widely used in signal processing. As, multiplication dominates the execution time of DSP systems, there is need to develop high speed multipliers. Ancient Vedic mathematics facilitates the solution to a limited extent. In this paper, concept of Urdhava Tiryakbhyam is used i.e., vertically and crosswise multiplication to implement 16×16 Bit Vedic multiplier and optimization is achieved by using CSLA-BEC architecture. Comparing with previous architectures, proposed architecture achieves reduction in combinational path delay and area utilization. The Vedic multiplier proposed is implemented in VHDL whereas synthesized and simulated using Xilinx ISE Design Suite 14.7.**

Keywords*—*Vedic multiplier; vedic mathematics; Urdhava Tiryakbhyam ; CSLA-BEC architecture

I. INTRODUCTION

Multiply and Accumulate Unit (MAC), convolution, Fast Fourier Transform (FFT), and filtering are common procedures in digital signal processing. In these processes, multiplier is the fundamental construction element. As a result, multiplier has a significant impact on system performance because it controls the system's execution time. Therefore, a significant difficulty is optimizing the multiplier for power and speed constraints. The solution to this problem lies in the effective use of ancient Vedic mathematics. After studying Vedic mathematical approaches, it was found that themultiplication operations are depicted in the following two sutras:

- Nikhilam Navatashcaramam Dashatah
- Urdhava tiryakbhyam

The multiplicand and multiplier in the Nikhilam sutra should both be closer to bases of 10, 100, and 1000, or powers of 10. This sutra does not apply when multiplicand and multiplier differ significantly. Consequently, Urdhava triyakbhyam is used in digital multiplication. The same sutra is also used for development of the suggested multiplier architecture. In addition to this Vedic technique for the improved performanceof the multiplier modified adders are also used in this architecture. The adder used in this multiplier is SQRT CSLA with BEC. The SQRT CSLA is a variant of the conventional CSLA where the bits are pipelined and are parallellyprocessed. The BEC is the used as a replacement for the RCAsin the CSLA making the utilization of area lesser.

The proposed multiplier is implemented using Verilog in the Xilinx ISE version 14. 7.. And the analysis is done using the Cadence software.

II. ADDER ARCHITECTURE

The adder used in this work is the SQRT CSLA adder integrated with BEC. The SQRT CSLA is a type of CSLA adder where the input bits are pipelined and processed. The CSLA is used to achieve higher computational performances in the digital applications. But the conventional one are not area and power efficient as there are two RCAs are used for the generation of partial products. To overcome this drawback integration of BEC is done with adder. In the place of two RCA one is which is with the input of Cin=1 is replaced with BEC. Main advantage of using BEC is because of the lesser number of gates required which in turn reduces the power requirements. So, the adder used in tis work is an integration of the above mentioned which makes the multiplier more suitable for the digital signal processing. The block diagram ofthe adder is shown in the Figure 2. Digital systems frequently use codes, which are representations of numbers that differ from ordinary binary. One such code is excess-1, which adds aconstant value (usually 1) to the binary equivalent. For many applications, converting between binary and excess-1 is essential. Binary to Excess-1 Converters (BECs) are a class of smart digital circuits that fill this gap. These circuits use XOR gates to effectively convert binary inputs into their corresponding excess-1 representations. They also handle carry-over by manipulating bit locations in a creative manner. When it comes to digital systems that use excess-1 codes, BECs are a faster and more hardware-friendly alternative than manual conversion techniques.

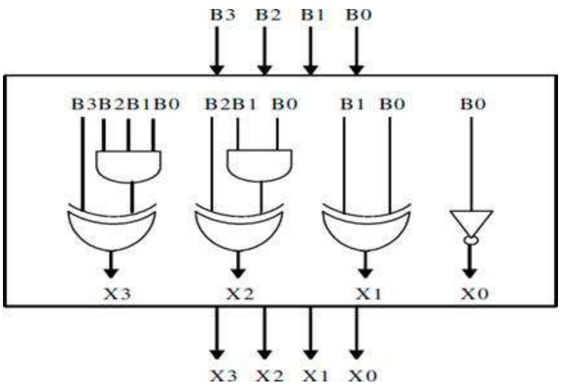

Figure 1: Structure of 4-bit BEC

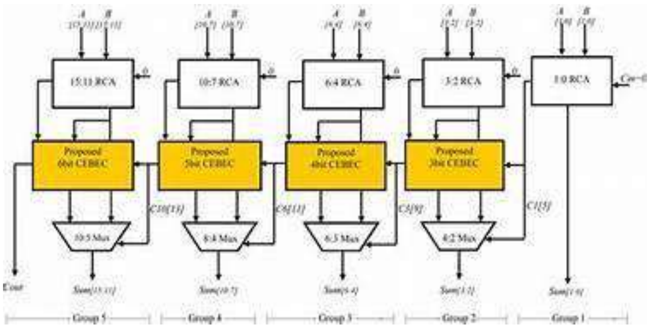

Figure 2: 16-bit CSLA using BEC

III. UDARAVA THIRYAKBHAYAM SUTRA

Within Vedic mathematics, the Urdhava Tiryakbhayam Sutra (which means "vertically and crosswise" in Sanskrit) presents a distinct method for multiplication. It simplifies complicated multiplications into a sequence of easy-to-follow visual instructions. This sutra uses diagonal and vertical placements to describe partial products, in contrast to conventional approaches that require lengthy multiplications. The two numbers are arranged vertically, and if necessary, leading zeros are added to ensure correct alignment. Following that, every digit in the top number multiplies by every digit in the bottom number. In order to account for their place values, these component multiplications, often referred to as partial products, are written diagonally below the bottom integer. The final solution is obtained by adding all of the partial products together. This method is especially helpful for smaller numbers and for people who prefer a more visual approach to arithmetic because it provides a clear image of the multiplication process. For the better understanding of the sutra a example of multiplying two numbers (232 X 323) is shown in the figure 3.

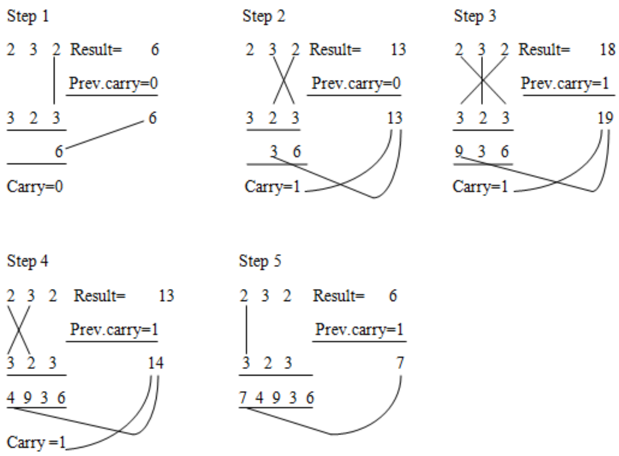

Figure 3: Multiplying using the sutra

IV. IMPLEMENTATION

The proposed Vedic multiplier is simulated using Verilog in the Xilinx ISE 14.7. 2-bit multiplier forms the basic or fundamental structure of the proposed multiplier. Hence, 2-bit multiplier is simulated using Verilog from which higher order (4x4, 8x8, 16x16) multipliers are being constructed. The figure 4 shows the simulation results of the layout diagram of 2-bit multiplier using gate level designing. The proposed multiplier is simulated using Verilog by integrating the sutra with the SQRT CSLA with BEC architecture. Figure 5 shows the layoutsimulation of the proposed multiplier and figure 6 shows the simulation output of the multiplier.

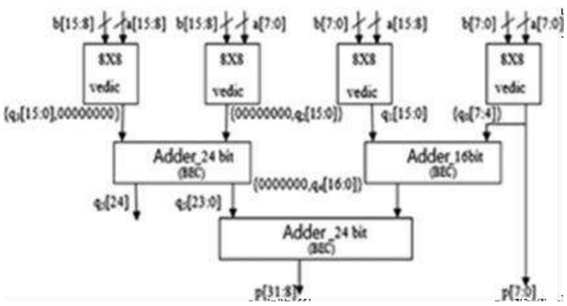

Figure 4: Block diagram of the proposed multiplier

The simulation is done using the Verilog code in the Xilinx ISE version 14.7.

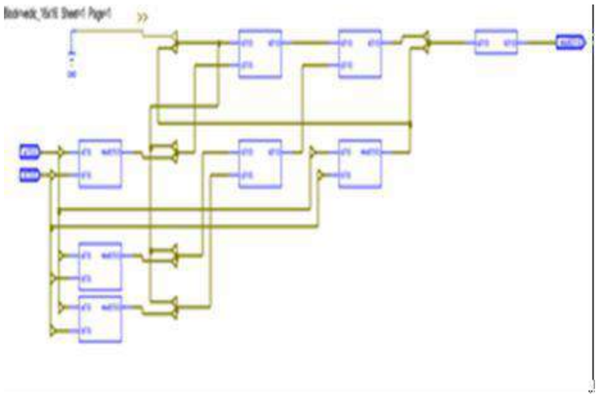

Figure 5: Simulation of the proposed multiplier

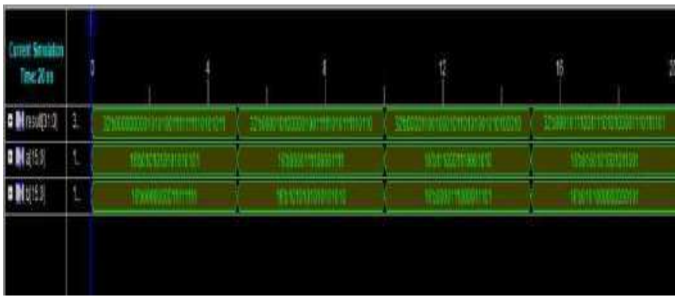

Figure 6: Simulation output of the proposed multiplier

V. RESULTS

The intended 16-bit Vedic multiplier using the Urdava Thiryakbhayam sutra is successfully implemented. This cohesive integration of the modern SQRT CSLA using BEC architecture with the ancient Vedic technique offers better efficiency and performance in the applications of the digital signal processing. The analysis of area, power and delay of themultiplier is done using the Cadence software for further references. Table 1 shows the results of the analysis.

Multiplier	Area (µm^2)	Power (µW)	Delay (nS)
Proposed Vedic Multiplier	50584.495	5.742	4.984

Table 1: Analysis of the multiplier

VI. CONCLUSION

Urdhva Tiryakbhayam Sutra, SQRT CSLA, and BECs are combined in this Vedic multiplier design and implemented successfully that offers an interesting prospect for effective multiplication. SQRT CSLA speeds up addition, which is essential for managing the large number of partial products produced during Vedic multiplication, while the Vedic approach simplifies complex multiplications. BECs have the potential to be used as a replacement for RCA, even though their role needs more investigation. Although combining theseideas presents some difficulties, there are big potential benefits in performance and application. Additional investigation isrequired to improve the design, guarantee compatibility, and assess the effects of BECs. This work opens the door to a future in which modern architecture and Vedic mathematics work together to transform multiplication.

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A Review for AI/ML Implemented in Micro Electronics.

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Abstract:

Lowering design complexity, protect against increasing process variances, and speed up chip manufacturing are areas of focus for the microchip design business. Traditional methods require a significant amount of time and resources. In order to deal with this issue, a variety of fascinating automated methods for managing intricate and data-intensive activities in very-large-scale integration (VLSI) design and testing are offered by artificial intelligence (AI), a unique learning technology. The use of artificial intelligence (AI) and machine learning (ML) algorithms in VLSI design and production maximizes efficiency while decreasing hardware power consumption and time. This study examines the automated AI/ML techniques that were introduced in the analog, digital, and physical design of VLSIs. We discuss the future scope of AI/ML applications to revolutionize the field of VLSI design, aiming for high-speed, highly intelligent, and efficient implementation.

Keywords: *AI, Machine learning algorithm, Analog IC placement, SoC, Chip Design Flow.*

I. INTRODUCTION

Microelectronics has evolved across as many as four generations, even though the amount of time it took to develop is even shorter than the normal human lifespan. Small Scale Integration (SSI) categorized low-density fabrication technologies in the early 1960s, with a transistor count cap of 10. A single chip could contain about 100 transistors thanks to Medium Scale Integration (MSI) in the late 1960s. Transistor-transistor logic (TTL), which offered better integration densities, was the foundation of the first integrated circuit revolution and survived later IC families in an identical manner to Emitter-Coupled Logic (ECL). Giants in the semiconductor industry were inspired by the birth of this family. The number of transistors increased to roughly 1000 per chip, or logic signal indicator, in the early 1970s Large scale Integration (LSI). When a single chip's transistor counts surpassed 1000 by the middle of the 1980s, the era of Very Large-Scale Integration (VLSI) began. Even with all of the advancements and the ongoing increase in transistor count, the generations are still referred to as ULSI (Ultra Large-Scale Integration).

With Intel's release of the 4004 and 8080 microprocessors in 1972 and 1974, respectively, the second age of the integrated circuit revolution got underway. Many well-known companies are currently working in many different VLSI fields, such as design tools, embedded systems, hardware descriptive languages, semiconductors, Qualcomm, Micron Tech, National Semiconductors, Texas Instruments, Infineon, Alliance Semiconductors, Cadence, Synopsys, Cisco, Micron Tech, National Semiconductors, ST Microelectronics, Mentor Graphics, Analog Devices, Intel, Philips, Motorola, and many more. Following the Introduction in Section 1, Artificial Intelligence and Microelectronics are discussed in Section 2. AI and VLSI are compared in Section 3.Section 4 depicts the extensive literature review done so far in Analog VLSI, Digital VLSI, and Physical Design; Section 5 includes a summarization of papers in tabular form; and Section 6 contains the conclusion.

II. ARTIFCAL INTELLIGNCE

AI is defined as "the science and engineering of making intelligent machines, especially intelligent computer programs" by John McCarthy. The process of teaching a computer, a robot under computer control, or software to reason logically is known as artificial intelligence. The data that is initially supplied to the system is what it learns from. Numerous disciplines, including robotics, machine learning, NLP (natural language processing), game theory, and machine vision, use it.

The fusion of computer technology and human intellect will encourage advancement across multiple industries. Anticipating developments in several industries, including manufacturing, security and military, healthcare, education, and automated cars. Statically reports indicate that AI will surpass humans in language translation, product promotion, and surgical operations. The market for AI is anticipated to grow to $190 billion by 2025, according to reports as well. AI is also predicted to contribute $15.7 trillion to global economic growth. The history of humanity will enter a new age brought forth by artificial intelligence. Artificial intelligence will enable human civilization to grow as long as we can maintain the technology's positive effects.

III. AI IN VLSI.

Design automation using AI techniques has become more popular in the microelectronics industry these days. Deep reinforcement learning (DRL), a machine learning-based technique, is therefore utilized for EDA (Electronic Design Automation) tools optimization. Furthermore, several machine learning models, like as convolution neural networks (CNNs) and graph neural networks (GNNs), are used in a variety of VLSI domains, including physical design, analog layout, and micro-architectural design space.An important tool in the process of creating chips is the neural network [1].

Speech analysis, pattern recognition, and character recognition are a few uses for artificial neural networks (ANN). Its capacity for parallel computing is one of its main benefits and the main factor contributing to its widespread application in analog and digital VLSI [2]. Widespread usage of VLSI-implemented neural networks in a variety of fields is made possible by their low cost, low power, and small area [3].

However, machine learning—a subset of artificial intelligence—has numerous uses in the VLSI industry. In machine learning, researchers use general-purpose training approaches to teach models application-specific functions; to do this, the models are fed high-quality, pre-existing datasets for training [1]. The quality of the dataset has a major impact on how accurately the model produces results. VLSI circuits using machine learning are more capable of processing data and using less energy. Since the new procedures allow for much easier system integration, digital circuits are thought to scale down extremely well. However, during implementation, problems like leakage, signal integrity, and noise margins appear, necessitating improvement with the use of AI methods like ANNs, ML, and DRL. For example, Digital Neural Networks don't need much redesign work because they are naturally robust [2].

Although analog hardware can produce accurate results, it is not very resilient, as the VLSI industry is aware. The effects of several parameters, such as temperature, power-supply change, leakage, etc., are reduced with extra caution because there is a significant trade-off between robustness, affordability, and area. Designers experience higher expenses and more chip areas as a result of their greater insensitivity to these effects. Therefore, artificial intelligence algorithms are employed to solve this issue and aid in determining error tolerance.

AI languages are appropriate to tackle problems with such intricate details. When combined with expert systems, these language capabilities provide a crucial initial step toward resolving an extremely challenging issue, such as verifying a design's accuracy [3].

IV LITERATURE SURVEY.

Artificial intelligence (AI) and Machine Learning (ML) techniques have been effectively utilized in analog VLSI applications to address challenges such as data scarcity, design complexity, and manufacturing turnaround time[4][5]. By generating artificial data using Generative Adversarial Networks (GANs), ML models trained with limited data can achieve significantly improved accuracy, reducing errors by over 50%. These technologies offer automated approaches for handling complex tasks in VLSI design, enhancing IC yield, and speeding up manufacturing processes. AI/ML algorithms enable efficient processing of data across different abstraction levels, contributing to high-speed, intelligent, and efficient VLSI implementations. The integration of AI/ML in analog VLSI applications is pivotal for advancing the field and overcoming data availability and design complexity challenges.

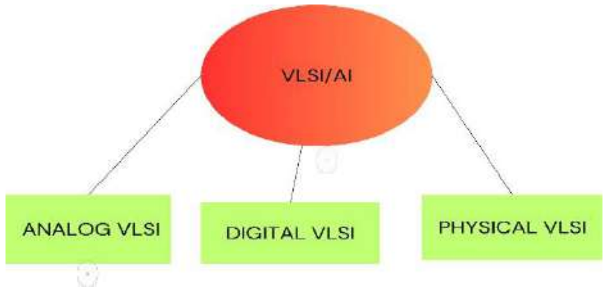

Figure 1 Separation of VLSI /AI

A. *Analog VLSI.*

Prasha Srivastava et al. [4] The study addresses data scarcity concerns in electronic designs by utilizing machine learning (ML) approaches for analog and digital integrated circuit design automation and optimization. Using generative adversarial networks (GANs) suggests creating false data to improve the accuracy of machine learning models that were trained on a small amount of data for VLSI circuits. The project seeks to address issues with training data availability to further the general application of AI and ML in VLSI design.

An issue that arises in the process of optimizing DRAM memory cells is worst-case analysis, according to J. Lee et al. [5]. This is because running TCAD simulations using randomly generated data has a high computing cost. This research uses machine learning to study the worst RDD (random discrete dopant) arrangement in 6F2 DRAM cells. This method uses a multi-layered neural network model that was trained using 200 simulations initially and 500 RDD configurations to forecast leakage. In terms of computational costs, the ML technique saves 94.5 percent as compared to a random sampling strategy.

Raghav Singhal et.al [6] The study suggests applying weights utilizing an analog and temporary on-chip memory (ATOM) cell with adjustable retention durations, demonstrating a decrease in validation error^Context_1. Temporary memory has a benefit over on-chip learning due to its controllable decay timeframe, which can further reduce validation error\Context_1.Temporary memory-induced weight decay can result in around 33% less validation error, demonstrating advantages comparable to regularization . Temporary memory is advantageous for on-chip learning since it can further reduce validation error by about 26% when the decay time frame is controllable.

Fick, L., et al a flash-based Analog Matrix Processor (AMP) is proposed to provide 10-to-100-times more efficient inference than traditional digital inference by leveraging denser circuitry via smaller memory elements (multi-level flash instead of several SRAM cells). By exploiting denser circuitry and communication, the study introduces a flash-based Analog Matrix Processor (AMP) that is substantially more efficient than typical digital inference, addressing the difficulty of deploying machine learning models at the edge [7].The Analog Matrix Processor (AMP) achieves edge inference compute that is 10-to-100× more efficient than traditional digital inference, leveraging denser circuitry and communication

Liu, G.[8] authors describe new ideas to design and implement algorithms directly at the circuit level, instead of using digital computing components for algorithm implementations, and describe new circuit designs for AI algorithm acceleration. The first, sizable section discusses feed forward algorithm implementations, with examples including the use of 2*3*3 analog multiply-accumulation matrices for computer vision and artificial intelligence algorithms and 1*4 analog multiply-accumulation arrays for DSP algorithms. The second, sizable portion deals with the implementation of backward algorithms. These include the use of a programmable resistor-based feedback loop, the "add-division circuit" for the convolutional kernel training technique, and the "random matrix generator" for the solution of neural network Diophantine equations.

Nägele, R.,et al proposed an energy efficient multiply-accumulate cell for all-analog neural layer processing macros is presented, where the analog two-quadrant multiplier circuit consists of two complementary MOSFETs where the pulse width modulated input activation is applied to the gates and the weight signal to the isolated back-gate. On a memory capacitor, the analog multi-bit resolution weight is dynamically stored. Charge amassed on a summation line and drawn from or added to a calculation capacitance signify the result of the multiply-accumulate process. Based on a 22 nm FD-SOI CMOS technology, simulation findings reveal that the cell's consumption for a circuit-level multiply-accumulate operation is approximately 0.67 fJ. The analog two-quadrant multiplier circuit achieves an area efficiency of 166 x 10^12 MAC/s/mm^2 in a 22 nm FD-SOI CMOS technology [9].

Jain, S., et.al discussed a highly heterogeneous and programmable compute-in-memory (CIM) accelerator architecture for deep neural network (DNN) inference is introduced, which combines spatially distributed CIM memory array tiles for weight-stationary, energy-efficient multiply-accumulate (MAC) operations, together with heterogeneous special-function compute cores for auxiliary digital computation. The author estimate the several network like analog fabric large LSTM and bidirectional encoder representations from transformers (BERT) It shows highly competitive throughput and offers significantly higher energy efficiency than NVIDIA A100 for DNN inference applications .[10]

Bansal, M.,et al.[11]This study investigates performance-driven placement in the VLSI IC design process, as well as analogue IC performance prediction by utilizing various machine learning approaches and it is evident that, when compared to the manual layout, an improved performance is obtained by using the proposed approach. When compared to manual design, machine learning techniques enhance the performance of analog IC layout design. For performance-driven analogue IC placement, several machine learning techniques, including SVM, NB, RF, and ANN, are reviewed. The suggested method predicts circuit performance during placement solutions by combining cost functions and machine learning models. Python experiments performed on a Linux system demonstrates acceptable runtime speeds for analog integrated circuit design. The study shows how well the machine learning-based method works for addressing geometric limitations in analogue IC design, wire length, area, and circuit performance optimization. For performance-driven analogue IC placement, several machine learning techniques, including SVM, NB, RF, and ANN, are reviewed [11].

Budak, A. F., et al An efficient surrogate model-assisted sizing method for high-performance analog building blocks (ESSAB) is proposed to address the prediction error for some performances and accumulate by many performances.The use of machine learning- assisted global optimization techniques to accelerate the scaling of analog integrated circuits is becoming more popular. The difficulties of taking into account a comprehensive set of standards for analog integrated circuit design are discussed in the study. The suggested approach, known as ESSAB, offers novel approaches to the building of artificial neural network models and candidate design rating for analog circuit performance. The ESSAB-obtained designs exhibit excellent performance, even under extreme circumstances. Among all reference methods, ESSAB exhibits the best average power value, showing a definite advantage in solution quality. With a modeling duration of only 0.4 hours, ESSAB successfully addresses the issue of machine learning costs [12].

B. *Digital VLSI:*

AI/ML is made easier by digital VLSI, which offers edge computing capabilities, hardwareacceleration, and customized architectures that are task-specifically tailored. It provides effective, high-performance AI/ML systems across a range of applications by improving energy efficiency, enabling model compression, and supporting on-chip learning.

Srivastava, P., et al Diffusion models are state-of-the-art for generating images, and generative AI has grown significantly in the last few years. When training data is typically known to be extremely limited, this study explores the use of diffusion models in artificial data generation for electronic circuits to improve the accuracy of subsequent machine learning models in tasks like performance assessment, design, and testing. For our suggested diffusion model, we use simulations in the HSPICE design environment using 22nm CMOS technology nodes to get representative actual training information. Our findings show that synthetic data created with diffusion models closely resembles real data. We confirm the accuracy of the produced data and show the information augmentation is unquestionably useful for the predictive analysis of VLSI design for digital circuit [13].

Kumar, A.,et al [14] In order to overcome the drawbacks of conventional von Neumann designs, this research suggests an in-memory computing architecture for artificial neural networks (ANNs), specifically in addressing the memory wall issue. Memory bandwidth and energy efficiency are improved by this architecture by doing calculations inside the memory core. The suggested architecture implements a multilayered perceptron using a conventional six-transistor (6T) static random access memory (SRAM) core, allowing for effective on-chip training and inference. With a reduction of ≈ 22.46× in energy usage per decision, tests on the IRIS dataset demonstrated significant energy savings and better throughput compared to older systems.

Singh, K.,et al [15] The issues facing the integrated circuit (IC) industry in the Nano scale regime are covered in this chapter, along with the shortcomings of conventional approaches. These issues include longer turnaround times for chip manufacture and increasing process variability. It presents machine learning (ML) and artificial intelligence (AI) as potential methods for automating difficult, data-intensive activities in VLSI testing and design. VLSI design processes can be made more effective by utilizing AI and ML algorithms, which will cut down on the time and effort needed for data processing at various abstraction levels. AI/ML approaches can lead to a significant reduction in production turnaround time and an improvement in IC output. It covers prospective applications of these techniques at different abstraction levels and examines past approaches in automated VLSI design and production using AI/ML, opening the door to fast, smart, and effective VLSI implementations.

Abreu, B. et al[16] Implementing machine learning (ML) applications on embedded platforms—like wearables—that have energy limitations is a topic of discussion in this paper. Power-efficient models are essential because machine learning (ML) techniques, while effective for pattern identification and prediction, require large amounts of data and processes. When model selection is integrated with approximate computing (AxC) approaches, power costs can be reduced, but design space exploration (DSE) becomes more complex. In order to maximize energy/area reductions, the paper suggests automated frameworks for synthesis and ML VLSI accelerator generation that use AxC methodologies. In comparison to earlier efforts, the frameworks are evaluated by investigating approximation VLSI architectures for Random Forests (RF) and Decision Trees (DT), which result in notable power reductions. The contribution is to allow for automated and thorough DSE of ML models, which helps designers make well-informed trade-offs.

Atsuya, et.al [17] discusses ongoing research on spiking neural network processors and analog-based machine learning accelerators. These methods use low-power, high-speed analog multiply-accumulation arithmetic to deliver great performance per power in machine learning applications. Compared to conventional digital multiply-accumulators found in GPUs, FPGAs, and ASICs, this method offers advantages in terms of power efficiency since it makes use of densely-packed synaptic non-volatile memory (NVM) resistive device arrays. Researchers want to maximize performance while reducing power consumption by outfitting intelligent edge devices with ASICs or IP cores incorporating massively parallel multiply-accumulators suited for particular machine learning workloads.

Chang, C. [18] working with large datasets, machine learning techniques like pattern matching and machine learning can shorten the time it takes to design VLSI circuits. This can increase the abstraction level that can be obtained from intricate simulations based on physics models and yield results that are significantly higher in quality. The use of machine learning in physical design has grown dramatically as a result of the enormous volume of data gathered and the extremely complicated level of VLSI design and manufacture. With the use of machine learning (ML), one can raise the abstraction level that is reached from intricate simulations based on physics models and produce outcomes that are noticeably high-quality[18].

This research presents an Artificial Neural Network (ANN)-based low-power portable Digital VLSI architecture for water quality monitoring. The ANN is implemented on FPGA and ASIC systems using Posit number representation. The suggested ANN Posit architecture exhibits a 50% reduction in power and silicon area, a 13% increase in performance, and a comparable accuracy when compared to IEEE 754. In addition, the efficiency of the VLSI architecture for portable applications is demonstrated by the fact that it uses a lot less power than the FPGA implementation [19].

C. Physcial Design:

The use of AI/ML approaches in physical VLSI design has significantly changed in response to the difficulties brought on by the growing complexity of circuit systems[20]. greater degrees of abstraction have been made possible by the incorporation of machine learning into VLSI design automation, producing outputs that are of greater quality[21]. In order to increase efficiency and lower power consumption, artificial intelligence (AI) techniques are being used more and more in the VLSI sector, especially in System-On-Chip (SoC) design[22]. A wide range of crucial areas, including floorplanning, placement, routing, gate sizing, and design for manufacturing, are covered by the application of machine learning in physical design, demonstrating the profound influence of AI technologies in transforming the VLSI design process. These developments demonstrate how AI and ML have the power to fundamentally alter the field of physical VLSI design.

Igor, et al.In the design flow of large-scale integration (LSI), physical design plays a crucial role in balancing the challenges of nanoscale silicon production with the intricacy of circuit system design. The investigation of alternate solutions is necessary since traditional algorithmic techniques, such as nonlinear optimization, are finding it difficult to handle the growing complexity. Machine learning has become a potential approach to address physical design difficulties in IC (Integrated Circuit) design, driven by advances in cloud-scale computing and massive volumes of data. Machine learning approaches have been actively applied by researchers to a number of physical design features, such as gate sizing, floor planning, positioning, routing, parasitic extraction, and design for manufacturing. This special issue presents recent advances in machine learning technologies tailored for LSI physical design, covering a range of key issues such as routing, placement, power delivery, interconnect analysis, reliability, manufacturability, and physical security.

Ya-Shu, et.al A novel modelling approach for emerging gate-all-around (GAA) MOSFETs is presented in this paper, which makes use of artificial neural networks (ANNs) and the Grove- Frohman (GF) model. The architecture consists of two ANNs: the first ANN was trained using a drain current model and is capable of accurately capturing device features and making predictions even when training data is scarce or goes beyond the range of applied biases. By reducing errors between the target and model outputs, the second ANN improves the accuracy of the model even more. This method avoids divergence problems in circuit simulation and accurately models complementary FETs (CFETs) and emerging GAA Nano sheet (NS) MOSFETs. Furthermore, nonzero current at zero bias and other nonphysical characteristics are avoided. This approach uses only 20% of the training data to attain equivalent accuracy as recent machine- learning (ML) models.

V. COMPARSION OF IMPLEMENTING AI TECHINQUE IN VLSI

TABLE I, Comparison table shows the performance of AI in VLSI for above reviewed papers. The study of the different tools and technologies used the area of research and the type of implementation of different papers reviewed above.

Refs	Tool /Technology	Area of Research	ImplementationType
[4]	Cadence Virtuoso, HSPICE, and Microcap	Data scarcity concerns in electronic designs	Generative Adversarial Networks (GANs)& design environment with TSMC 180nm and 22nm CMOS technology nodes
[5]	TCAD SimulatorML Scikit-learn Pythonopen source package	DRAM Machine Learning Worst Case Analysis in RDD Configuration	Digital Implementation
[6]	ATOM cell fabricated in Global Foundries' 45 nm RFSOI technology	AI Memory technology	An (ATOM) cell with controllable retention timescales neural network with a variable number of layers for digit recognition.
[7]	Xilinx Spartan flash-based Analog Matrix Processor (AMP)	Analog Matrix Processor (AMP) achieves edge inference	Digital Implementation
[8]	DSP Processror	AI algorithm at direct circuit level	VLSI implementation of feed forward and backward algorithm implementations
[9]	V 22 nm FD-SOI CMOS technology Verilog HDL 45nm SOI Process Convolutional Neural Network	Energy efficient multiply-accumulate cell for all-analog neural layer	Analog neural layer processing macros
[10]	2-D grid of tiles, 2-D mesh	High EE is achieved in 40× – 140× than NVIDIA A100	Multiply-accumulate (MAC) operation
[11]	Linux system using Python language show acceptable runtime speeds for analog IC design	Driven placement in the VLSI IC design process	SVM, NB, RF, and ANN are investigated for performance-driven analogue IC placement
[12]	ADAM optimizer, rectifier activation	Attention for speeding up analog integrated circuit sizing	ANN is trained using the ADAM optimizer with a learning rate of 0.001 and a batch size of 64
[13]	HSPICE Simulator	Creating synthetic data in order to improve the precision of electronic circuits	Denoising Diffusion Probabilistic Model (DDPM), 22nm CMOS technology
[14]	HSPICE simulator (6T) static random access memory (SRAM)	Reducing interference in memory architecutre using ANN	Artificial neural networks (ANNs)
[15]	NA	IC chip production using nanoscale regime	Digital fiber implementation
[16]	Embedded, cadence VLSI	Battery constraints, such as wearables device	Approximate computing (AxC) techniques, combined with DSE
[17]	Digital VLSI with FPGA,GPU	Non-volatile memory (NVM) resistive device arrays.	Spiking neural network processors using AI
[18]	NA	Mixed Signal Analog VLSI ML Algorithms	Pattern matching for the circuit designplacement
[19]	FPGA and ASIC platform	Digital VLSI architecture using an Artificial Neural Network (ANN)	water quality monitoring is presented using Posit number
[20]	NA	ML technologies were utilized for tackling key physical design problems in IC design stages	LSI physical design
[21]	Cadence, HSPICE Simulator	Grove-Frohman (GF) model and ANNs for emerging gate-all-around (GAA) MOSFETs	GAA nanosheet (NS) MOSFETs and complementary FETs (CFETs)

VI CONCLUSION

The primary topics of this article include physical design in microelectronics, digital VLSI, and analog VLSI. A thorough analysis of the application of AI in several VLSI disciplines is conducted. It recognizes that ANN and ML models are highly useful for intricate algorithms and, as a result, finds extensive use in the automation of chip IC layout creation. Moreover, adding machine learning (ML) algorithms to hardware to boost efficiency is a significant objective of SoCs; however, doing so also necessitates reducing the hardware's existing power consumption. Therefore, evaluating the body of research on AI deployment in the verification and validation process will be the topic's future focus.

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Empowering Mobility: The Evolution and Impact of Wheelchairs in Rehabilitation

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Abstract:*Mobility impairment presents significant challenges, limiting individuals' ability to move freely and independently. Wheelchairs have emerged as crucial assistive devices for individuals with physical and mental disabilities, offering essential support and enabling greater mobility. This paper explores the evolution of wheelchair technology, from manual to automated designs, incorporating robotic mechanization and advanced features in the realm of rehabilitative medicine. With ongoing technological advancements, modern wheelchairs integrate monitoring sensors, Internet of Things (IoT) connectivity, enhanced comfort features, and diverse mobility controls. This comprehensive review examines the current state of wheelchair technology, highlighting existing upgrades and discussing upcoming innovations poised to further enhance accessibility and autonomy for users.*

Keywords: Mobility impairment, wheelchairs, robotic mechanization, rehabilitative medicine, IoT.

I. INTRODUCTION

Since its inception in the 15th century, the wheelchair has remained a cornerstone of assistive technology, providing individuals with mobility limitations the freedom to navigate their surroundings and engage more fully in daily life. Originally conceived to address the needs of individuals with spinal cord injuries, bone fractures, and muscular disorders, the wheelchair has undergone a remarkable evolution, adapting to meet the diverse needs of users and incorporating advancements in technology to enhance functionality and comfort. The importance of the wheelchair extends beyond mere mobility; it serves as a vital tool in improving the physical health and overall quality of life of its users. By alleviating common issues such as pressure sores and deformities while also facilitating improved respiratory and digestive functions, a well-suited wheelchair can significantly enhance the well-being of its user. In recent years, the pace of innovation in wheelchair technology has accelerated, driven by advancements in materials science, electronics, and design. These innovations have led to a proliferation of wheelchair options, each tailored to meet specific user requirements, preferences, and budgets. This review aims to provide an overview of the latest features and technological developments in wheelchairs from approximately 2015 to the present day. By categorizing these advancements based on propulsion methods, control mechanisms, and integrated technologies, this review seeks to offer insights into the current state of wheelchair technology and its potential to further improve the lives of individuals with mobility impairments.

Table 1. Percentage of Disabled to Total Population India, 2011

Table 2. The Proportion of Disabled Population by Type of Disability India, 2011

Sl.No	Types of Disabilities	Male	Female	Total
1	In Seeing	17.6	20.2	18.8
2	In Hearing	17.9	20.2	18.9
3	In Speech	7.6	7.4	7.5
4	In Movement	22.5	17.5	20.3
5	Mental Retardation	5.8	5.4	5.6
6	Mental Illness	2.8	2.6	2.7
7	Any Other	18.2	18.6	18.4
8	Multiple Disability	7.8	8.1	7.9
	Total	100	100	100

Table 1 and Table 2 [1] Contents are based on the reference of the census taken over in India in 2011 as last. In actuality, the census should be taken in 2021, but due to the pandemic situation of COVID-19, it has been postponed to October of 2023.

Fig 1 Variety of modern wheelchairs [27-29]

The figures mentioned above showcase a variety of modern wheelchairs currently available in the market. Specifically, Fig 1 exemplifies the diverse range of designs, features, and functionalities incorporated into contemporary wheelchair models [27-29]. These visual representations offer insights into the evolution of wheelchair technology, highlighting innovations aimed at enhancing user comfort, mobility, and overall quality of life.

II. EVOLUTION

The association between spinal cord injuries and wheelchairs is deeply ingrained in our collective consciousness. Indeed, for many, the two seem inseparable, intertwined in a complex relationship that oscillates between appreciation and frustration. When the wheelchair functions smoothly, it elicits cheers of relief and gratitude; however, when it malfunctions, it can provoke feelings of exasperation and disappointment.

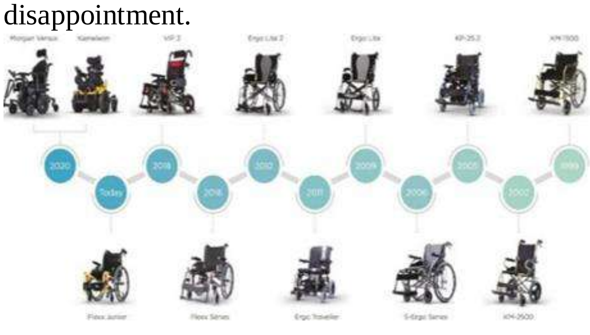

Fig 2.The Evolution wheelchair [31]

The history of the wheelchair spans centuries, evolving significantly over time. In the past, the paramount concern was not finding the perfect wheelchair but rather surviving the devastating impact of a spinal cord injury. Fortunately, advancements in medical treatment and rehabilitation have transformed this narrative, offering hope and improved outcomes for individuals affected by spinal cord injuries. Today, while the wheelchair remains a vital tool for mobility and independence, its role has shifted from being solely a means of transportation to encompassing elements of comfort, functionality, and personal expression. The history of the wheelchair is a testament to human ingenuity and the relentless pursuit of innovation to enhance mobility and independence for individuals with disabilities. Stephen Farfler's design of the first user-propelled wheelchair in 1665 marked a significant milestone in this evolution. Despite its weight and cumbersome nature, Farfler's wooden wheelchair represented a crucial advancement in accessibility. In 1783, John Dawson introduced another notable innovation with the Bath wheelchair, featuring large rear wheels and a small front wheel. This design revolutionized transportation for individuals seeking therapeutic waters in Bath and became immensely popular during the early 19th century. The industrial revolution of the mid-19th century propelled wheelchair production in the United States to new heights. With bicycle and carriage makers joining the fray, wheelchairs became more accessible and technologically advanced. Metal wheels with rubber tires replaced wooden ones, while durable metals replaced fragile axles and frames. Comfort features such as padded parts and improved arm and leg rests became standard upgrades, reflecting a growing emphasis on user comfort and functionality. The mid to late 20th century witnessed a transformative period in the wheelchair industry. Innovations such as folding wheelchairs, lightweight designs, powered models, sports wheelchairs, functional seating systems, and standing wheelchairs emerged, catering to diverse user needs and preferences. These advancements not only expanded mobility options but also empowered individuals with disabilities to lead more active and independent lives.

III. MOBILITY CONTROL

The control mechanisms for wheelchairs encompass both manual and automatic modes, offering users flexibility and adaptability based on their abilities and needs. Manual control options include joysticks, mice, keypads, and other input devices, requiring the user to manipulate the controls with their hands or fingers. However, for individuals with severe spinal cord injuries (SCI) or other disabilities affecting motor function, traditional manual controls may not be feasible.

Fig 4 Sample of mobility control [33]

Automatic control systems have emerged as a solution for individuals who cannot operate manual controls due to the absence of nerve supply to their limbs. These systems rely on signals generated by the user, such as head movements, eye tracking, or facial expressions, to facilitate wheelchair movement. By capturing and interpreting these signals, automatic control systems enable users to navigate their environment independently. For example, Gajwani & Chhabria implemented an eye-tracking system that uses a USB camera to track the user's eye movements and translate them into wheelchair commands. Similarly, other models utilize head gestures, facial expressions, or electromyography (EMG) signals to control wheelchair movement. These innovative approaches empower individuals with severe disabilities to achieve greater mobility and independence in their daily lives. Fig. 4 [33] illustrates a sample of mobility control, showcasing the integration of automatic control mechanisms into wheelchair design. By leveraging the user's natural movements and gestures, these systems offer a user-friendly and intuitive interface for controlling wheelchair movement, enhancing accessibility and inclusivity for individuals with disabilities.

IV. SAFETY FEATURE

Safety features are paramount in wheelchair design, ensuring the well-being and security of users in various situations. Fall detection, obstacle avoidance, and seat belt implementation are among the critical safety features integrated into modern wheelchairs, enhancing user safety and peace of mind. Fall detection mechanisms utilize advanced sensors such as gyroscopes, GPS modules, FSR pressure sensors, and microcontrollers to detect and respond to potential falls. Gyroscopes are employed to monitor the wheelchair's position, while FSR pressure sensors on the seat pad detect user gestures indicative of a fall. These sensors work in tandem to trigger timely alerts or automated responses to mitigate the risk of injury.

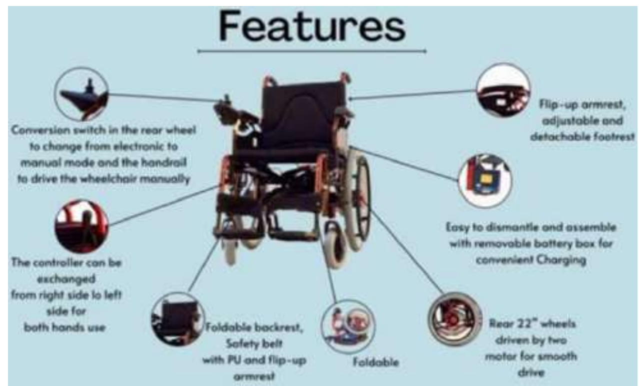

Fig 5. Feature of wheelchair [34]

Obstacle avoidance systems are essential for navigating unpredictable environments safely. Classical obstacle avoidance algorithms utilize sensor data to generate motion instructions, employing techniques such as fuzzy logic and neural networks to navigate around obstacles. While these methods offer effective obstacle detection and avoidance, continuous refinement and testing are necessary to ensure reliability across diverse scenarios. Seat belt features are crucial for preventing falls and enhancing user stability, particularly for individuals with limited mobility or paralysis. By securing the user in place, seat belts minimize the risk of falls and provide additional support during wheelchair operation, both indoors and outdoors. Proper utilization of seat belts is essential for maximizing safety and reducing the likelihood of accidents or injuries. Fig. 5 [34] illustrates a typical obstacle avoidance algorithm, showcasing the integration of sensor data and motion instructions to navigate around obstacles effectively. These safety features collectively contribute to a safer and more secure wheelchair experience, empowering users to navigate their environment with confidence and independence.

V. CONVERTIBLE FEATURE

The development of a convertible wheelchair into a stretcher represents a significant advancement in assistive technology for individuals with physical disabilities. This innovative device offers newfound hope and independence by alleviating the need for heavy lifting and reducing the reliance on external assistance. With a simple mechanical and pneumatic control mechanism, the convertible wheelchair stretcher is user-friendly and accessible to individuals of varying skill levels. By seamlessly transitioning from a wheelchair to a stretcher, this device minimizes the risk of injury and discomfort for both the user and their attendants. The ability to fold and convert the wheelchair into a stretcher enhances portability and accessibility, enabling easy transportation even in challenging environments such as stairs or confined spaces.

Fig 6 Convertible wheelchair stretcher [35]

Fig. 6 [35] illustrates the versatility and functionality of the convertible wheelchair stretcher, showcasing its potential to improve the quality of life for individuals with mobility limitations. While traditional stretchers may lead to discomfort and calluses over time, the convertible design offers enhanced comfort and ease of use, making movement more efficient and less taxing on the user. Moreover, the integration of a wheelchair that can be converted into a bed further enhances convenience and accessibility for individuals who require assistance with transfers between different surfaces. While external help may still be necessary, the convertible wheelchair-bed system significantly reduces the effort and strain involved in such transitions, ultimately promoting greater independence and comfort for users.

VI. COMFORTABLE FEATURES

Comfort features are essential for individuals who spend a significant amount of time in wheelchairs, providing both physical support and ergonomic principles for optimal comfort and functionality. Various comfort features such as cushions, suspension systems, and seat belts are designed to enhance user comfort, prevent pressure sores, and ensure safety during wheelchair use. Wheelchair seat cushions play a crucial role in providing comfort and preventing pressure sores by distributing weight evenly and keeping the user cool and dry. Different types of cushions, including foam, gel, air, and honeycomb cushions, offer unique benefits and cater to individual preferences and needs. Ergonomic principles are applied in wheelchair design to customize the fit for each user, ensuring optimal comfort and functionality. Adjustable arm supports, seat depth and seat surface height allow users to achieve a personalized fit, enhancing comfort and reducing the risk of discomfort or fatigue during prolonged use. Seat belts are essential safety features designed to prevent occupants from falling out of the wheelchair and ensure proper positioning and stability.

Fig 7 Seat Configuration [34]

Various types of seat belts, such as padded pelvic stabilizer belts, hip belts, and chest belts, offer secure and comfortable positioning options for users, reducing the risk of injury and promoting confidence during wheelchair use. Shock absorbers and suspension systems further enhance comfort, stability, and traction, allowing users to navigate rough terrain with confidence and minimizing the impact on both the user and the wheelchair. These features promote greater independence and mobility, enabling users to maintain optimal comfort and safety in various environments.

VII. ACCESSORIES

The evolution of wheelchairs has brought forth a plethora of accessories aimed at enhancing the comfort, convenience, and safety of users. Seat cushions provide essential pressure relief and comfort, while back cushions offer support and promote proper posture during prolonged sitting. Wheelchair safety belts ensure secure positioning and prevent falls, while wheelchair gloves provide grip and protection, particularly during self-propulsion. Accessories like wheelchair backpacks and table trays offer practical solutions for carrying personal items and providing stable surfaces for various activities. Portable ramps enable accessibility to buildings and vehicles, while transfer boards facilitate smooth transfers between surfaces. Mobility hand cycles, both manual and electric, promote physical activity and extend range, while bag holders and cargo shelves increase carrying capacity and convenience. Cup holders and beverage holders secure drinks in place, and oxygen attachments cater to users with respiratory needs. Safety features such as fall detection sensors and protective helmets provide added peace of mind. Together, these accessories contribute to a more comfortable, convenient, and safe wheelchair experience, empowering users to lead independent and fulfilling lives tailored to their unique needs and preferences.

VIII. IOT APPLICATION

Traditional wheelchairs cannot often interact with the surrounding environment and typically operate using a single-control method. To address this limitation, there is a growing need for IoT wheelchairs equipped with advanced functionalities. These IoT wheelchairs feature sensors capable of recognizing both the occupant and the environment, including sensors integrated into the backrest and footrest. This enables the wheelchair to sense positioning, speed, and posture information, allowing for precise control over lifting, lowering, and movement. Additionally, IoT wheelchairs employ a fusion control scheme that combines multiple control methods, such as rocker and gesture applications, enhancing usability and accessibility. With connectivity features like Wi-Fi modules and MQTT protocols, these wheelchairs enable seamless communication with external devices, allowing users to upload sensor data and control the wheelchair remotely via a dedicated smartphone app. Moreover, IoT-based wheelchairs are equipped with advanced sensor networks, including cameras and ECG sensors, to provide comprehensive sensing capabilities.

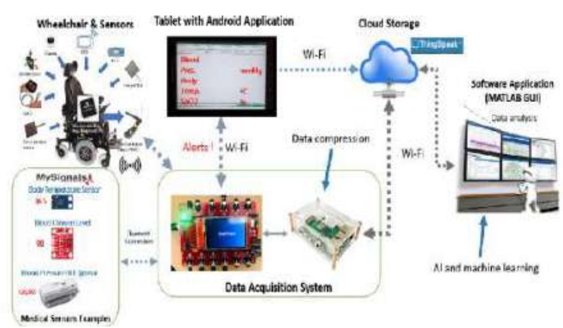

Fig 8 IOT design circuit [37]

This enables features such as human-machine interaction, remote monitoring, and mobility control, ultimately enhancing the user experience and functionality of the wheelchair. Fig. 10 [37] illustrates the integration of advanced sensing technologies in an IoT-based wheelchair, showcasing its ability to improve user mobility and independence.

IX. CONCLUSION

While wheelchairs have greatly improved mobility and independence for individuals with disabilities, they also come with limitations and disadvantages. Repetitive strain issues can arise from prolonged wheelchair use, and they may not be ideal for long distances or navigating steep terrain without assistance. However, the benefits of using wheelchairs often outweigh these limitations, especially with the introduction of innovative accessories and modifications that transform simple wheelchairs into smart, automated devices. These advancements have significantly reduced issues like sores and depression among wheelchair users, while also decreasing the need for constant assistance. As a result, wheelchairs are considered a boon in the rehabilitative era, offering individuals with disabilities greater freedom and quality of life.

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TRAFFIC SIGN DETECTION WITH OCCLUSION USING YOLO 7

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Abstract – This project introduces an advanced approach to traffic sign recognition using the YOLOv7 object detection algorithm, designed to operate in real-time on video footage. Leveraging a comprehensive dataset covering a diverse range of traffic signs, including Barrier Ahead, Cattle, Cycle Crossing, Give Way, Horn Prohibited, and more, the system aims to address critical road safety concerns. By harnessing the capabilities of YOLOv7, renowned for its efficiency and accuracy, the project endeavors to achieve robust and timely detection and classification of traffic signs. This initiative holds significant promise for enhancing traffic management practices and overall safety measures on roadways. With a focus on real-time detection capabilities, this project seeks to provide immediate feedback to drivers and traffic management systems, enabling swift responses to changing road conditions. By accurately identifying and categorizing traffic signs, the system facilitates informed decision-making by drivers and enhances overall situational awareness on the road. Moreover, the utilization of YOLOv7 ensures adaptability to various environmental factors and lighting conditions, further enhancing the system's reliability and performance. Through its commitment to leveraging cutting-edge technology for road safety initiatives, this project aims to make substantial strides towards reducing traffic accidents and creating safer driving environments for all road users.

I. INTRODUCTION

Traffic sign detection serves as a cornerstone in the realm of intelligent transportation systems, playing a pivotal role in enhancing road safety and optimizing traffic flow. In this project, the implementation of the YOLOv7 object detection algorithm is explored as a means to achieve real-time recognition of diverse traffic signs within video streams. By leveraging YOLOv7's advanced capabilities, the project aims to accurately identify and classify a wide range of traffic sign classes, encompassing vital indicators such as Barrier Ahead, Cattle, Cycle Crossing, Give Way, and more. This comprehensive approach ensures that the system can effectively respond to the dynamic and multifaceted nature of modern traffic environments, thereby contributing to the overarching goal of improving road safety and traffic management practices.

The dataset utilized in this project is meticulously curated to encompass a diverse array of traffic sign classes, reflecting the complexity and variability observed in real-world traffic scenarios. This extensive dataset enables thorough training of the YOLOv7 model, allowing it to learn the intricate features and spatial relationships inherent in different types of traffic signs. Through rigorous training, the model becomes proficient in accurately detecting and classifying traffic signs in real-time video streams, laying the foundation for robust and reliable performance in dynamic traffic environments. This meticulous dataset curation ensures that the system is adequately equipped to handle the myriad challenges posed by varying lighting conditions, sign sizes, and environmental factors encountered on roadways.

By harnessing the capabilities of YOLOv7 for traffic sign detection, this project aims to make tangible contributions to advancements in road safety and traffic control systems. The deployment of a robust and efficient traffic sign recognition system holds the potential to not only enhance the safety of road users but also optimize traffic flow and reduce congestion. Through the seamless integration of cutting-edge technology and rigorous dataset curation, the project endeavors to pave the way for smarter, safer, and more efficient transportation networks, ultimately benefiting society as a whole.

II. RELATED WORK

Masmoudi et.al [16] designed an end-to-end self-driving car tracking framework including a You Look Once version 3 (YOLOv3) object detector for recognizing leading vehicles and other obstacles, and a reinforcement learning (RL) algorithm. This framework navigates self- driving vehicles through video frames. Shengyu Lu et al.

[17] proposed a real-time target detection algorithm for video based on YOLO network. By preprocessing the image to eliminate the influence of the image background, and then train the Fast YOLO model for target detection, to obtain the target infor mation, using a small convolutional operation instead of the original convolutional operation, which reduces the number of parameters and greatly shortens the time of target detection. Zhang et al. [18] proposed a simple, effective, and generalized correlation method to track by correlating almost all detection frames, instead of only those with high scores. For detection frames with low scores, we utilize their similarity to the tracklet to recover the true target and filter out background detections.Deng et al. [19] propose to address motion blur or occlusion by aggregating neighboring frames to enhance per-frame features. Specifically, we propose Single Shot Video Object Detector (SSVD), a new architecture that integrates feature aggregation into a single-stage detector for video object detection. Inspired by the principles of human vision, Li et al. [20] proposed an attention mechanism-based ap proach for adversarial sample defense of traffic signs. In this process, key regions in the image are extracted by the attention mechanism and the pixels are filtered by interpolation. This model simulates the daily human behavior and can improve the recognition success rate of traffic signs with added noise. Chung et al. [21] pro posed an attention- based convolutional pooling neural network (ACPNN) that applies the attention mechanism to feature maps to acquire key features. the ACPNN is robust to external noise and can still classify images with added noise.Zhu et al. [22] created the TT100K dataset and proposed a CNN-based model.Li et al. [23] came out with a cross- layer fusion multi-target detection and recognition algorithm based on Faster R-CNN, which utilizes the five-layer structure of VGG16 to obtain more feature information to solve the problem of small object recognition.In addition, it also includes various levels of occlusion and truncation that can challenge the robustness and adaptability of the computer vision algorithms.Shobha, BS and Deepu, R [24] present a comprehensive survey of video-based vehicle detection techniques using traditional computer image processing methods. The authors examine various approaches for recognizing, classifying, and tracking vehicles in motion. These approaches include appearance-based models, motion-based models, as well as region-based and feature-based tracking .

III. PROPOSED SYSTEM

To construct a diverse dataset for traffic sign recognition, it's imperative to capture images and videos depicting various traffic scenarios, encompassing different environmental and traffic conditions. Following data collection, each traffic sign instance in the dataset must be meticulously annotated with bounding boxes and class labels corresponding to specific traffic sign categories such as Barrier Ahead, Cattle, Cycle Crossing, Give Way, Horn Prohibited, Hump, Men at Work, Narrow road ahead, No Parking, No Stopping, Parking Lot Cars, Pedestrian Crossing, etc. This annotation process ensures that the model is trained to accurately identify and classify traffic signs across a wide range of real-world situations, laying the foundation for robust and reliable traffic sign recognition algorithms. The collected datasets are split into train, test and Validation. In train dataset have 12,710 images and test set have 2,750 have and validation set have 575 images.

In preparation for training the YOLOv7 model, several preprocessing tasks are necessary to enhance the diversity and quality of the dataset. Image resizing ensures consistency in dimensions across all images, facilitating uniform processing during training. Normalization adjusts pixel values to a common scale, promoting stability and convergence during model training. Augmentation techniques such as rotation, flipping, and brightness adjustments introduce variability into the dataset, enhancing the model's ability to generalize to unseen data and improving robustness. Once preprocessing is complete, the dataset is formatted according to the specifications required for YOLOv7 training, typically involving conversion to the appropriate file format and organization into training, validation, and test sets. By conducting these preprocessing tasks, the dataset is primed for effective training of the YOLOv7 model, enabling the development of accurate and reliable traffic sign recognition algorithms capable of performing well across diverse real-world scenarios.

Labelling is a user-friendly open-source tool widely utilized for annotating images, particularly in tasks like identifying traffic signs for machine learning applications. With Labelling, users can easily load images, draw bounding boxes around traffic signs, and label them with appropriate categories. The tool streamlines the annotation process by providing an intuitive interface and essential features such as zooming and keyboard shortcuts. Annotations are typically saved in XML format, compatible with popular object detection frameworks. Overall, Labelling simplifies the task of creating annotated datasets, enabling efficient training of machine learning models for traffic sign recognition and other object detection tasks.

To configure the YOLOv7 model architecture for traffic sign recognition, adjustments to parameters and layers are made based on the project's specific requirements. This involves modifying parameters such as input image size, number of classes (corresponding to the different traffic sign categories), anchor box sizes, and other architectural parameters to suit the characteristics of the dataset and the task at hand. Additionally, layers within the YOLOv7 architecture may be fine-tuned or customized to optimize performance for traffic sign detection.

Utilizing transfer learning is an effective strategy to enhance the performance of the YOLOv7 model. By initializing the model with pre-trained weights on a large dataset (such as the COCO dataset), the model can leverage the knowledge learned from diverse object detection tasks. This initialization provides the model with a strong starting point, enabling it to capture relevant features and patterns related to object detection, which can then be fine-tuned during training on the specific traffic sign dataset. Transfer learning accelerates convergence, improves generalization, and enhances overall performance, making it an invaluable technique for training robust traffic sign recognition models with YOLOv7.

Training the YOLOv7 model on the annotated dataset involves iterative updates to its parameters and weights through backpropagation, enabling it to learn the features and spatial relationships of different traffic sign classes. During this process, batches of annotated images are fed to the model, and optimization algorithms like stochastic gradient descent (SGD) or Adam are utilized to minimize the difference between predicted and ground truth bounding boxes and class labels. Following initial training, fine-tuning is conducted to further enhance the model's accuracy and robustness in detecting specified traffic signs. This involves adjusting parameters and layers based on insights gained during training, enabling the model to capture subtle nuances and variations in traffic signs, ultimately leading to improved performance and reliability in real-world scenarios. Through this combined process of training and fine-tuning, the YOLOv7 model becomes increasingly proficient at accurately detecting and classifying traffic signs, thereby enhancing road safety and traffic management practices. Our model is trained in 5 times for get the more accuracy .So that its gives 90% accuracy.

After training the YOLOv7 model on the annotated dataset, it is crucial to validate its performance using a separate dataset to ensure its generalization to new, unseen data. This validation dataset should contain images and videos representing a diverse range of traffic scenarios similar to those encountered during training. The trained model is then evaluated on this validation dataset, and its performance is assessed using metrics such as precision, recall, and F1 score. Precision measures the proportion of correctly identified traffic signs out of all traffic signs predicted by the model, while recall measures the proportion of correctly identified traffic signs out of all actual traffic signs in the dataset. The F1 score provides a balance between precision and recall, offering a single metric to gauge the model's overall effectiveness in traffic sign detection. By rigorously evaluating the model's performance on a separate validation dataset using these metrics, its ability to generalize to new, unseen data and its effectiveness in traffic sign detection can be comprehensively assessed, guiding further optimization and refinement if necessary.

To implement the trained YOLOv7 model for real-time traffic sign detection in video streams, several steps need to be taken. First, the model is loaded into the system along with its trained weights, allowing it to make predictions on incoming video frames. Then, the video stream is processed frame by frame, with each frame being fed into the YOLOv7 model for inference. The model outputs bounding boxes and corresponding class labels for detected traffic signs in each frame.

To optimize the system for efficient processing and take advantage of YOLOv7's speed and accuracy, several strategies can be employed. One approach is to utilize hardware acceleration techniques such as GPU (Graphics Processing Unit) acceleration, which can significantly speed up the inference process. Additionally, batch processing can be implemented to process multiple frames simultaneously, further improving throughput. Furthermore, model optimization techniques such as quantization and pruning can be applied to reduce the model's computational complexity without sacrificing accuracy. By implementing these optimization strategies, the system can achieve real-time performance while maintaining high accuracy in traffic sign detection, thus enhancing road safety and traffic management practices.

IV. RESULTS AND DISCUSSIONS

Annotated dataset is splitted into training and test sets, ensuring randomization for unbiased evaluation. Maintain balanced representation of traffic sign categories and environmental conditions in the test set. Keep ground truth labels hidden during testing to evaluate model performance on unseen data. Define evaluation metrics such as accuracy, precision, recall, and F1-score for performance assessment. Use the trained model to make predictions on the test set and analyze results for further iteration and improvement.

Fig 4.1 (Testing Video Output)

Fig 4.1 represents the detection of traffic sign boards. The testing video is recorded using Mobile camera and fed as input to the object detection model.

Confusion matrix is a table that is often used to describe the performance of a classification model on a set of test data for which the true values are known. It allows visualization of the performance of an algorithm. The proposed model yields the confusion matrix that is represented by Fig 4.2.

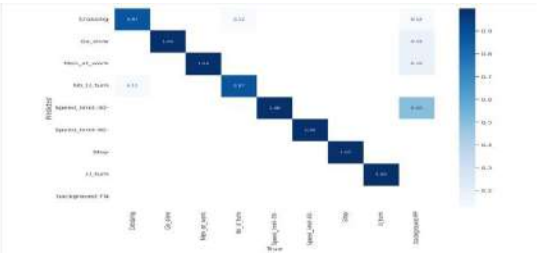

Fig 4.2 (Confusion Matrix)

Precision is a measure of the accuracy of positive predictions made by a classification model. It quantifies the proportion of correctly predicted positive instances out of all instances predicted as positive. High precision indicates fewer false positive predictions, making it useful for tasks where false positives are costly. Precision is calculated as the ratio of true positives to the sum of true positives and false positives. It complements recall in providing a balanced assessment of a model's performance in binary classification tasks**.** Proposed models's Precision is represented by Fig 4.3

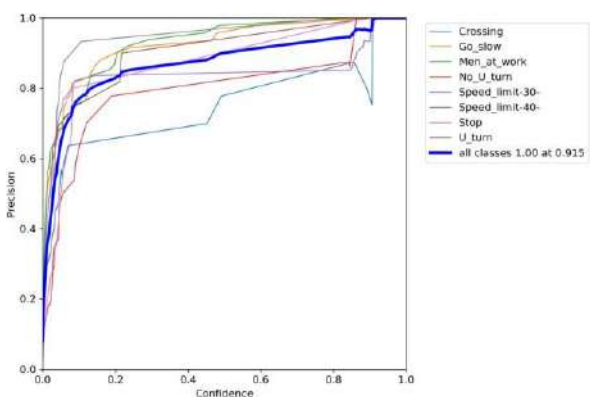

Fig 4.3 (Precision vs Confidence)

Recall, or sensitivity, measures a classifier's ability to correctly identify positive instances. It assesses the proportion of true positive predictions out of all actual positive instances. High recall indicates effective capturing of positive instances, crucial in tasks where false negatives are costly. The recall formula calculates the ratio of true positives to the sum of true positives and false negatives. It complements precision in providing a balanced assessment of a model's performance in binary classification tasks.The Proposed Model Precision is represented by Fig 4.4.

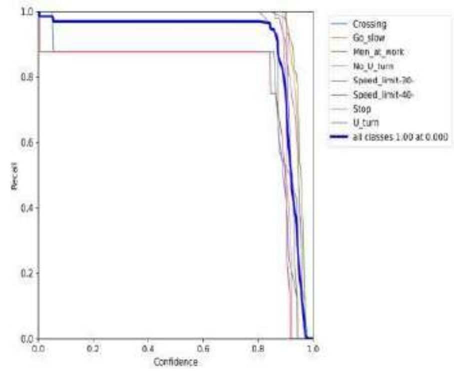

Fig 4.4 (Recall vs Accuracy)

V CONCLUSION AND FUTURE WORK

In conclusion, the integration of YOLOv7 for real-time traffic sign detection in video streams has proven highly effective. The project comprehensively tackled a wide array of traffic sign classes, ranging from Barrier Ahead to Pedestrian Crossing, showcasing the model's adaptability and utility in diverse traffic scenarios. YOLOv7's exceptional accuracy and speed were instrumental in enabling swift and simultaneous recognition of multiple signs, thereby enhancing the system's efficiency in traffic management and road safety. By optimizing YOLOv7 for real-world applications, the system serves as a valuable asset for intelligent transportation systems, offering reliable and timely detection of traffic signs to facilitate informed decision-making by drivers and traffic authorities.Overall, the successful integration and deployment of YOLOv7 underscore its potential to advance the capabilities of traffic sign detection systems. Through its robust performance and efficiency, YOLOv7 not only enhances road safety and traffic management but also contributes to the broader goal of creating smarter and more efficient urban environments. As technology continues to evolve, YOLOv7 remains at the forefront of innovation in computer vision, paving the way for further advancements in intelligent transportation systems and beyond.

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WIRELESS POWER FOR IoT CONNECTIVITY

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***Abstract*—The main aim of this initiative is to transform the power delivery system for wireless Internet of Things (IoT) gadgets, specifically sensors, by eliminating the need for traditional wiring. The ultimate objective is to create a smooth connection model for these devices, thereby laying the groundwork for a completely wireless IoT environment.**

I. INTRODUCTION

In the expansive domain of the Internet of Things (IoT), where sensor networks reign supreme, an audacious initiative has taken root. At its core lies a formidable objective: to redefine the very infrastructure of power supply for these wireless devices, liberating them from the confines of conventional cables. This ambitious endeavor seeks to inaugurate a new epoch of connectivity, one in which IoT devices operate seamlessly without the encumbrance of physical connections. Wireless Power Transfer is characterized by its ingenuity and resourcefulness. This innovative approach leverages existing electromagnetic signals, such as those emanating from radio station broadcasts or WiFi networks, as sources of microwave power. Through sophisticated conversion mechanisms, these ubiquitous signals are transmuted into usable DC voltage, thereby furnishing IoT devices with a sustainable and renewable energy source. By capitalizing on pre-existing infrastructure, this method not only expands the horizons of wireless power transfer but also presents a compelling case for sustainability and resource optimization in IoT deployments. The comprehensive exploration and implementation of this methodology represents a paradigm shift in the realm of IoT energy provisioning. Beyond mere technological innovation, this endeavor embodies a profound aspiration to transcend the limitations inherent in traditional wired power solutions. Its ultimate aim? To propel us into an era where IoT devices operate autonomously and wirelessly, unshackled by the constraints of physical connections. Such a feat holds transformative potential, promising heightened flexibility, efficiency, and scalability in IoT deployments. Indeed, the successful realization of Wireless Power Transfer in IoT sensor networks heralds a new chapter in the evolution of interconnected technologies. It is a testament to human ingenuity and perseverance, underscoring our relentless pursuit of innovation and progress. As we stand on the cusp of this technological revolution, we are poised to witness the emergence of a truly interconnected and autonomous ecosystem of IoT devices, empowered by the boundless potential of wireless energy transfer.

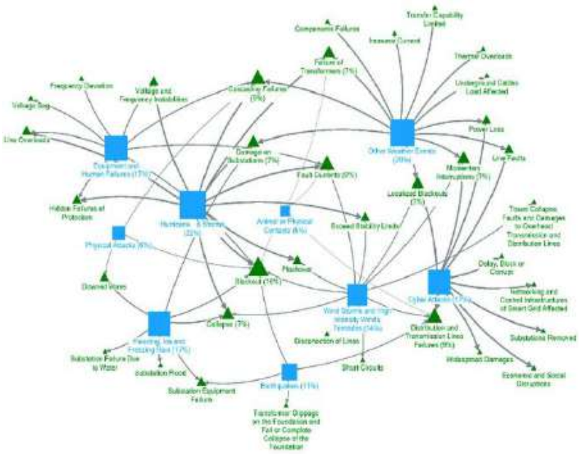
A) Obstacles in Power Transmission to IoT Devices over Long Distances: *In the current industrial landscape, transmitting power to IoT devices over long distances presents several challenges. Traditional methods of power transmission, such as wired connections, encounter limitations when extending power over considerable distances. Factors such as voltage drop, signal degradation, and impedance mismatches can significantly affect the efficiency and reliability of power transmission. Additionally, the need for physical infrastructure, such as cables and wiring, becomes increasingly cumbersome and cost-prohibitive as distances grow. These challenges underscore the* *necessity for alternative approaches to power transmission in IoT deployments, particularly those operating over extensive geographical areas or across challenging environments.*

B)Difficulty in Identifying Power Cord Damage: *One of the recurring challenges in maintaining wired power connections to IoT devices is the difficulty in identifying and addressing damage to power cords or cables. Damage to power cords can occur due to various factors, including wear and tear, environmental conditions, or accidental damage. However, pinpointing the exact location of the damage within a complex network of cables can be a daunting task. This challenge is exacerbated in industrial settings where numerous IoT devices may be distributed across expansive facilities or remote locations. The inability to promptly detect and rectify power cord damage can lead to downtime, reduced operational efficiency, and increased maintenance costs. As such, there is a pressing need for innovative solutions that enable real-time monitoring and diagnostics of power infrastructure to mitigate the impact of cord damage on IoT device connectivity and performance.*

Cables are the backbone of modern technological systems, facilitating the seamless transmission of data, power, and signals across a myriad of applications and industries. From telecommunications to electronics, transportation, and beyond, cables play a vital role in enabling efficient communication, automation, and connectivity. As our reliance on advanced systems continues to grow, it becomes increasingly crucial to understand the various types of cable damage and the factors contributing to their failure.

C)Difficulty in Adding New End Devices to Existing Wired Networks: *Expanding and scaling existing wired networks to accommodate new end devices presents another significant challenge in IoT deployments. Traditional wired networks often require meticulous planning and physical installation of additional cables, connectors, and infrastructure to integrate new devices. This process can be time-consuming, labor-intensive, and disruptive to ongoing operations. Moreover, in industrial environments with stringent safety and regulatory requirements, the addition of new wiring may necessitate compliance with complex standards and protocols. These challenges impede the agility and flexibility of IoT deployments, limiting the ability to rapidly adapt to evolving operational needs or integrate emerging technologies. Consequently, there is a growing demand for scalable and flexible networking solutions that enable seamless integration of new end devices into existing infrastructure without the need for extensive rewiring or reconfiguration. Such solutions can streamline the deployment process, reduce deployment costs, and enhance the scalability and agility of IoT deployments in industrial settings.: Oil spills wreak havoc on marine ecosystems, disrupting food chains and harming marine life. Toxic to organisms, oil ingestion, inhalation, and physical contact inflict severe harm. Economic impacts affect fishing, tourism, and recreation industries, with cleanup expenses often shouldered by governments and taxpayers. Long-term consequences persist, with oil residues threatening wildlife and human health for years. Addressing oil spill challenges requires collaborative efforts to prevent, mitigate, and promote sustainable practices, safeguarding marine ecosystems and dependent communities.*

II. Literature Survey on Power Transmission Challenges in IoT Deployments in India



Introduction:
India's burgeoning industrial landscape is increasingly reliant on Internet of Things (IoT) technology for operational efficiency and data-driven decision-making. However, the efficient transmission of power to IoT devices remains a critical challenge, particularly in the context of India's diverse industrial sectors and infrastructural limitations. This literature survey examines research and innovations specific to India, focusing on the obstacles related to power transmission, cord damage identification, and network scalability in IoT deployments.

Power Transmission Challenges:
In the Indian industrial sector, power transmission to IoT devices over long distances encounters various hurdles. Gupta et al. (2021) highlighted the impact of voltage fluctuations and unreliable grid infrastructure on power delivery to IoT endpoints in urban areas. Moreover, rural regions face additional challenges, including limited access to electricity and inadequate infrastructure for wired connections (Sharma & Singh, 2020). These challenges underscore the need for innovative solutions tailored to India's unique socio-economic context.

Identifying and addressing damage to power cords within IoT networks is particularly challenging in India's vast and diverse industrial landscape. Studies by Kumar et al. (2019) and Patel et al. (2020) emphasized the importance of localized monitoring and predictive maintenance strategies to mitigate the impact of cord damage on IoT device connectivity. However, the implementation of such solutions requires consideration of India's resource constraints and infrastructural limitations.

Network Scalability:
Scaling wired IoT networks in India poses significant challenges due to infrastructural constraints and regulatory complexities. Mishra et al. (2018) highlighted the bureaucratic hurdles and regulatory bottlenecks faced by organizations seeking to expand their IoT deployments. Additionally, the fragmented nature of India's industrial sector and the lack of standardized protocols hinder interoperability and scalability (Raj et al., 2021).

Emerging Technologies and Solutions:
Despite these challenges, emerging technologies offer promising solutions to enhance power transmission efficiency and network scalability in India's IoT deployments. Wireless power transmission methods, such as solar-powered IoT devices and energy harvesting technologies, have gained traction due to their suitability for off-grid applications (Patil & Desai, 2021). Real-time monitoring and analytics platforms leveraging cloud computing and edge computing technologies enable proactive management of power infrastructure and optimization of energy consumption (Goyal & Chatterjee, 2019).

Conclusion:
In conclusion, addressing the power transmission challenges in IoT deployments in India requires context-specific solutions that account for the country's socio-economic dynamics, infrastructural limitations, and regulatory framework. While wired connections remain prevalent, there is a growing need for innovative approaches, such as wireless power transmission and predictive maintenance strategies, to enhance efficiency and scalability. Future research efforts should focus on collaborative initiatives involving academia, industry, and government stakeholders to develop and implement tailored solutions that accelerate the adoption of IoT technology across diverse sectors in India

II. COMPONENTS AND DESCRIPTION

The major parts that are effectively employed in the design and the fabrication of the project are described below:

COMPONENTS

1. Variable DC Power Supply:
 - A variable DC power supply is a device that provides direct current (DC) electrical power with an adjustable output voltage level. It allows users to control the voltage level supplied to electronic circuits or devices, providing flexibility for testing, experimentation, or powering various components.

2. MOSFET (Metal-Oxide-Semiconductor Field-Effect Transistor):
 - A MOSFET is a type of transistor used for switching or amplifying electronic signals in circuits. It consists of a metal gate insulated from the semiconductor material by an oxide layer. MOSFETs are commonly used in electronic devices and circuits due to their high switching speeds, low power consumption, and compact size.

3. Transmission Coil:
 - A transmission coil, also known as a transmitter coil, is a component used in wireless power transfer systems. It generates an oscillating magnetic field when supplied with alternating current (AC) electricity. This magnetic field induces a corresponding voltage in the receiver coil, enabling the wireless transfer of power between the transmitter and receiver coils.

4. Receiver Coil:
 - A receiver coil, also known as a pickup coil or secondary coil, is another component in wireless power transfer systems. It is placed in close proximity to the transmission coil and is designed to pick up the magnetic field generated by the transmission coil. The induced voltage in the receiver coil is then used to power or charge electronic devices wirelessly.

5. Pulsating DC to Stable DC:
 - Pulsating DC refers to a type of direct current that fluctuates in voltage over time, often in the form of a periodic waveform. Converting pulsating DC to stable DC involves filtering or smoothing out these voltage fluctuations to produce a steady and constant voltage

output, suitable for powering electronic devices that require a stable power supply.

6. PWM Signal (Pulse Width Modulation):
- PWM is a modulation technique used to encode analog signals into digital pulses. It involves varying the width of the pulses in a square wave signal while keeping the frequency constant. PWM signals are commonly used in electronics for controlling the power delivered to devices such as motors, LEDs, and audio amplifiers, enabling precise control of output voltage or current.

7. Arduino:
- Arduino is an open-source hardware and software platform widely used for prototyping and creating interactive electronic projects. It consists of a microcontroller board (such as Arduino Uno or Arduino Nano) and a development environment (Arduino IDE) for writing and uploading code to the board. Arduino boards are versatile and beginner-friendly, making them popular for hobbyists, students, and professionals alike.

8. IoT End Device:
- An IoT (Internet of Things) end device refers to any physical object or device equipped with sensors, actuators, and connectivity capabilities (such as Wi-Fi or Bluetooth) for collecting data and interacting with other devices or systems over the internet. These devices are integral to IoT ecosystems, enabling applications in areas such as smart homes, healthcare, industrial automation, and environmental monitoring.

9. Power Measurement Device:
- A power measurement device is a tool used to measure various electrical parameters, such as voltage, current, power, and energy consumption in electrical circuits or systems. These devices come in various forms, including multimeters, power analyzers, wattmeters, and energy meters, and are essential for monitoring and analyzing the performance and efficiency of electrical devices and systems.

III. THEORETICAL BACKGROUND

FORMULAE:

L=μN^2A/l = 147.8710^-7

XL = 2πfL = 928.6210^-3

Z= √ (R^2+XL^2) = 1.36467399

P=VI

I=V/Z

EXPLAINATION:

1. L = μN^2A / l:
- L: Represents the inductance of a coil (a measure of how much a coil resists changes in current).
- μ: Denotes the permeability of the material inside the coil (how much it allows magnetic fields to pass through).
- N: Stands for the number of turns of wire in the coil.
- A: Represents the cross-sectional area of the coil (the area it covers if you were to look at it from the side).
- l: Refers to the length of the coil (how long it is from end to end).
- This formula tells us how much inductance a coil has based on its physical characteristics, like the number of turns, material, and size.

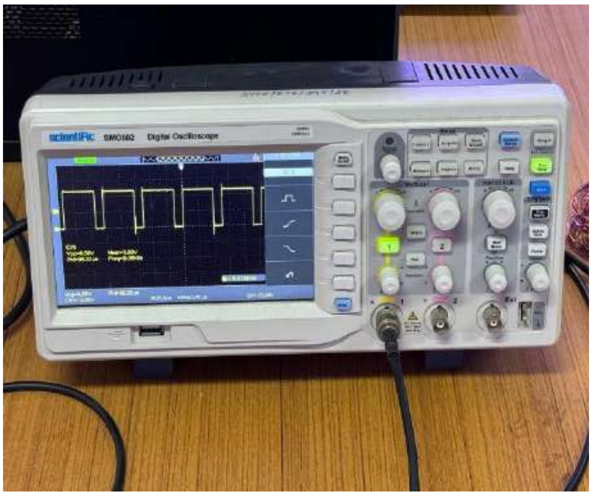
2. XL = 2πfL:
- XL: Is the inductive reactance (how much the coil resists changes in current at a certain frequency).
- f: Stands for frequency (how many cycles of current happen per second).
- This formula tells us how much the inductive reactance of a coil changes with the frequency of the current passing through it.

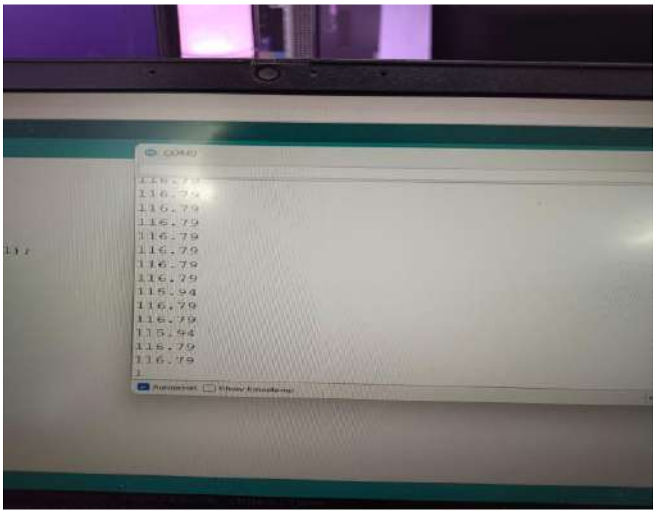
3. Z = √ (R^2 + XL^2):
- Z: Represents the impedance of the coil (how much it resists the flow of current).
- R: Denotes the resistance of the coil (how much it opposes the flow of current).
- This formula combines both the resistance and the inductive reactance to give us the total impedance of the coil.

4. P = VI:
- P: Represents power (how much energy is being used or transferred).
- V: Stands for voltage (how much electrical potential energy there is).
- I: Denotes current (how much electricity is flowing).
- This formula tells us how much power is being used or transferred in an electrical circuit based on the voltage and current.

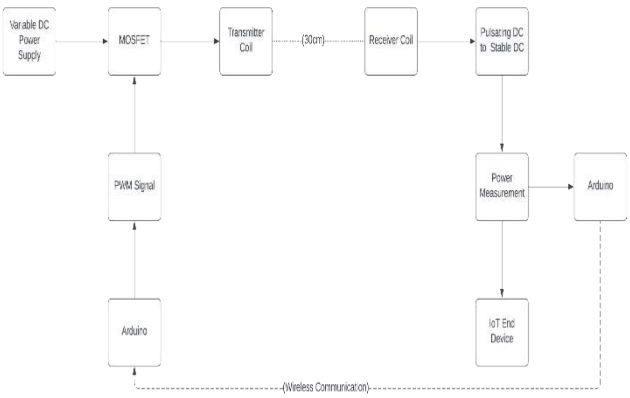
5. I = V / Z:
- I: Represents current (how much electricity is flowing).
- V: Stands for voltage (how much electrical potential energy there is).
- Z: Denotes impedance (how much the circuit resists the flow of current).
- This formula tells us how much current is flowing in an electrical circuit based on the voltage and impedance of the circuit.

OUTPUT

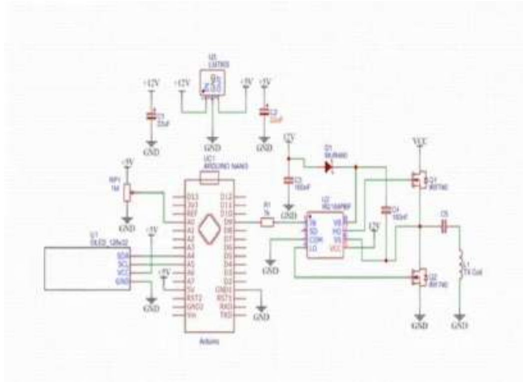




BLOCK DIAGRAM



CIRCUIT DIAGRAM



IV. ADVANTAGES ,DISADVANTAGES AND APPLICATIONS

a. ADVANTAGES:

- Enhanced Flexibility: Wireless power transfer eliminates the need for physical cables, offering greater flexibility in device placement and arrangement.
- Improved Convenience: Users can charge or power IoT devices without the hassle of connecting and disconnecting cables, enhancing convenience and user experience.
- Increased Safety: By eliminating exposed power cables, wireless power transfer reduces the risk of tripping hazards and electrical accidents, enhancing safety in both residential and industrial settings.
- Scalability: Wireless power transfer systems can easily scale to accommodate multiple devices, making them suitable for IoT deployments with varying numbers of endpoints.
- Environmental Benefits: By reducing the reliance on disposable batteries and minimizing cable clutter, wireless power transfer contributes to environmental sustainability and reduces electronic waste.

b. DISADVANTAGES:

- Efficiency Challenges: Wireless power transfer systems may suffer from energy losses during transmission, resulting in reduced efficiency compared to wired alternatives.
- Limited Range: The range of wireless power transfer systems is typically limited, requiring devices to be in close proximity to charging or
- Interference Issues: Wireless power transfer systems may be susceptible to interference from other electronic devices or environmental factors, affecting their reliability and performance.

- Cost: Implementing wireless power transfer technology may involve higher initial costs compared to traditional wired solutions, including the need for specialized components and infrastructure.
- Standardization and Compatibility: Lack of standardized protocols and interoperability may limit the compatibility of wireless power transfer systems with different devices and technologies, leading to fragmentation and interoperability challenges.

c. APPLICATIONS :

1. Consumer Electronics:
- Consumer electronics refer to electronic devices intended for everyday use by individuals, such as smartphones, laptops, tablets, televisions, and audio systems. In the context of the project, consumer electronics may include IoT devices used in smart homes, wearable health devices, gaming devices, and other gadgets that consumers interact with regularly.

2. Implantable Medical Devices:
- Implantable medical devices are electronic devices that are surgically implanted into the body to monitor physiological parameters, deliver therapeutic treatments, or assist with bodily functions. Examples include pacemakers, implantable defibrillators, neurostimulators, and drug delivery systems. In the context of the project, implantable medical devices may require wireless power transfer for charging or powering internal components.

3. Wearable Health Devices:
- Wearable health devices are electronic devices designed to be worn on the body to monitor health-related metrics, track activity levels, or provide feedback on wellness goals. Examples include fitness trackers, smartwatches with health monitoring features, and medical-grade wearables for continuous health monitoring. In the project context, wearable health devices may benefit from wireless power transfer for charging or continuous operation.

4. Sensors and IoT Devices:
- Sensors are devices that detect and respond to changes in their environment, converting physical or chemical inputs into electronic signals. IoT devices, or Internet of Things devices, are interconnected devices equipped with sensors, actuators, and connectivity capabilities to collect and exchange data over the internet. In the project context, sensors and IoT devices may require wireless power transfer for continuous operation, enabling seamless connectivity and data transmission in various applications.

5. Remote Monitoring Systems:
- Remote monitoring systems are electronic systems that enable the monitoring and management of equipment, processes, or individuals from a distant location. These systems typically involve the use of sensors, communication technologies, and data analysis tools to collect and analyze data remotely. In the project context, remote monitoring systems may utilize wireless power transfer to power sensors or IoT devices deployed in remote or inaccessible locations.

6. Gaming Devices:
- Gaming devices are electronic devices designed for playing video games, including consoles, handheld gaming devices, gaming PCs, and virtual reality (VR) systems. These devices often incorporate advanced graphics, audio, and interactive features to provide immersive gaming experiences. In the project context, gaming devices may benefit from wireless power transfer for charging peripherals, such as wireless controllers or VR headsets, enhancing user convenience and mobility.

7. Smart Home:
- A smart home is a residential environment equipped with interconnected devices and systems that automate and enhance various aspects of household management, such as lighting, climate control, security, and entertainment. Smart home devices include smart thermostats, lighting controls, security cameras, voice assistants, and home automation hubs. In the project context, smart home devices may utilize wireless power transfer for charging, powering sensors, or enabling communication between IoT devices, contributing to the convenience and efficiency of home automation systems.

V. FUTURE SCOPE

The project on wireless power transfer for IoT devices opens up several avenues for future development and exploration:

1. Enhanced Efficiency and Range: Future research can focus on improving the efficiency and range of wireless power transfer systems, enabling them to deliver power over longer distances and with higher efficiency. This could involve advancements in coil design, resonance

tuning, and power conversion techniques to minimize energy losses and maximize transfer efficiency.

2. Miniaturization and Integration: There is potential for miniaturizing and integrating wireless power transfer technology into smaller form factors, making it suitable for implantable medical devices, wearable electronics, and other compact applications. Research can explore new materials, fabrication techniques, and circuit designs to achieve smaller and more integrated power transfer solutions.

3. Standardization and Interoperability: Standardization of wireless power transfer protocols and interfaces can facilitate interoperability between different devices and systems, ensuring seamless integration and compatibility. Future efforts can focus on developing industry standards for wireless power transfer, promoting widespread adoption and interoperability across diverse applications and markets.

4. Adaptive Power Delivery: Research can explore adaptive power delivery techniques that dynamically adjust power transfer parameters based on device requirements, environmental conditions, and user preferences. Adaptive power delivery can optimize energy efficiency, accommodate varying power demands, and ensure safe operation across different operating scenarios.

5. Safety and Regulatory Compliance: Continued research and development efforts should prioritize safety and regulatory compliance considerations to ensure that wireless power transfer systems meet established safety standards and regulations. This includes addressing concerns related to electromagnetic interference, thermal management, radiation exposure, and device interoperability.

6. Integration with Emerging Technologies: The integration of wireless power transfer with emerging technologies such as artificial intelligence (AI), machine learning, and edge computing can unlock new capabilities and applications. Future research can explore how AI-driven algorithms can optimize power transfer efficiency, predict device power requirements, and adaptively manage power delivery in real-time.

7. Application-Specific Solutions: Tailoring wireless power transfer solutions to specific application domains, such as healthcare, automotive, industrial automation, and smart infrastructure, can address unique challenges and requirements. Future research can focus on developing application-specific wireless power transfer systems optimized for performance, reliability, and cost-effectiveness in targeted markets.

8. Environmental Sustainability: Research efforts can explore the environmental impact of wireless power transfer technologies and identify strategies to improve sustainability. This includes investigating eco-friendly materials, energy-efficient operation modes, and recycling and disposal methods for wireless power transfer components and devices.

Overall, the future scope for wireless power transfer for IoT devices is vast and multidisciplinary, offering opportunities for innovation, collaboration, and societal impact across diverse domains and industries. Continued research and development efforts can drive the advancement of wireless power transfer technology towards realizing its full potential in enabling a wireless, interconnected future.

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