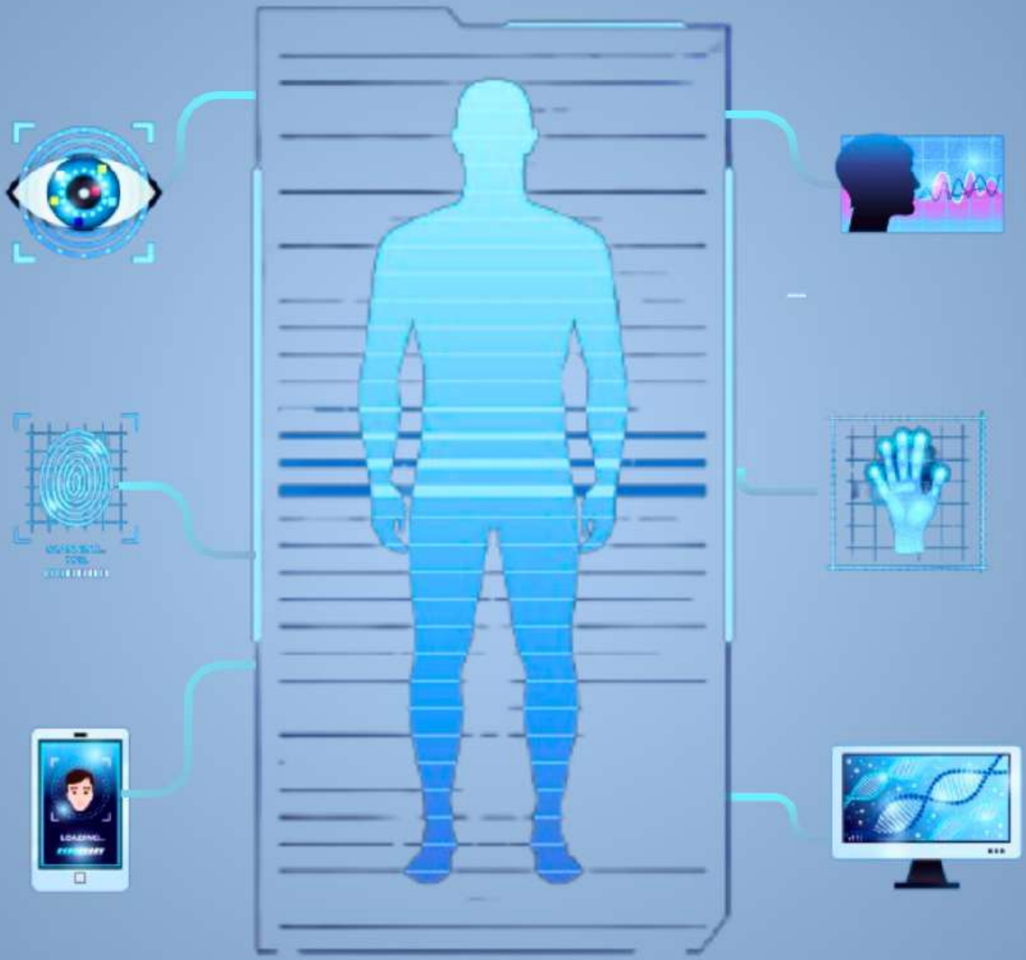
PILLAI COLLEGE OF ENGINEERING

DEPARTMENT JOURNAL

ELECTRONICS AND TELECOMMUNICATION ENGINEERING



HEALTH CARE

DEC 2024 - MAY 2025

FROM PRINCIPAL'S DESK

I am happy to share the continuing efforts of faculty and students in the Electronics and Telecommunication department for their collaborative work in producing an innovative journal. This publication serves as an outstanding representation of the various technological advancements in the field of electronics and telecommunication.

In the fast-paced world of engineering today, ongoing exploration and progress are essential, requiring the utmost creativity. To reach significant objectives, the current generation must discover fresh and inventive methods of learning. I am dedicated to fostering an environment that encourages both academic excellence and creative exploration for our students.

The journal has exceeded my expectations, showcasing the commitment and skill present within the department. I wish the staff and students continued success in all their future pursuits.

Dr. Sandeep Joshi
Principal
Pillai College of Engineering

FROM HOD'S DESK

I am very happy to publish the issues of Department Journal for AY 2024 25 defining characteristic of Pillai College of Engineering, and I take immense pride in the Electronics and Telecommunication department as we unveil the latest issue of our departmental journal. The insightful articles within provide a comprehensive look at the diverse interests present in our department, highlighting the creativity and originality of both our students and faculty.

I would like to express my sincere gratitude to the students for their remarkable commitment and exceptional contributions. Their ability to develop impressive projects while prioritizing cost-effectiveness exemplifies a vital aspect of sustainable practices.

The papers featured in the journal stand as a testament to the hard work and dedication of our students. I commend the journal committee for their efforts in ensuring that the valuable contributions of our students are recognized. As our students embark on various journeys in life, I encourage them to continue exploring innovative solutions.

Wishing all students the very best in their future endeavors.

Dr. Avinash Vaidya
Head of Department
Pillai College of Engineering

FROM TEACHER'S DESK

The annual journal of the Electronics and Telecommunication Department provides an excellent platform for our students to showcase their innovative ideas and proposals. It not only highlights their academic and technical strengths but also serves as a valuable resource for peers and future learners. The efforts of the Journal Committee are truly commendable. Their meticulous planning, organization, and guidance throughout the article-writing process greatly contributed to the success of this edition. Their commitment and timeliness deserve special recognition.

The technical papers featured this year are a reflection of the creativity, insight, and forward-thinking mindset of our students—a promising sign for the future.

I wholeheartedly congratulate the committee and extend my best wishes. I look forward to many more impressive editions of this journal in the years ahead.

Prof.Jayashri Bhosale
Assistant Professor
Electronics and Telecommunication Engineering

VISION AND MISSION

INSTITUTE VISION :

Pillai College of Engineering (PCE) will admit, educate and train in technology, a diverse population of students who are academically prepared to benefit from the Institute's infrastructure and faculty experience, to become responsible professionals. It will further attract, develop and retain, dedicated, excellent teachers, scholars, scientists and professionals from diverse backgrounds whose work gives them visibility beyond the classroom and who are committed to making a significant impact in the lives of their students and the community.

INSTITUTE MISSION:

To develop professional engineers with respect for the environment and to make them responsible citizens, both from a local and global perspective. This objective is fulfilled through quality education, practical training, research, entrepreneurship and interaction with industries and social organizations.

DEPARTMENT VISION:

Strive towards producing world class engineers who will continuously innovate, upgrade telecommunication technology and provide advanced, hazard-free solutions to the mankind.

Inspire, educate and empower students to ensure green and sustainable society.

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Benchmarking against technologically sound global telecommunication institutions with a view towards continuous improvement.

Continually exposing students to scenarios that demand structuring of complex problems and proposing solutions.

Educate students and promote values that can prevent further degradation of our planet.

Becoming responsible citizens genuinely concerned with and capable of contributing to a just and peaceful world.

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To evolve a teaching-learning process where by students have freedom of thought and thereby explore the various aspects of technological development.
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To promote the interaction of students and faculty with the industry.
To collaborate with other leading institutions in India and overseas to gain improvement for the lives of all global citizens.

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Provide graduates with a strong foundation in mathematics, science and engineering fundamentals to enable them to analyze and solve challenging problems in Electronics and Telecommunication Engineering.
Impart analytic and thinking skills to develop innovative ideas in the field of Telecommunication Engineering.
To keep students up to date with the latest advancement in the field of Electronics and Telecommunicatio.Inculcate qualities of leadership skills, multi-disciplinary team work and an ability to adapt to evolving professional environment in the field of Engineering and Technology.
To create awareness among the students towards ethical, social and environmental issues in the professional career.

PROGRAM SPECIFIC OUTCOMES:

Able to understand the concept of Basic Electronics, Network and Circuit Analysis, Analog and Digital circuits, Signals and System, Electro magnetics and apply them in various areas like Microwave Engineering, Wireless Communication, Digital image processing, Advance Communication systems etc.
Able to use techniques, skills, software, equipments and modern engineering tools necessary for Electronics and Telecommunication Engineers to identify, formulate and solve problems in industries and research work.
Able to work in multi disciplinary environment to provide socially acceptable technical solutions for complex communication engineering problems.

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ParalyzeAssist: A Smart Wearable Solution for Paralysis

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Abstract* — Individuals with complete speech loss and limited arm mobility face significant challenges in communication and daily life. Assistive technologies are essential for improving their quality of life. In this research, techniques such as sensor-based health monitoring, gesture-to-voice communication, and clinically intuitive software platforms are explored. Gesture-to-voice communication offers an alternative, non-verbal method for expressing needs, while sensors enable remote health monitoring and encourage physical therapy. Clinically intuitive software allows the storage and analysis of patient data, providing valuable personalized insights. Traditional communication methods, such as writing or using other assistive devices, can be cumbersome, time-consuming, and physically taxing. Additionally, existing health monitoring solutions often lack flexibility and fail to cater to individuals with diverse needs. The chosen approach in this project addresses these limitations by integrating intuitive, user-friendly technology. Gesture-to-voice communication enables a natural and efficient interface, while sensors provide real-time data for better health management. The software platform enhances data-driven decision-making for personalized interventions. This smart glove is designed to empower individuals with speech loss and limited arm mobility by improving communication, health monitoring, and physical therapy engagement.

***Keywords*— Paralysis, Smart Glove, Gesture technology, Healthcare monitoring.**

I. INTRODUCTION

Paralysis affects millions globally, severely limiting their ability to communicate and engage with their environment. In response, ParalyzeAssist introduces an innovative solution that empowers paralysis patients to communicate using intuitive hand gestures. This system is built around a smart glove equipped with flex sensors that detect finger movements. The data is processed through signal processing algorithms, which are implemented on the STM32 microcontroller. The microcontroller serves as the central hub for handling input from sensors, converting detected gestures into audible speech using the APR33A3 voice module. Real-time visual feedback is provided via an integrated LCD display, allowing users to confirm gesture recognition and message output instantly. Additionally, an ECG sensor is incorporated to monitor the user's heart rate, ensuring continuous health monitoring. The STM32 microcontroller enhances the system's performance, offering efficient data processing, seamless integration with other hardware components, and scalability for future upgrades. Through GSM and GPS integration, Paralyze Assist can also notify caregivers or healthcare providers in emergencies, broadening its utility. This solution is aimed at providing a reliable, scalable, and user-friendly platform that fosters independent communication for paralysis patients.

II. RELATED WORK

A. Problem Definition

Individuals with complete speech loss and limited arm mobility face significant challenges in communication, health monitoring, and daily activities. Traditional methods of communication, such as writing or using other assistive devices, are often cumbersome, physically demanding, and time-consuming. Additionally, current health monitoring solutions are not sufficiently flexible to meet the diverse needs of these individuals. As a result, there is a pressing need for intuitive, user-friendly technology that can improve communication efficiency, enable real-time health monitoring, and support physical therapy.

B. Objective

The objective of this research is to develop a smart glove that enables individuals with speech loss and limited arm mobility to communicate effectively through gesture-to-voice technology, while also facilitating real-time health monitoring through embedded sensors. The system will integrate a clinically intuitive software platform to store, analyze, and provide personalized insights based on the patient's data. This technology aims to improve communication, enhance health management, and support physical therapy engagement, ultimately leading to better quality of life for these individuals.

C. Literature Review

The field of assistive technologies for paralyzed patients and individuals with hand paralysis has seen significant advancements in recent years. Researchers have focused on developing smart gloves, robotic systems, and monitoring solutions to improve communication and care for disabled individuals.

Gesture-based communication systems using smart gloves have emerged as a promising solution for individuals with limited mobility. These systems enable users to communicate through hand gestures, providing a more intuitive and accessible means of interaction [1]. The integration of EMG sensing in soft robotic gloves has further enhanced the functionality of these devices, allowing for more precise control and improved hand function for individuals with hand paralysis [2]. Automated monitoring systems have been developed to address the challenges of continuous care for paralysis patients. These systems utilize various sensors and algorithms to track vital signs, movement patterns, and other health indicators, enabling healthcare providers to remotely monitor patients and respond promptly to any changes in their condition [3]. Mobile applications have also been employed to facilitate health monitoring, providing a user-friendly interface for patients and caregivers to track and manage health-related information [4]. Assistive rehabilitation robotic gloves have shown promise in supporting post-stroke patients during their recovery process. These devices aim to improve hand function and dexterity through targeted exercises and assistance during daily activities [5]. Additionally, sign language and voice-based monitoring systems have been developed to cater to the needs of paralyzed and physically disabled individuals, offering alternative means of communication and interaction with their environment [6].
While these advancements demonstrate significant progress in assistive technologies, further research is needed to improve the effectiveness, affordability, and accessibility of these solutions. Future studies should focus on enhancing the integration of multiple technologies, improving user experience, and addressing the diverse needs of individuals with varying degrees of paralysis and mobility impairments.

D. Block Diagram

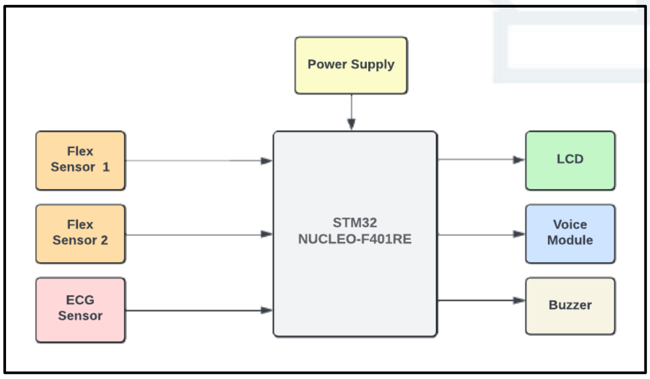

Fig 2.1. Block Diagram

This is the block diagram of the ParalyzeAssist system which shows the flow of the project. It has sensors as input and when all of these go through the STM32 Microcontroller they give various outputs. These outputs will be seen in the LCD.

E. Circuit Diagram

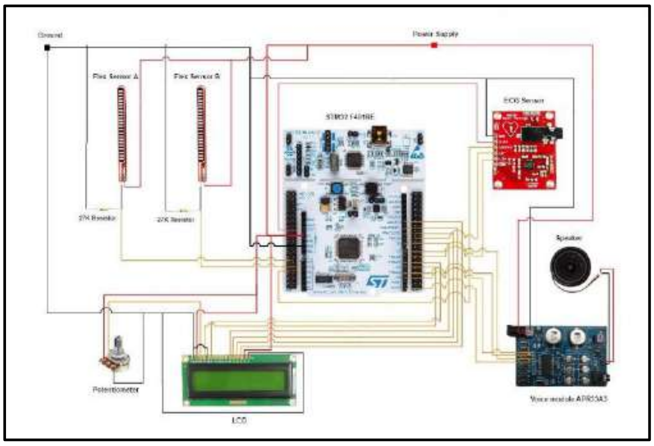

Fig 2.2 Circuit Diagram

F. Components

1) STM32F401RE

The STM32F401RE is a high-performance, low-power microcontroller from STMicroelectronics, based on the ARM Cortex-M4 core. It features 512KB of Flash memory, 96KB of SRAM, and operates at up to 84 MHz, making it ideal for applications requiring efficient processing and low power consumption. It also includes advanced peripherals like ADCs, timers, and communication interfaces (UART, SPI, and I2C).

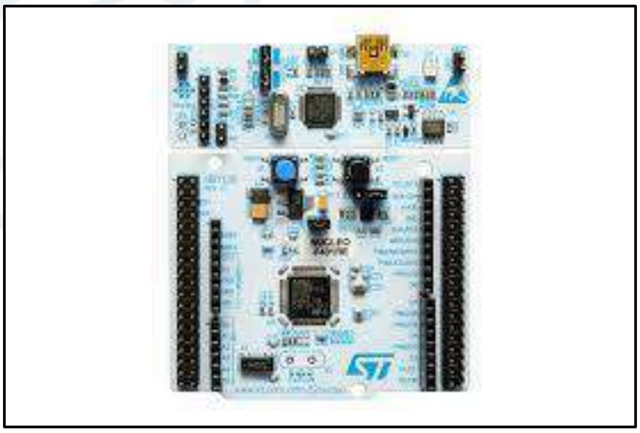

Fig 2.3. STM32F401RE Board

2) Flex sensor

A flex sensor is a resistive sensor that measures the amount of bending or flexing. As the sensor is bent, its resistance increases, allowing it to detect angular displacement. Flex sensors are commonly used in wearable devices, robotics, and motion tracking applications to capture gestures or movements.

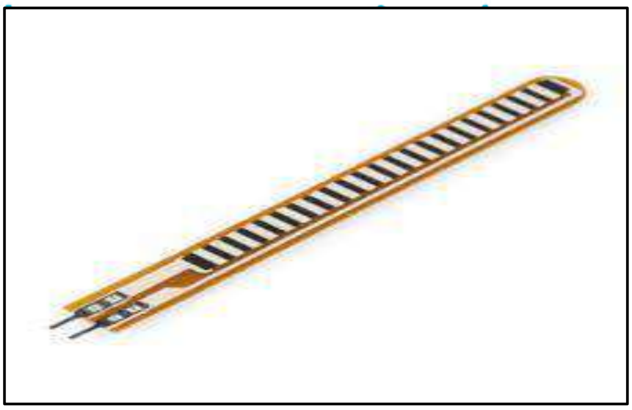

Fig 2.4.Flame sensor

3) AD8232 ECG Sensor

The AD8232 ECG sensor is a compact, low-power integrated signal conditioning block for ECG (electrocardiogram) and heart rate monitoring. It amplifies, filters, and extracts heart signals from noisy environments, making it ideal for wearable health devices. The sensor is commonly used for measuring heart activity in fitness trackers, portable medical equipment, and bio-potential signal monitoring systems.

Fig 2.5. AD8232 ECG sensor

4) APR33A3 Voice Module

The APR33A3 Voice Module is a high-quality, low-cost voice recording and playback module that can store up to 11 minutes of audio. It supports multiple message segments with different durations and allows users to record and play back voice messages directly through onboard buttons or via microcontroller control. This module is commonly used in embedded systems for applications like voice prompts, alarms, or interactive voice responses. It features non-volatile storage, so the recorded audio is retained even when power is lost.

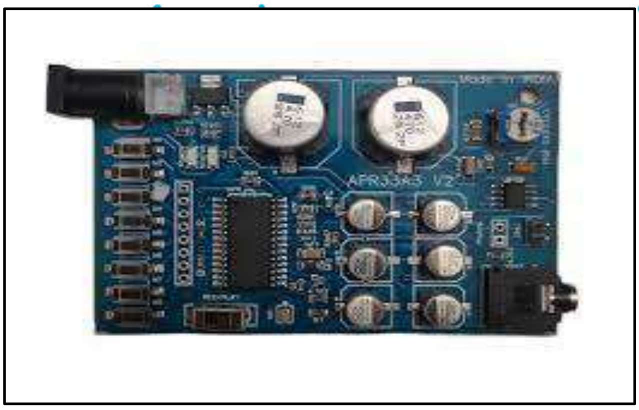

Fig 2.6.APR33A3 Voice Module

5) Speaker

A normal 8W speaker is an electroacoustic device that converts electrical signals into sound using a diaphragm and voice coil within a magnetic field. When the signal passes through the coil, the diaphragm moves, producing sound waves. Speakers are used in devices like audio systems, TVs, and computers to play music or voice. They vary in size and power depending on the application.

Fig 2.8. Speaker

7) LCD Display

A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in a 5x7 pixel matrix. The 16 x 2 intelligent alphanumeric dot matrix display is capable of displaying 224 different characters and symbols. This LCD has two registers, namely, Command and Data.

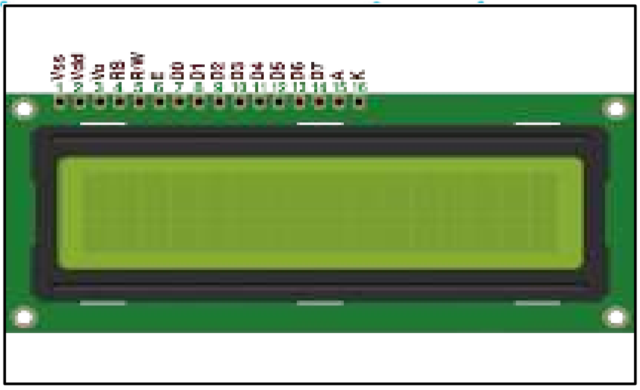

Fig 2.9. LCD 16*2

G. Results

The fig 2.13 shows the entire system of the ParalyzeAssist where the flex sensor, voice module and ECG sensor are integrated with STM32

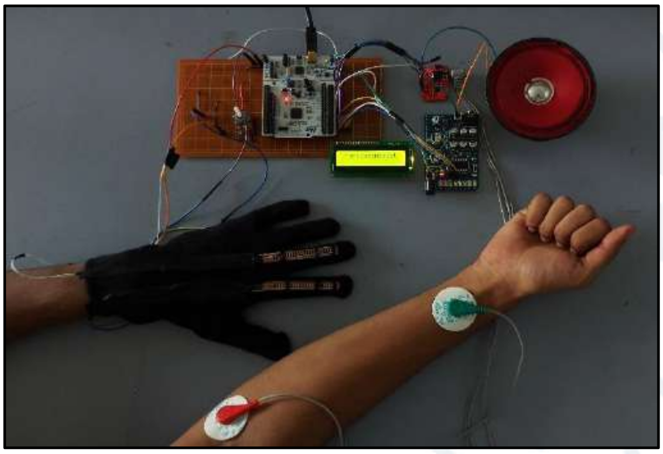

Fig 2.13. ParalyzeAssist System

The fig 2.14 is the output when the there is no bending of fingers and the BPM value is displayed.

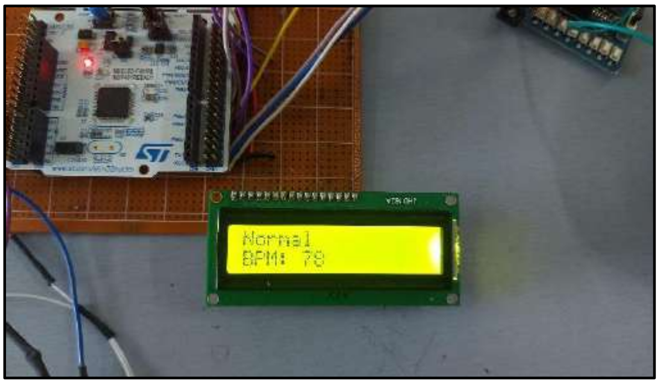

Fig 2.14. Flex and BPM output (no finger is bent)

The fig 2.15 is the output when the index finger is bent.

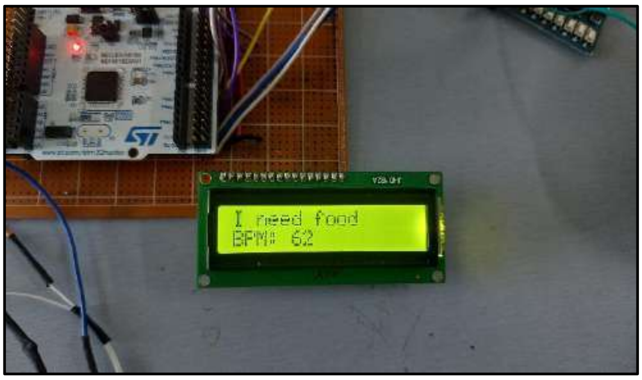

Fig 2.15. Flex A output

The fig 2.16 is the output when the middle finger is bent.

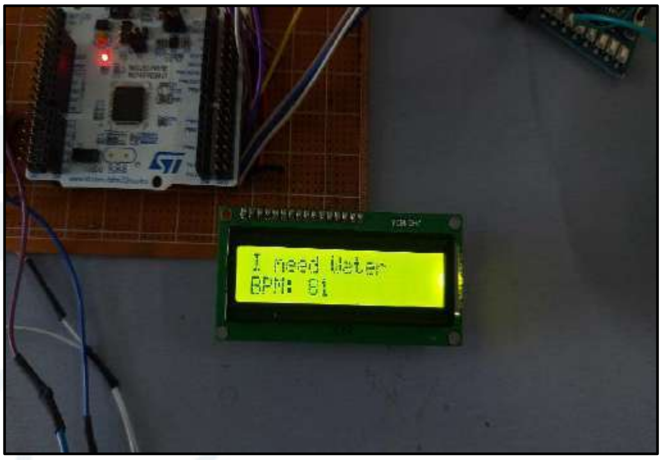

Fig 2.16. Flex B output

H. Applications

1) Enhanced Communication for Non-Speaking, Partially Paralyzed

The Paralyze Assist system allows individuals who have partial paralysis and no speech capability to communicate using gestures. By bending specific fingers, they can convey basic needs like requesting water or food, enabling faster and clearer communication with caregivers.

2)Improved Quality of Life

Patients who are unable to speak or have limited mobility often face challenges in expressing their needs, leading to frustration. This system empowers them with a tool that provides independence in communication, improving their overall well-being and emotional state.

3) Remote Health Monitoring

By integrating health sensors, the system continuously monitors vitals like heart rate, enabling remote health monitoring. This real-time data can be sent to healthcare providers, reducing the need for constant physical visits while still ensuring patients receive timely interventions when necessary.

4) Prevention of Complications Due to Immobility
The system can assist in identifying when patients need help repositioning or moving, preventing conditions such as bedsores or blood clots that may arise from long-term immobility.

5) Customizable Gesture System
While the current system focuses on basic gestures, future expansions could allow the system to learn and adapt to individual users' needs, customizing gestures for more complex commands or integrating with home automation systems.

6) Assistance in Emergency Situations
The system can serve as a valuable tool for patients to alert caregivers or emergency services in critical situations, providing a quick response mechanism when they are unable to speak or move freely.

III. CONCLUSION

The Paralyze Assist system demonstrates an innovative approach to improving the quality of life for individuals with complete speech loss and limited arm mobility. By integrating gesture-based communication, real-time health monitoring, and a clinically intuitive software platform, the system empowers users to express their needs, monitor vital health metrics, and engage in physical therapy more effectively. The smart glove technology offers a non-invasive, user-friendly solution that bridges the gap between traditional assistive devices and modern healthcare technology. As a result, the system not only enhances communication and independence but also supports personalized healthcare interventions, improving overall patient care. Future developments will focus on expanding gesture recognition capabilities, enhancing system responsiveness, and integrating additional health monitoring features to further extend the system's utility in both medical and daily life contexts.

ACKNOWLEDGMENT

We would also like to take this opportunity to express profound gratitude and deep regard to our project guide, Prof. Ishmeet Singh Riar, for his exemplary guidance, valuable feedback, and constant encouragement throughout the duration of the project. His valuable suggestions were of immense help throughout our project work. His perspective criticism kept us working to make this project in a much better way. Working under him was an extremely knowledgeable experience for us. We would like to thank our family and friends who supported us throughout. We would also like to express our gratitude towards our HOD, Dr. Avinash Vaidya for giving us this great opportunity to do a project on Paralyze Assist. Without his support, this project would not have been completed. We would like to thank our principal Dr. Sandeep Joshi for providing all the required facilities in completion of this project.

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Posture Recognition System

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Abstract: Posture recognition systems aim to analyze and interpret the physical stance or positioning of a person using various sensing technologies. This paper presents a framework for developing a posture recognition system that utilizes computer vision, machine learning algorithms, and sensor data to identify and assess the posture of an individual in real-time. The system incorporates advanced techniques like deep learning, feature extraction, and sensor fusion to achieve accurate and robust posture classification. Applications for such systems include healthcare monitoring, ergonomic assessments, and human-computer interaction. By analyzing posture, the system can identify abnormalities, suggest improvements, and potentially prevent posture-related health issues. The study demonstrates the system's efficacy in diverse environments and its potential for use in both clinical and everyday settings.

I. Introduction

A posture recognition system is a technology designed to detect, monitor, and analyze the physical posture of an individual, usually in real-time. These systems leverage various techniques, including computer vision, machine learning, and sensor-based inputs, to assess the alignment and positioning of the body. Posture recognition is often used for health and wellness applications, such as promoting correct posture, reducing the risk of musculoskeletal disorders, or improving ergonomics in the workplace. It can also be applied in sports to optimize performance or in healthcare settings to monitor patients. Key Components of Posture Recognition Systems: Sensors: Wearable sensors (e.g., accelerometers, gyroscopes) or non-wearable sensors (e.g., depth cameras or infrared sensors) collect data about the body's position and movements.Computer Vision: Using cameras (like RGB or depth cameras), computer vision techniques, such as pose estimation, track key points on the human body (like joints, limbs, and head) to analyze posture. Machine Learning: Algorithms are employed to process the data from sensors or cameras. These models are trained on large datasets to recognize different postures and movements accurately. Feedback Mechanism: Once the system detects improper posture, it can provide feedback to the user, often through a visual, auditory, or haptic alert, encouraging correction. Healthcare: Detecting bad posture to prevent injuries such as back pain, Ergonomics: Improving workplace setups to reduce strain from poor posture, Sports: Analyzing an athlete's posture to enhance performance and prevent injuries, Rehabilitation: Assisting in tracking the recovery progress of patients with musculoskeletal or neurological disorders. Overall, posture recognition systems hold great promise in enhancing physical well-being by providing insights into posture and helping individuals make necessary adjustments.

II. Methodology

A posture recognition system typically involves detecting and analyzing human postures or body positions, often using sensors or computer vision techniques. The methodology behind such a system can be broken down into several stages. Here's an outline of a general approach:

1. Data Collection

Sensors-based systems: Data from devices like accelerometers, gyroscopes, or depth sensors (e.g., Kinect) is used to track body movements and angles. Vision-based systems: Cameras (RGB, depth, or infrared) are used to capture images or videos of the person. This data is then processed to identify key body landmarks or skeletons. Data Labeling: If supervised learning is used, labeled datasets of different postures are needed to train the model. This may include a variety of postures like standing, sitting, walking, etc.

2. Preprocessing and Segmentation

Image Preprocessing: If vision-based methods are used, preprocessing may include tasks like noise reduction, color normalization, and image resizing. Segmentation: For vision systems, segmentation is the step where the human body is isolated from the background, often using techniques like background subtraction or edge detection. Pose Estimation: In this step, keypoints (e.g., head, shoulders, elbows, knees, etc.) are detected to form a human skeleton model, which allows the system to understand the positions and orientations of different body parts.

3. Feature Extraction

Keypoint Detection: In a vision-based system, features are extracted by detecting human keypoints (like joints or body parts) using algorithms such as OpenPose, PoseNet, or DeepLabCut. Motion Features: In sensor-based systems, features such as acceleration, angular velocity, and position can be calculated to track the motion and posture of the person. Temporal Features: If the system is analyzing video data, temporal features (movement over time) may be extracted to help distinguish between different postures.

4. Posture Classification

Model Training: Using labeled data, machine learning models (e.g., decision trees, support vector machines, or deep neural networks) are trained to classify different postures based on the extracted features. Deep Learning Approaches: Convolutional Neural Networks (CNNs), Recurrent Neural

Networks (RNNs), or other deep learning methods may be used, especially if temporal information or high accuracy is required. Multimodal Fusion: In some systems, data from both sensor-based and vision-based modalities may be combined to improve the accuracy and robustness of posture recognition.

5. Posture Recognition and Feedback

Recognition: After classification, the system can recognize and output the specific posture the person is in (e.g., standing, sitting, and bending). Real-time Feedback: In some systems, real-time feedback may be provided to the user, such as posture correction alerts or recommendations to improve ergonomics.

6. Post-processing and Analysis

Posture Evaluation: In systems designed to assess the quality of a posture (e.g., for ergonomic monitoring or rehabilitation), post-processing steps might be used to evaluate the correctness or comfort of the posture, based on pre-defined criteria, Visualization: The results may be displayed in the form of 2D or 3D visualizations of the body or posture, helping users understand their body alignment or movement.

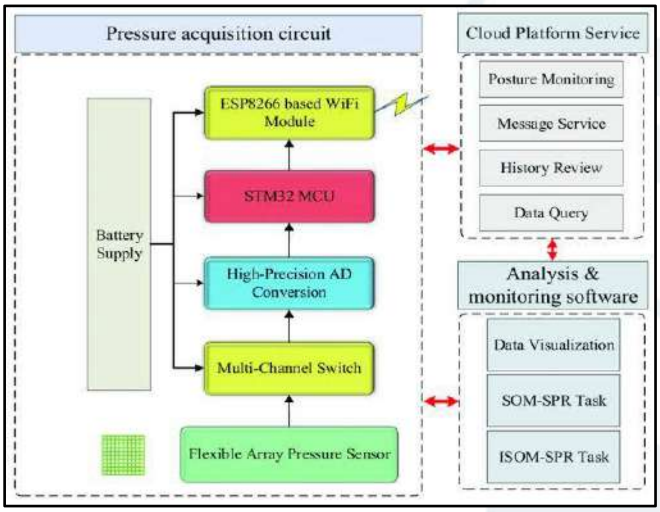

Fig 2.1 System Architecture

III. Design and Development

The design and development of the posture recognition system aims to monitor and analyze a person's posture in real-time, detecting improper postures that may lead to discomfort or injury, especially in workplace environments or for health monitoring purposes. Key Components:

1] Sensors/Devices:

Cameras (2D or 3D): Used for capturing images or videos of the user to analyze their posture. Depth cameras (like Microsoft Kinect or Intel RealSense) provide 3D information that can be used to identify the body structure more accurately.

Wearable Devices (e.g., IMUs): These are sensors like accelerometers, gyroscopes, and magnetometers worn on the body to track orientation and movement. These can give real-time data on the body's positioning.

2] Preprocessing:

Image Preprocessing (for camera-based systems): Images or video frames from cameras are processed to remove noise, adjust contrast, or filter out irrelevant information. Sometimes, background subtraction techniques are used to isolate the subject. Sensor Data Processing (for wearable systems): The raw sensor data from accelerometers and gyroscopes needs to be calibrated and filtered to remove errors and noise., Posture Detection Algorithms: Computer Vision Algorithms: In camera-based systems, machine learning and computer vision methods such as pose estimation, key point detection (e.g., OpenPose, MediaPipe), and human body skeleton detection can be applied to detect the user's posture, Pose Estimation: This refers to estimating the body's keypoints (such as shoulders, elbows, hips, knees, etc.) in a 2D or 3D space. This helps in determining whether the user is sitting, standing, or in another posture, Sensor Fusion Algorithms (for wearable systems): In a wearable-based posture detection system, sensor fusion combines data from multiple sensors (accelerometer, gyroscope, and magnetometer) to accurately estimate the body's orientation and position, Machine Learning Models: These models can be trained on labeled datasets of different postures, and used to classify the user's posture. Supervised learning techniques, such as decision trees, support vector machines (SVMs), or deep neural networks, can be applied here.

3] Posture Classification:

The posture classification system labels different body positions (e.g., sitting, standing, slouching, leaning forward, etc.) based on the data provided by sensors or image analysis. The system must account for variations like sitting on a chair, standing with hands on the hips, leaning to one side, etc. Testing and optimization of the speech recognition system involve evaluating its accuracy with users speaking different languages to ensure robust multilingual support. The NLP model is optimized for improved contextual understanding and response generation, enhancing overall performance. Key challenges such as noise reduction and dialect adaptation are addressed to improve recognition accuracy and user experience.

IV. Hardware Implementation

The hardware implementation of the posture recognition system consists of the following components:

A. Cameras (RGB or Depth Sensors):

RGB Cameras: Standard cameras can capture visual data of a person to analyze their posture through image processing and machine learning techniques. Depth Cameras: Devices like Microsoft Kinect or Intel RealSense capture depth data, providing 3D information about the body's position, which is more accurate for posture analysis than just 2D images.

Fig 4.1 Microsoft Kinect

B. *Infrared Sensors:*

These sensors help in detecting the position and movement of the body by emitting infrared light and measuring the reflected light. This can be especially useful for creating depth maps and detecting postures in low light conditions.

C. *Wearable Wires (IMUs or Motion Sensors):*

Accelerometers, Gyroscopes, and Magnetometers (often in the form of Inertial Measurement Units (IMUs)): These devices, when placed on the body (e.g., on the back, wrists, or waist), measure movement, orientation, and rotation, helping in posture analysis.
Smartwatches: These can be used to track body movements and can help in assessing posture.

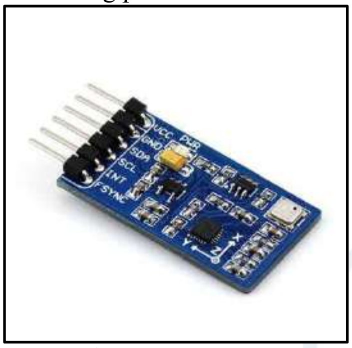

Fig 4.2 Gyroscope

D. *Force Plates:*

These are specialized platforms used to measure force and weight distribution across different body parts. They are often used for more detailed analysis of posture and gait.

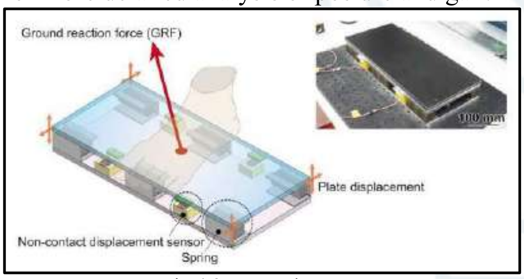

Fig 4.3 Force Plate

E. *Flex Sensors:*

Flex sensors can be used in wearable clothing or accessories to monitor the angle of joints, such as the spine, to provide posture feedback.

F. *Force Sensors:*

These sensors measure the pressure exerted on different body parts, which helps in determining posture, especially in a sitting position. They can be embedded in chairs or mats.

G. *Pressure Sensors:*

Placed in specific areas like a seat cushion or a mat, these sensors detect how the body is positioned, such as whether the user is sitting straight or slouching.

Circuit Connections diagram

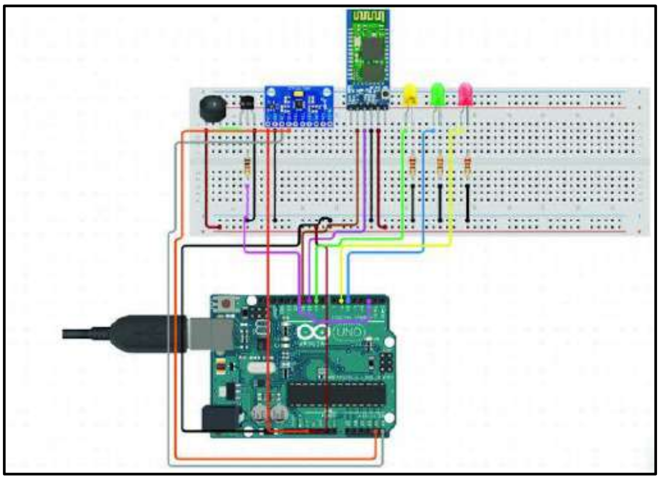

Fig 4. Circuit Connection

Working Mechanism

In a posture recognition system, the circuit connections would typically involve a combination of sensors, microcontrollers, and communication modules that work together to detect and analyze body posture. The exact connections will depend on whether the system uses sensor-based technology, vision-based technology, or a hybrid system (a combination of sensors and cameras). Below is an explanation of the circuit connection for a sensor-based posture recognition system, which is one of the most common types used in wearable devices and health monitoring. optionally, communication modules like Bluetooth or Wi-Fi for transmitting the posture data. The sensors provide data on movement and orientation, which is processed by the microcontroller to determine the user's posture, and feedback is provided either locally or remotely through connected devices.

V. Conclusion

In conclusion, a posture recognition system leverages advanced technologies such as machine learning, computer vision, and sensor data to detect and analyze an individual's posture. The primary goal of such systems is to provide real-time feedback, improve health outcomes, and optimize user experiences in various applications like healthcare, ergonomics, sports, and human-computer interaction. By using data from cameras, sensors, or wearable devices, the system can classify postures, identify potential risks (such as poor posture that could lead to discomfort or injury), and recommend corrective actions. With continuous advancements in artificial intelligence and sensor technologies, posture recognition systems are becoming more accurate and efficient, contributing significantly to improving well-being and performance across different domains. However, challenges like environmental factors, device accuracy, and privacy concerns remain. As technology improves and these challenges are addressed, posture recognition systems are expected to play an increasingly important role in personalized health monitoring, rehabilitation, and prevention of posture-related issues.

VI. Future Scope

The future scope of posture recognition systems is quite promising, and it has the potential to significantly impact various industries and applications. Here are a few key areas where posture recognition systems are expected to grow:

Healthcare and Rehabilitation: Chronic pain management: Posture recognition can help track and correct posture-related issues, reducing the risk of developing chronic conditions like back pain, joint strain, and other musculoskeletal problems.
Physical therapy: It can assist in monitoring and guiding patients undergoing rehabilitation by ensuring they perform exercises correctly and track progress over time.
Aging population: For elderly people, posture monitoring can help prevent falls or detect signs of mobility issues early.
Sports and Fitness: Performance enhancement: Athletes can use posture recognition systems to improve their posture and body alignment for better performance and injury prevention.
Real-time feedback: Coaches and trainers can use posture recognition technology to provide immediate feedback to sathletes during training sessions, helping them refine techniques and form.
Workplace Ergonomics: Reducing workplace injuries: In environments where workers sit for long hours (e.g., office settings), posture recognition systems can alert employees when they adopt poor posture or sit in ways that could lead to discomfort or long-term health issues.
Personalized ergonomic solutions: These systems could be integrated with workplace equipment (chairs, desks, etc.) to provide personalized adjustments for better posture.
Consumer Devices: Smartwear and wearables: The integration of posture recognition with smartwatches, fitness trackers, and clothing could enable real-time posture tracking sposture throughout the day.
Virtual reality (VR) and augmented reality (AR): Posture recognition can be crucial for immersive VR/AR experiences, ensuring users maintain proper body alignment for optimal interaction and to prevent discomfort or injury.
Human-Computer Interaction (HCI):
Gesture control and interaction: In future HCI systems, posture recognition could be combined with gesture control to provide more intuitive ways for users to interact with devices.
Virtual assistants: Virtual assistants could use posture recognition to adjust how they interact with users based on their physical state (e.g., adjusting voice volume if the user is slouched or leaning forward).
Autonomous Vehicles and Driver Safety: Driver monitoring: In self-driving cars, posture recognition could be used to monitor the driver's attention and readiness to take control of the vehicle if needed. It could also ensure the driver maintains a safe posture for optimal reaction times.
AI and Machine Learning Integration: Predictive analytics: Advanced AI models could analyze posture data over time to predict potential health risks or injuries, providing early warnings and suggestions for corrective action.
Real-time adaptive systems: As machine learning evolves, posture recognition systems could adapt in real-time to environmental changes, providing continuous and automatic adjustments based on the user's posture, environment, and activity.
As technologies such as AI, computer vision, and sensor-based systems improve, posture recognition systems will likely become more accurate, accessible, and versatile. They could play a pivotal role in enhancing health, performance, safety, and user experience in numerous fields.

Acknowledgement

This project was supported by Pillai College of Engineering as part of an internally funded initiative, providing us with the necessary resources and platform to explore advancements in voice-controlled automation. We would like to offer our sincere salutations to **Prof. Ruchira Patole, Prof. Suchitra Patil, and Dr. Avinash Vaidya** for their invaluable guidance, encouragement, and continuous support throughout the project. Their expertise and insights were instrumental in shaping the research, development, and successful implementation of this work. We extend our heartfelt gratitude to the entire **Electronics and Telecommunication Engineering Department** for fostering an environment of learning and innovation, which greatly contributed to the depth and quality of this project. Special appreciation goes to our fellow peers and lab staff, whose discussions and technical support helped us refine our approach. We also acknowledge our parents and families, whose unwavering encouragement, patience, and belief in our capabilities played a crucial role in overcoming challenges and achieving project milestones. Their emotional and moral support kept us motivated throughout the journey. This project stands as a testament to collective effort, mentorship, and the spirit of innovation, which has inspired us to pursue further advancements in intelligent automation solutions.

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Soldier Health Monitoring and Position Tracking System

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Abstract--This paper discusses the development of a soldier health monitoring and position tracking system. The proposed system can be mounted on the soldier's body to track their health status and current location using GPS. This information will be transmitted to the control room through IoT. The proposed system comprises of tiny wearable physiological equipment's, sensors, transmission modules. Hence, with the use of the proposed equipment, it is possible to implement a low-cost mechanism to protect the valuable human life on the battlefield. This provides essential data to ensure the soldier's well-being and their exact location in case of emergency situations.

Keywords: Wearable sensors, Health monitoring, Real-time tracking, GPS-based positioning, Biometric sensors, IoT in defense

I.INTRODUCTION

The Indian armed forces, recognized as the third-largest standing army in the world, consist of over 1.2 million active personnel and nearly 1 million reservists. Despite their strength, the army faces significant challenges due to the lack of real- time information about injuries sustained by soldiers, which often leads to preventable deaths or permanent disabilities. It has been observed that a substantial number of casualties in the battlefield arise not directly from assaults, but from the inability to provide timely medical care. The absence of continuous communication with soldiers, especially in geographically challenging environments, further exacerbates this issue.

To address these concerns, a real-time monitoring and tracking system is proposed in this paper, utilizing Raspberry Pi, heart rate and oxygen sensors, a panic button, GPS, and GSM technologies. This system is based on the Internet of Things (IoT) concept, enabling real-time monitoring of vital health parameters and the location of soldiers. By transmitting this data to the control room, immediate action can be taken, reducing the response time in emergencies. The portable and wireless nature of this system ensures that it is not only cost- effective but also reliable, even in adverse battlefield conditions. Section 2 discusses the existing technologies in soldier health and location tracking, while Section 3 outlines the operation of the proposed system. Finally, Section 4 concludes the paper, highlighting future directions for research.

Problem Statement

Soldiers often operate in extreme conditions where their health can be compromised without warning. Without proper monitoring, life-threatening conditions may go unnoticed, resulting in delayed treatment. Furthermore, in the event of an emergency or when a soldier is isolated, knowing their precise location is critical for rescue missions.

The challenge is to develop a robust and reliable real-time health monitoring and position tracking system that continuously monitors vital signs such as body temperature, oxygen levels, and pulse rate, and provides GPS-based location tracking. In critical situations, such as a sudden drop in oxygen levels or body temperature, the system should send immediate alerts to the command center or designated personnel via SMS or a custom user interface.

Objectives:

[1] To monitor a soldier's health parameters, such as body temperature, heart rate, and oxygen levels, in real-time.

[2] To track the soldier's location using GPS technology.

[3] To communicate the data to a base station using GSM technology.

[4] To allow soldiers to send an alert using a panic button when in distress.

II. LITERATURE REVIEW

Several efforts have been made by researchers and academicians to develop systems for tracking the location and health conditions of soldiers on the battlefield. These attempts aim to provide real-time information that can help reduce casualties due to delays in medical response. In the International Conference on Computing, Communication and Automation (ICCCA2017) and other studies, various technologies and methodologies have been explored.[1] In one study, Pavan Kumar et al. proposed a GPS-based system for monitoring soldier health parameters and location tracking using the AT89C51 microcontroller. This system transferred health data to a base unit via GSM technology. Another approach, presented by researchers, utilized ZigBee to transmit health information and location, providing a wireless solution for real-time monitoring.[2] In the International Journal of Soft Computing and Artificial Intelligence (ISSN: 2321-404X), **a** Raspberry Pi-based system was introduced for tracking parameters such as body temperature, respiration, movement, and heartbeat. The collected data were sent to cloud-based servers using IoT technology. Similarly, R. Shaikh et al. designed an ARM processor-based system to monitor vital parameters such as temperature, heartbeat, and ECG. This system used both ZigBee and GSM to send patient updates, enabling immediate medical action

Despite these advances, many of these systems suffer from drawbacks such as high implementation costs, delays in response time, and bulky equipment. To address these challenges, a portable, wireless, real-time system based on iot has been developed, offering a more efficient and cost-effective solution for monitoring soldier health and location on the battlefield. The proposed system aims to overcome the limitations of previous technologies while ensuring quick response times in critical situations. Table 1 provides a comparative overview of the state-of-the-art systems for soldier health and location monitoring.

III. METHODOLOGY

The solider health monitoring and position tracking system retrieves the exact location and the health status of a soldier using sensors and GPS. The system uses oxygen and heart rate sensors to monitor the soldier's health, while the GPS module retrieves the exact location in terms of latitude and longitude. A gas sensor is also used to detect toxic gases in the surrounding environment. All this data is processed by a Raspberry Pi, which controls the system. The GSM module communicates the soldier's health and location information to the base station. Additionally, a panic button allows the soldier to send an alert in emergencies. The Raspberry Pi processes the data from the sensors and GPS, then sends the information via GSM to the base station, where immediate help can be dispatched if needed. This system is very useful for military operations, as it helps monitor soldiers' health and location in real-time, ensuring quick response in critical situations. The system also integrates a temperature sensor to monitor body temperature, ensuring comprehensive health tracking. In critical situations, the system can automatically trigger an alert when abnormal health parameters are detected, reducing the response time for providing medical aid. The use of low-power components ensures the system operates efficiently for extended periods in the field. Data encryption is employed to secure sensitive health and location information during transmission. The system is designed to function in harsh environments, with weatherproof casing to protect the hardware.

Block Diagram

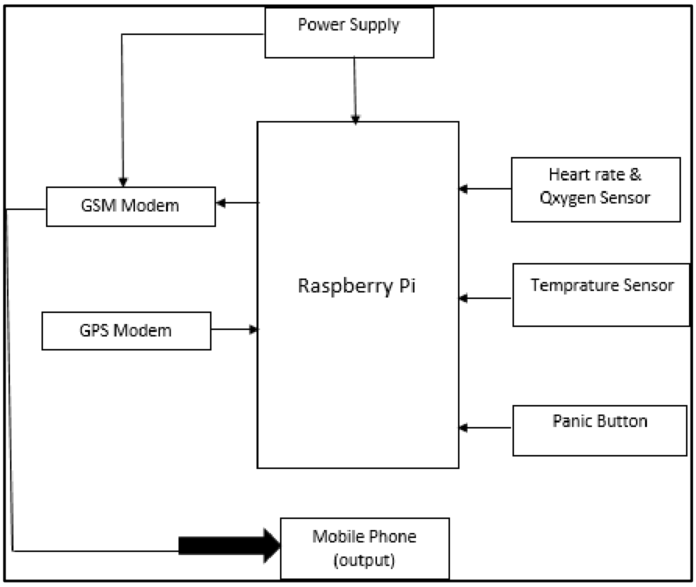

Fig 2.1 Block diagram

The proposed System

The proposed system not only monitors the health of soldiers but also tracks their location using IoT. The control room can access real-time information about the soldier's position and orientation through GPS. In case a soldier loses direction, the GPS will guide them back on track. The base station can continuously monitor the soldier's status as all tracking data is transmitted via a Wi-Fi module. This data is stored on the cloud and can be accessed on a computer at the control room as needed. Based on this information, authorities can quickly send medical help, a rescue team, or backup forces. The system uses various biomedical sensors to monitor a soldier's health, as well as the environmental conditions around them. The system is divided into two parts: the soldier unit and the control room unit. The soldier unit includes sensors like the LM35 temperature sensor, a pulse rate sensor, and an oxygen level sensor to continuously track the soldier's health. The GPS module helps determine their real-time location and orientation.

The data from these sensors and the GPS is collected and processed using a Raspberry Pi. The Raspberry Pi is chosen because it is more powerful than many other processors, offering greater flexibility, higher processing speed, and better interfacing capabilities. It is also a cost-effective option, making it a reliable choice for this system.

The data collected from the sensors is processed by the Raspberry Pi. It is then sent to the control center using the GSM module, which communicates through SMS or GPRS. The system is designed to work efficiently in real-time, ensuring that data reaches the control room promptly.

IV. RESULTS

- ***Health Monitoring***

The system accurately measured and transmitted health data, including temperature, heart rate, and oxygen levels. The temperature sensor worked effectively in detecting sudden changes in body temperature, while the heart rate and oxygen sensors maintained accuracy across different conditions.

Fig 4.1 Health monitoring

- ***Position Tracking***

The GPS module successfully tracked the soldier's location with minimal delay, ensuring real-time updates to the control room. The system was tested in different terrains, and the GPS consistently provided precise location data.

Fig 4.2 Position Tracking

- ***Panic Button***

The panic button feature proved to be effective in alerting the control room in case of emergencies. Once pressed, the button immediately sent a distress signal along with the soldier's location and health data, allowing for a quick response.

Fig no 4.3 Emergency Message

CONCLUSION

This research presents a cost-effective and reliable solution for monitoring soldiers' health and tracking their positions during field operations. The system ensures that critical health data and location information can be transmitted in real-time, allowing for quick responses in emergencies. Future improvements could involve integrating more advanced sensors or wireless communication technologies, such as 4G or 5G, to enhance the system's performance.

V. FUTURE WORK

1. Improved Sensor Accuracy: More precise sensors could be incorporated to further improve the accuracy of health monitoring.

2. Wireless Communication Upgrades: Future iterations of the system could use advanced wireless technologies like 5G for faster data transmission.

3. Additional Features: Further research could integrate advanced monitoring tools such as motion detection or dehydration sensors to enhance the system's utility.

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Smart Helmet for Coal Miners: Real-Time Monitoring Using IoT and Sensing Technologies

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Abstract—India, endowed with substantial mineral resources, faces ongoing challenges in ensuring the safety of its mining workforce, particularly in coal mining, which is fraught with health risks and hazardous conditions. Despite established safety protocols, accidents continue to occur due to factors such as surface warming, methane hydrate leaks, and carbon dioxide emissions. To address these concerns, we propose a Smart Helmet designed for mining safety, equipped with advanced IoT technologies. This innovative helmet integrates a

Comprehensive alerting system and environmental monitoring capabilities, employing smart sensors to detect critical conditions in real-time. Data is transmitted via Wi-Fi networks to a central control room, facilitating immediate response measures. The helmet features an integrated Pi Camera for live video feed, enhancing situational awareness for both miners and supervisors. When hazardous situations are detected, the Smart Helmet Indicator activates an alert system, providing warnings through a buzzer to both the miner and the control room. This paper details the design, implementation, and effectiveness of the Smart Helmet in improving safety protocols in mining operations, ultimately contributing to the reduction of workplace accidents and enhancing the overall safety of miners.

Keywords— IoT, mining safety, smart helmet, real-time monitoring, gas sensors, Raspberry Pi, Pi Camera, Wi-Fi communication.

I. INTRODUCTION

India possesses a vast domestic coal stockpile and ranks among the world's largest consumers of coal. In the fiscal year 2020-2021, the country utilized approximately 906.08 million metric tons (0.99878 billion short tons) of coal, with 79.03% sourced from domestic production [1]. Over the past decade, coal consumption has grown at an annual compound growth rate of 3.96%, underscoring the mining sector's crucial role in meeting this increasing demand. Coal stands as one of the planet's most vital natural resources.

However, frequent accidents in mines pose significant challenges to ensuring the safety of miners, primarily due to a shortage of skilled workers and the inherent dangers of coal extraction. Miners are exposed to a variety of hazardous conditions, including high temperatures, carbon dioxide emissions, and harmful hydrocarbons. Ensuring the safety and security of miners is of paramount importance as mining operations are integral to India's economic development.

While the mining industry is crucial for energy production, mining accidents have tragically resulted in the loss of lives. To mitigate such incidents, leveraging modern technologies—such as sensing devices and embedded processors—can help predict dangerous situations and provide real-time alerts. Continuous environmental monitoring is necessary to address the risks of coal mining, and this paper proposes a Smart Helmet system that monitors working conditions, communicates with a control room, and provides immediate response measures to protect miners.

II. LITERATURE SURVEY

Several efforts have been made to design safety helmets for miners using IoT technologies. For example, Pranjal Hazarika [1] presented a prototype that senses methane and carbon monoxide levels using sensors embedded in a helmet. A wireless XBee module transfers the data to a

Control center, where alarms are triggered when dangerous gas levels are detected. Similarly, Sufia Banu [2] implemented a system that integrates motion detectors, humidity sensors, and biosensors, such as heart rate and SpO2 monitors, to provide comprehensive monitoring of miners' conditions. The system employs wireless communication through Wi-Fi and cloud computing to relay information to a control room in real-time.

Venkatesh Kumar S [3] designed a smart helmet featuring two-way connectivity, capable of detecting hazardous gasses such as carbon monoxide, sulfur dioxide, and nitrogen dioxide. His system used a PIC microcontroller and radio frequency transmitters to send critical information to the control room. Cheng Qiang [4] proposed a helmet system with a Zigbee communication module that could collect real-time production data and send it to a control room for monitoring.

These studies demonstrate the potential of smart helmets for improving mining safety, but they lack the integrated video feed feature, which we address in our proposed system.

III. METHODOLOGY

A. System Overview

The proposed Smart Helmet is an IoT-based device designed to enhance the safety of coal miners. It integrates a variety of sensors to monitor environmental conditions in real time, ensuring miners' safety through early warnings and live monitoring. Key components include gas sensors (e.g., MQ-7), a DHT-11 temperature and humidity sensor, and a Pi Camera for live video transmission.

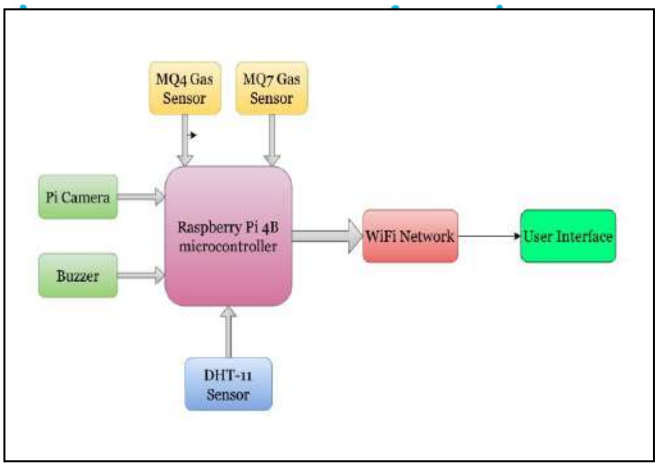

Fig. 3.1. Block Diagram

At the core of the helmet is the Raspberry Pi 4B, which functions as the central processor, collecting and processing data from all sensors. The Pi Camera provides a continuous video feed from within the mine, allowing supervisors in the control room to assess conditions visually.

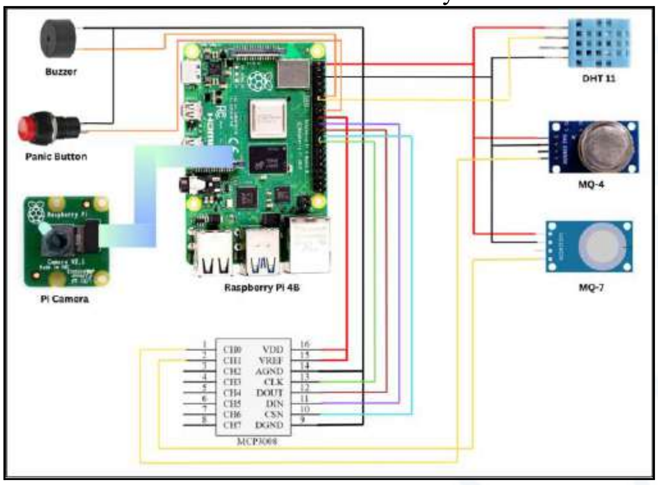

Fig. 3.2. Circuit Diagram

B. Hardware Components

- Raspberry Pi 4B: A versatile single-board computer that processes sensor inputs, manages data transmission via Wi-Fi, and handles video streaming.

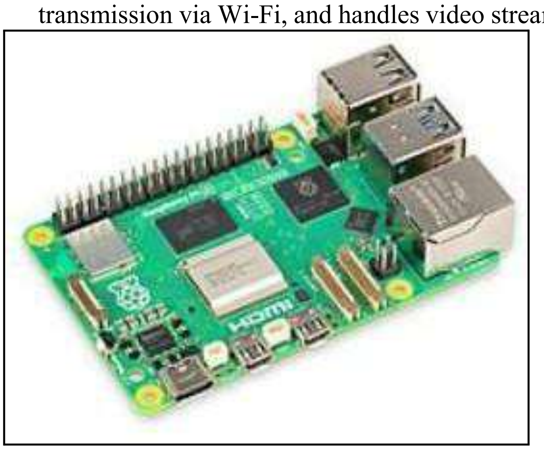

Fig. 3.3. Raspberry Pi 4B

- DHT-11 (Temperature and Humidity Sensor): Monitors environmental temperature and humidity levels within the mine, ensuring that changes in conditions are detected early.

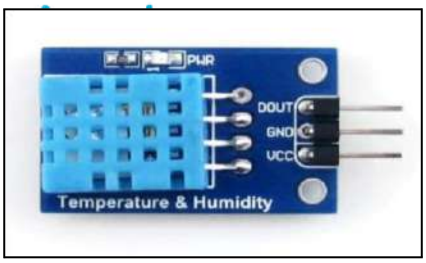

Fig. 3.4. DHT11 Sensor

- MQ-7 (Gas Sensor): Detects the presence of harmful gasses like methane and carbon monoxide, which are common in mining environments.

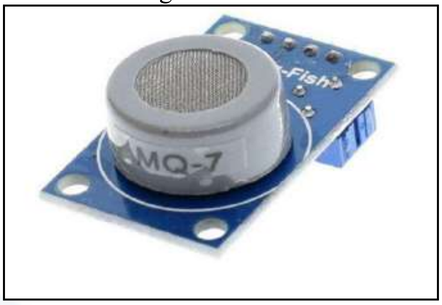

Fig. 3.5. MQ-7 Gas Sensor

- Pi Camera: Captures live video feeds and transmits them to the control room over a Wi-Fi connection.

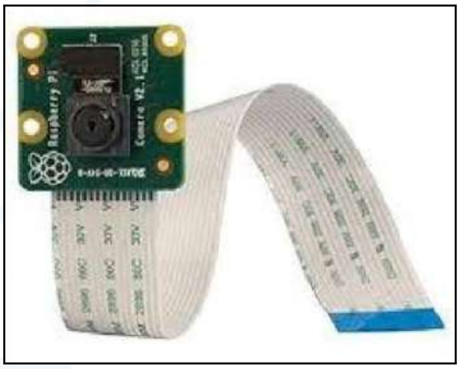

Fig. 3.6. Pi Camera

- Voltage Sensor: Monitors the battery level to ensure that the helmet remains operational during the miner’s shift.

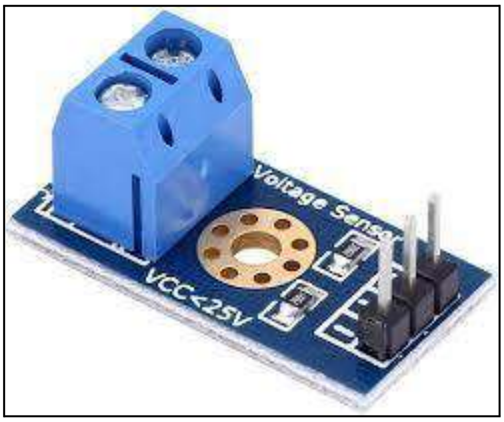

Fig. 3.7. Voltage Sensor

- Buzzer: An audio signalling device like a beeper or buzzer may be electromechanical or piezoelectric or mechanical type. The main function of this is to convert the signal from audio to sound.

Fig. 3.8. Buzzer

C. Software Implementation

We used a combination of tools to support data collection, visualization, and remote management:

- VNC for Raspberry Pi: Allows remote access to the Raspberry Pi, enabling supervisors to control and monitor the system without physically accessing the helmet.
- Flask for Backend Development: Flask, a lightweight Python web framework, handles the processing of sensor data and communicates it to the control room over the internet.
- HTML for Frontend Development: HTML was used to create a user-friendly web interface for displaying real-time data and video feeds.

D. System Functionality

The helmet continuously monitors environmental conditions and sends sensor data to a web server using Flask. In critical situations (such as dangerous gas levels), an alert is triggered. A buzzer on the helmet notifies the miner, while the control room receives a notification through the web interface.

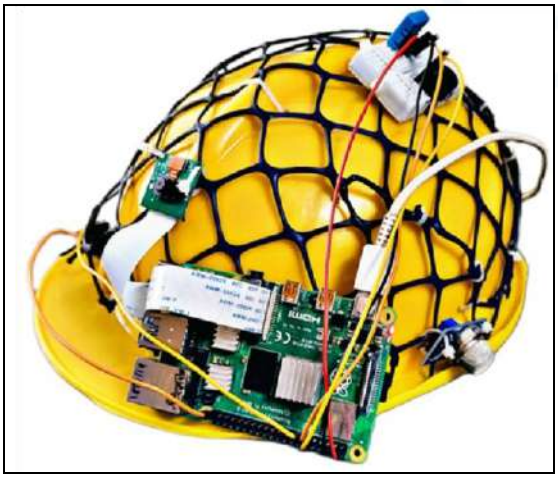

Fig. 3.9. Hardware Implementation of Helmet

Additionally, the Pi Camera provides a live video feed, allowing real-time visual surveillance of the miner's surroundings. This adds another layer of situational awareness for supervisors, helping them make informed decisions during emergencies.

IV. RESULTS

The implementation of the smart helmet has yielded promising results during testing in controlled environments simulating mining conditions. Preliminary trials demonstrated the helmet's effectiveness in accurately detecting hazardous gas concentrations, with the MQ-2 and MQ-7 sensors triggering alerts well in advance of danger levels. The integration of the DHT11 sensor facilitated real-time monitoring of temperature and humidity, allowing for proactive measures to be taken to ensure miner comfort and safety.

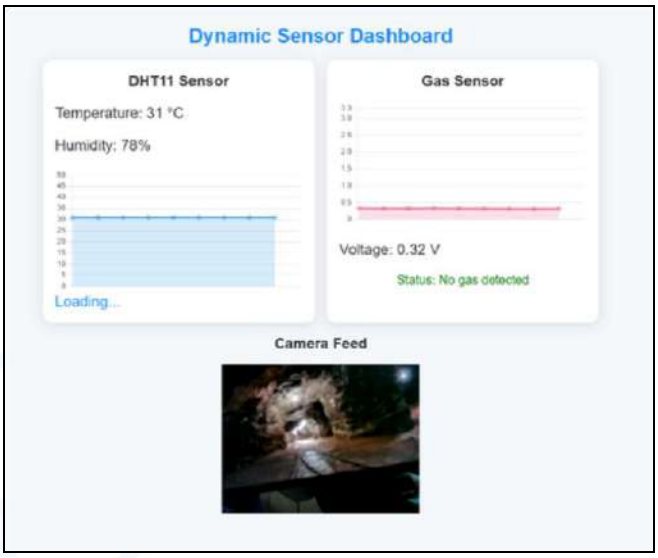

Fig. 4.1. Dashboard Showing Live Sensor Data and Camera Feed (No Gas Detected)

The Pi camera successfully transmitted live video feeds to the control room, enabling supervisors to maintain situational awareness of the mining environment. Feedback from test participants indicated a high level of confidence in the helmet's ability to detect dangers and provide alerts.

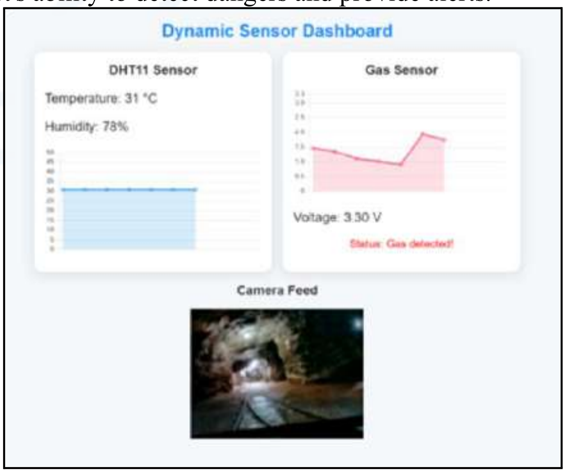

Fig. 4.2. Dashboard Showing Live Sensor Data and Camera Feed (Gas Detected)

However, challenges were encountered regarding the helmet's power consumption, necessitating further optimization of the energy management system to ensure extended operational periods without recharging. The development team is currently exploring energy-efficient alternatives and enhancements to prolong battery life while maintaining robust functionality.

Fig. 4.3. Output when Panic Button is pressed

V. FUTURE SCOPE

Future iterations of the smart helmet will focus on refining sensor calibration for increased accuracy and reliability in detecting hazardous conditions. The team aims to integrate machine learning algorithms to enhance predictive analytics, allowing the helmet to anticipate potential hazards based on historical data and real-time environmental changes.

Additionally, plans are underway to conduct field tests in actual mining operations to validate the helmet's performance under real-world conditions. This phase will involve collaboration with mining companies to gather data on the helmet's impact on worker safety and operational efficiency. The insights gained will inform future enhancements and adjustments to the design.

VI. Conclusion

The smart helmet represents a significant advancement in mining safety technology, leveraging IoT solutions to address the challenges faced by coal miners. By integrating advanced sensing capabilities, real-time monitoring, and immediate alerting systems, the helmet enhances miners' safety in hazardous environments. Continued development and field testing will refine the technology, ultimately contributing to a safer working environment in the mining industry. This innovative approach not only has the potential to save lives but also serves as a model for integrating smart technologies into high-risk occupations.

ACKNOWLEDGMENT

We would also like to take this opportunity to express profound gratitude and deep regard to our project guide, Prof. Harsha Ghadge, for her exemplary guidance, valuable feedback and constant encouragement throughout the duration of the project. Her valuable suggestions were of immense help throughout our project work. Her perspective criticism kept us working to make this project in a much better way. Working under her was an extremely knowledgeable experience for us. We would like to thank our family and friends who supported us throughout. We would also like to express our gratitude towards our HOD, Dr. Avinash Vaidya for giving us this great opportunity to do a project on Smart Helmet for coal miners. Without his support, this project would not have been completed. We would like to thank our principal Dr. Sandeep Joshi for providing all the required facilities in completion of this project.

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