# EMPOWER ASSIST: OFFLINE SPEECH & GESTURE CONTROLLED SMART SYSTEM FOR SAFETY

**A PROJECT REPORT**

*Submitted by*


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**(An Autonomous Institution, Affiliated to Anna University, Chennai)**


**APRIL 2025**

# PANIMALAR ENGINEERING COLLEGE

**(An Autonomous Institution, Affiliated to Anna University, Chennai)**

## BONAFIDE CERTIFICATE

Certified that this project report "**EMPOWER ASSIST: OFFLINE SPEECH & GESTURE CONTROLLED SMART SYSTEM FOR ACCESSIBILITY AND SAFETY**" is the Bonafide work of **"ARUNDHATHI T (211421104028), KALPANA DEVI M (211421104117), KAVYA SRI N (211421104175)"** who carried out the project work under my supervision.

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**INTERNAL EXAMINER** **EXTERNAL EXAMINER**

# DECLARATION BY THE STUDENT

We **ARUNDHATHI T (211421104028), KALPANA DEVI M (211421104117), KAVYA SRI N (211421104175)** hereby declares that this project report titled "**EMPOWER ASSIST: OFFLINE SPEECH & GESTURE CONTROLLED SMART SYSTEM FOR ACCESSIBILITY AND SAFETY**, under the guidance of **Dr. KAVITHA SUBRAMANI,** is the original work done by us, and we have not plagiarized or submitted to any other degree in any university us.

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**ARUNDHATHI T**

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**PROJECT COMPLETION LETTER**

We are glad to inform you that the below mentioned students of **PANIMALAR ENGINEERING COLLEGE,** of **CSE** department has completed their final year project in "**EMPOWER ASSIST: OFFLINE SPEECH & GESTURE CONTROLLED SMART SYSTEM FOR SAFETY**" in our company from **02.01.2025 to 28.03.2025**.

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# ABSTRACT

According to a survey census done by the World Health Organization (WHO) An estimated 1.3 billion people worldwide—approximately 16% of the global population—experience significant disability. Despite these substantial discussions surrounding the safety and support of individuals with disabilities often remain unresolved. To address this critical issue, we propose the development of a system that empowers disabled individuals to control electrical devices without the need for internet connectivity. This system will integrate speech and gesture recognition technologies, enabling users to operate appliances through natural interactions, thereby enhancing accessibility and independence. Additionally, the system will feature an emergency safety mechanism, allowing users to alert caregivers, family members, or neighbors in times of distress. By combining intuitive control interfaces with robust safety features, this project proposes a comprehensive and an efficient solution that aims to improve the quality of life for people with disabilities. The solution offered is a perfect example of an embedded system application with IoT.

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# INTRODUCTION

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# INTRODUCTION

## 1.1 OVERVIEW

Technology has transformed human interaction with electrical appliances, making it possible to control and monitor devices using voice commands and gestures. Automation plays a crucial role in modern life, reducing human effort, saving time, and enhancing convenience. While voice-controlled smart home systems have gained popularity, they often rely on internet connectivity, making them inaccessible in certain situations. To address this limitation, an offline speech and gesture control system is proposed, specifically designed for differently abled individuals.

Differently abled individuals often face challenges in operating conventional switches and controls. A system that can interpret their voice commands and hand gestures without requiring internet access can significantly improve their independence and quality of life. This system utilizes speech recognition modules and gesture sensors, integrated with a microcontroller, to process commands locally. By eliminating the dependency on cloud-based processing, it ensures faster response times, enhanced privacy, and greater reliability in areas with limited connectivity.

The proposed system allows users to control basic household appliances, such as lights and fans, using either voice commands or simple hand gestures. The voice recognition module captures spoken instructions, while the gesture sensor detects predefined movements, translating them into control signals. The microcontroller then executes the appropriate action, such as turning appliances ON or OFF.

This innovation not only enhances accessibility for individuals with disabilities but also provides a **cost-effective and efficient solution**, aiming to empower differently abled individuals.

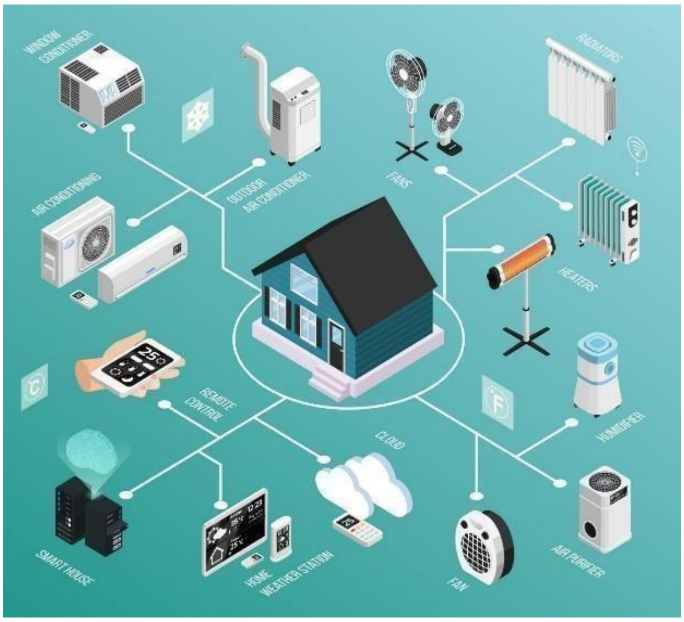



**Fig 1.1: Internet of Things**

## 1.2 PROBLEM DEFINITION

Despite rapid advancements in assistive technology, many differently abled individuals continue to face challenges in independently managing daily activities.

Technologies such as intelligent walking sticks for the visually impaired, sign language recognition systems for the speech impaired, and speech- to-text translation software for the hearing impaired have undoubtedly improved mobility and communication.

However, these innovations often come with inherent limitations, including reliance on internet connectivity, the need for external assistance, or dependence on complex and costly hardware.

These constraints significantly reduce the practicality and effectiveness of such solutions in real-world scenarios, where accessibility should be seamless, autonomous, and universally available.

## 1.3 OBJECTIVE

The primary objective of this project is to design a smart assistance system for differently-abled individuals, integrating offline speech and gesture recognition to control their surroundings with an alert system. The system enhances accessibility, independence, and safety without requiring an internet connection.

The Hands-Free Home Automation system is designed to provide users with a seamless and efficient way to control home appliances without physical interaction. It incorporates offline voice recognition, allowing users to give voice commands to operate lights, fans, and other electrical devices. Additionally, a gesture sensor is integrated into the system, enabling users to control nearby appliances with simple hand movements. This feature enhances accessibility and convenience, especially for individuals with mobility impairments or those who prefer a touch-free experience. The system also ensures an intuitive and user-friendly interface, making interactions smooth and effortless for all users.

The Internet-Free Operation for Reliability feature ensures that the system functions efficiently without depending on an internet connection. This makes it highly reliable in all environments, including remote areas with poor network connectivity. The system utilizes offline speech processing, which enables local command recognition without relying on cloud-based servers. This reduces latency, ensuring instant responses, and enhances privacy by preventing sensitive voice data from being transmitted over the internet. By eliminating internet dependency, the system provides uninterrupted functionality, making home automation more practical and robust.

The Emergency Assistance & Safety System is a crucial feature designed to enhance user safety during emergencies. In case of distress, the system can send an SMS alert with the user's exact location to a trusted contact, ensuring immediate assistance. Additionally, a loud alarm system is integrated to notify caretakers, family members, or neighbors within the vicinity, drawing attention to urgent situations. This feature is particularly beneficial for elderly individuals, individuals with disabilities, and those living alone, as it ensures a real-time response to emergencies, significantly improving overall safety and security.

To further improve accessibility and independence, the Enhancing Accessibility & Independence feature is tailored to assist individuals with mobility impairments and disabilities. The system eliminates the need for physical switches, making home automation more accessible to users who may find it challenging to reach or operate conventional controls. It offers an intuitive and easy-to-use interface, designed with inclusivity in mind, ensuring that users of all ages and abilities can interact with the system effortlessly. By enabling self-sufficient control of the home environment, this feature reduces reliance on caregivers, empowering users to lead more independent lives.

Finally, the Data Logging for Future Analysis feature records all user interactions and system responses, facilitating continuous improvement and troubleshooting. By analyzing recorded data, users and developers can gain insights into usage patterns, device performance, and potential issues. This allows for system customization based on user preferences, ensuring a more personalized experience. Additionally, data logs can help diagnose technical problems, optimize performance, and introduce new features based on user behavior and requirements, making the home automation system more adaptive and efficient over time.

## 1.4 OVERALL IMPACT OF THE PROJECT

The Offline Speech & Gesture-Based Smart Assistance System empowers differently-abled individuals by enabling hands-free control of home appliances and ensuring emergency assistance through an SMS-based alert system as it enhances accessibility, safety, and independence without requiring an internet connection, reducing caregiver dependency.

The project also contributes to inclusive smart home technology, supports elderly care and rehabilitation, and has the potential for future scalability in healthcare and assistive industries.

## 1.5 SCOPE OF THE PROJECT

This project aims to address the challenges faced by differently-abled individuals in interacting with household appliances, smart devices, and emergency systems. By integrating offline speech recognition, gesture-based controls, and an emergency alert system, the solution enhances accessibility, independence, and safety without relying on internet connectivity.

### 1. Hands-Free Smart Home Control

The Hands-Free Smart Home Control system is designed to provide users with a seamless and intuitive way to manage home appliances. It features a user-friendly interface that allows effortless interaction with various household devices, ensuring convenience for individuals of all abilities. The system leverages offline speech recognition, enabling users to operate appliances through voice commands without relying on an internet connection. This not only reduces latency but also enhances security by keeping voice data private. Additionally, for users with speech impairments or mobility restrictions, the system incorporates gesture-based controls, allowing them to interact with devices through simple hand movements. This multi-modal approach ensures that smart home control is accessible to a broader range of users, promoting inclusivity and ease of use.

### 2. Offline Operation for Reliability & Privacy

The Offline Operation for Reliability & Privacy ensures that the system remains functional regardless of internet connectivity. Unlike cloud-based smart assistants that require an active internet connection, this system processes commands locally, resulting in faster response times and greater reliability. By eliminating the need for cloud-based speech processing, it also enhances user privacy, preventing sensitive voice data from being transmitted over the internet, which could be vulnerable to security breaches. Additionally, this feature makes the system ideal for areas with poor network coverage, such as rural locations, remote households, or disaster-prone areas where online smart assistants may fail to function effectively. This guarantees that users can rely on the system at all times without worrying about connectivity issues.

### 3. Integrated Emergency Alert System

The Integrated Emergency Alert System is a critical safety feature designed to provide immediate assistance in times of distress. The system enables users to send distress signals effortlessly, ensuring that help is just a command away. It includes an SMS alert feature that sends the user’s exact location to a trusted contact or caregiver, allowing for prompt action. This is especially useful for elderly individuals, people with disabilities, and those living alone, as it ensures they can quickly request help when needed. Additionally, the system is equipped with a loud alarm feature, which alerts people nearby, such as family members, neighbors, or caregivers, ensuring a quick response to emergencies. This multi-layered approach enhances personal safety by providing both remote and immediate assistance options.

### 4. Enhanced Safety & Independence

The Enhanced Safety & Independence feature is designed to empower users by reducing their dependence on caregivers for routine tasks. By automating household appliances and integrating emergency assistance, the system allows individuals, particularly the elderly and differently-abled, to manage their surroundings independently. In case of emergencies, the system ensures quick access to assistance, improving overall safety and providing users with peace of mind. Furthermore, it plays a crucial role in promoting self-sufficiency by allowing individuals with physical limitations to interact with their environment effortlessly. With intuitive controls tailored for accessibility, users can operate home appliances without physical effort, fostering a sense of autonomy and confidence in their daily lives.

### 5. Practical & Scalable Solution

The Practical & Scalable Solution makes this system a versatile and future-ready approach to home automation. It is designed to be easily expanded by integrating additional smart devices and assistive technologies, ensuring that users can customize the system to suit their specific needs. Beyond individual homes, the system has potential applications in hospitals, elderly care centers, and rehabilitation facilities, where it can assist patients, provide emergency response solutions, and facilitate independent living for those with mobility challenges. Additionally, the system offers a cost-effective and accessible solution for home automation, making it a practical choice for individuals with disabilities who require assistive technology but may have budget constraints. Its affordability and scalability ensure that more people can benefit from its features, improving quality of life across various demographics.

# CHAPTER 2
# LITERATURE SURVEY

# CHAPTER 2

# LITERATURE SURVEY

M. Periša et al, proposed a paper that introduces an innovative approach to assistive technologies for individuals with disabilities. It emphasizes the importance of collecting and storing data in well-structured databases to generate predictive user information based on user profiles. The paper highlights the role of AI and ML in improving accessibility and autonomy by providing predictive insights into user preferences, habits, and potential incidents while also discussing a conceptual mathematical model for generating user-specific information, virtual assistants to manage home devices through speech.

Y. B. Anwaraly et al, developed a system that integrates various hardware components, including a gesture sensor, Bluetooth module, Arduino, LCD display, and a 4-channel relay module to manage devices such as fans, lights, etc. Voice commands and hand gestures are processed via Arduino, activating or deactivating appliances through relay modules. The Bluetooth module allows remote operation via smartphones, enhancing convenience and accessibility. A LCD display provides real-time feedback and status updates, improving user experience with clear and concise information.

N. Chumuang et al, designed an assistance system for aged people using voice commands by implementing speech recognition technology. This system is designed in a way that is useful for elderly individuals and also reduces their labour costs associated with hiring trustworthy caretakers. It also implements the principles of the Internet of Things (IoT) to control various household electrical devices through voice commands. Through Natural Language Processing (NLP), the system interprets voice commands, allowing users to control lights and applications, make phone calls, etc.

R. Manjesh et al, published a paper explores the development and potential of hand and face gesture recognition systems, which use machine learning (ML) and other computer-vision techniques for effective communication and interaction for individuals with physical disabilities. The paper stresses upon the importance of user-centered design and accessibility standards for real-world deployment, emphasizing the significant impact of gesture recognition technology in improving the quality of living.

P. R. Bagane et al, developed a system enhances mobility, safety, and independence by utilizing advanced sensors like ultrasonic and infrared to detect obstacles and hazards in real-time. It provides timely audio and haptic feedback through Bluetooth-enabled earpieces or wearable devices, ensuring users can navigate safely without excessive information. The system also incorporates machine learning techniques to differentiate between stationary and moving objects, and its GPS and voice-command features assist with navigation.

Shresth Agarwal et al, suggested system employs an artificial agent that knows when someone requires assistance and may be engaged without the intervention of a human. The software then uses a voice-to-text module to convert the input speech into text, which will be utilized to carry out the instruction. This voice assistant aims to increase accessibility, independence, and overall quality of life for people with disabilities by utilizing voice recognition and natural language processing technologies. Implements text-to-speech, whereas the Speech recognition component is used directly for command processing.

Irugalbandara I.B.C et al, proposed a paper most systems communicate personal data to cloud services via the internet; however, home automation systems require a consistent internet connection as well as a safe environment free of cyberattacks. Furthermore, because the internet quality index in underdeveloped countries is often low, users of these systems are unable to fully utilize them. This research proposes an offline home automation solution to overcome these issues. The suggested home automation system can work properly even without internet or cloud capabilities. It also has features like electricity tracking and cybersecurity. Offline speech recognition focuses on cyber-security, whereas we focus on immediate assistance for the disabled.

Aswani V et al, published a thesis that discusses the difficulties of communication between handicapped people and those who are not trained in hand gestures, with a special emphasis on the limits of existing hand gesture systems that rely on flex sensors, which deteriorate with time. To address this, the suggested system employs a MEMS sensor to collect hand movements, compares them to pre-recorded voice data, and outputs via an LCD display and speaker. In addition, a GSM module has been added for emergency alerts, which transmit messages to registered numbers when a push button is hit. The device, which is 98% accurate and runs on an Arduino Mega, provides a low-cost, portable solution for converting sign language into voice, allowing impaired and non- disabled persons to communicate more effectively.

Kavitha M et al, researched a paper offers a smart, energy-efficient home automation system that allows for remote control and monitoring of household gadgets via the Internet, employing an Internet connectivity module and a static IP address for wireless communication. The technology improves mobility and provides major benefits to the aged and differently abled people by promoting autonomous living. This home automation solution outperforms existing models by combining IoT and artificial intelligence, allowing common objects to operate as personal helpers in an unobtrusive manner. As sensors and gadgets become smaller and more inexpensive, this system opens the way for a world in which everything is smart and linked.

Ivan Froiz – Miguez et al, developed a system that provides a solution based on Edge Computing and voice commands that performs offline voice processing and can communicate with IoT systems. The suggested system conducts local speech inference and provides a communication interface with IoT devices in a Bluetooth mesh, all in a timely manner and without the requirement for an Internet connection. In addition, the suggested system is easily adaptable for speech recognition, as proven with the Galician language, which is spoken by less than 3 million people globally. The system uses Raspberry Pi 4 for Automatic Speech Recognition and a high-end Android smartphone to analyse data locally utilizing the CPU. This system is an offline voice recognition system that implements Galician, whereas we implement TAMIL and ENGLISH.

Vidhyashri A et al. developed a study on Li-Fi (Light Fidelity), a high-speed wireless communication technology that transmits data using visible light through LEDs, offering advantages such as enhanced security, high speed, and reduced interference compared to Wi-Fi. The system operates by modulating light signals, which are received by a photodiode and converted into electrical signals for processing. With applications in healthcare, traffic management, underwater communication, and aviation, Li-Fi ensures efficient data transmission without electromagnetic interference. Unlike Wi-Fi, which relies on radio waves, Li-Fi provides a more secure and high-bandwidth alternative, making it ideal for advanced communication systems.

Aswatha R et al, proposed a home automation system using Li-Fi (Light Fidelity) technology, offering a high-speed, secure, and interference-free wireless communication alternative to Wi-Fi. Li-Fi uses visible light for data transmission through LED modulation, making it ideal for confined spaces and high-density areas. The system comprises software and hardware components, where a PIC16F877A microcontroller is used for device control. The transmitter side converts input signals into light pulses via LEDs, while the receiver side uses an LDR (Light Dependent Resistor) to interpret these signals and activate devices accordingly. The system supports both data and voice communication, making it a potential solution for smart homes. A comparison between Li-Fi and Wi-Fi highlights Li-Fi's higher security, speed, and efficiency. Applications include education, medical fields, aviation, and underwater communication. The paper concludes that Li-Fi is a promising technology for future wireless communication, offering a greener, safer, and cost-effective alternative to radio frequency-based networks.

Aqeel-ur-Rehman et al, introduced the Voice-Controlled Home Automation System (VCHAS) is designed to control household appliances using voice commands, offering convenience, security, and accessibility, particularly for the elderly and disabled. It consists of three primary sections: Transmission (Handheld Device), which captures and processes voice commands via the HM2007 IC and transmits data via an RF module; Receiving & Control Circuits, which decode the signals, interface with a microcontroller, and execute automation tasks via a buffer, optocoupler, and solid-state relay; and Appliance Control, where devices like fans and lights are controlled in multiple states (ON/OFF, speed adjustments). Testing revealed that the system functions best in quiet environments, with limitations including sensitivity to noise and the need for multiple decoders due to unique address generation per command. Despite these challenges, VCHAS successfully controls appliances like fans and bulbs, with potential scalability to heavier loads like air conditioners. Future improvements aim to enhance portability, simplify circuit design, and expand device compatibility for a smarter home ecosystem.

Perumala Achyuth et al, have explored Sign Language Recognition (SLR) using various approaches, including computer vision and deep learning techniques. Traditional methods relied on hand-crafted feature extraction, such as skin color detection and motion trajectory analysis, which were often limited in handling variations in lighting, background, and hand occlusion. Recent advancements leverage deep learning, particularly Convolutional Neural Networks (CNNs), to automatically extract spatial and temporal features from video streams, improving accuracy and efficiency. Some systems utilize Microsoft Kinect for multi-channel input (color, depth, and skeletal data) to enhance recognition, while others employ transfer learning with pre-trained models like VGG16 and VGG19. Studies highlight challenges such as occlusion, complex hand variations, and real-time performance, which are mitigated using CNN-based architectures combined with advanced preprocessing techniques. Compared to traditional Gaussian Mixture Model-Hidden Markov Model (GMM-HMM) methods, CNNs demonstrate superior performance in recognizing dynamic sign language gestures, making them a promising approach for real-time, sensor-free communication aids for the deaf and mute.

Omar T et al, study explores smart home automation and IoT, emphasizing security and privacy challenges categorized into internal (user-controlled) and external (uncontrollable) threats, such as cyberattacks and power outages. An analysis of 32 security risks found most to be moderate, with high risks linked to human errors and poor programming practices, highlighting the need for stronger security measures. The system developed includes three key modules: Security Monitoring (sensor-based alarm triggering), Power Monitoring (voltage, current, and energy consumption tracking), and Safety Monitoring (detecting water leaks, fire, and smoke). A web-based interface integrates these modules, providing real-time monitoring and device control. The system is modular, scalable, and cost-effective (~$40), though excessive node additions may impact performance. Future enhancements include real-time access control, biometric security (RFID & fingerprint), expanded power monitoring, automated emergency alerts, and long-range communication using ZigBee/XBee. While currently a prototype, the system demonstrates strong potential for commercialization in smart home security, energy efficiency, and automation.

# CHAPTER 3
# THEORETICAL BACKGROUND

# CHAPTER 3
# THEORTICAL BACKGROUND

## 3.1 EXISTING SYSTEM

Most modern voice-controlled home automation systems, such as Amazon Alexa, Google Assistant, and Apple Siri, rely on cloud-based processing, where voice commands are transmitted to remote servers for interpretation. While these systems offer convenience and a wide range of functionalities, they also present several limitations, particularly for differently abled individuals, including the visually impaired. One of the primary concerns is the dependence on a stable internet connection. Since these systems require constant communication with cloud servers, users may experience delays in response times, making the system less efficient for real-time control.

And also, the system becomes entirely non-functional, restricting accessibility for those who rely on it. Another significant issue is privacy and security, as voice data is stored and processed remotely, raising concerns about data breaches or unauthorized access.

Many of these systems provide minimal auditory feedback, making it difficult for users to confirm whether a command has been successfully executed. Moreover, some voice assistants require users to remember specific phrases or navigate complex command structures, which can be challenging for individuals with disabilities. Furthermore, integrating these systems with household appliances often requires additional hardware or technical expertise, making adoption more difficult

The foundation of modern smart home automation lies in replacing traditional bell systems with Internet of Things (IoT)-based solutions. Traditional bell systems were initially designed to summon assistance within homes or workplaces but were limited to basic alert mechanisms. With the advancement of IoT, these systems have evolved into intelligent automation networks that allow users to control appliances remotely through voice commands, mobile applications, or gesture recognition. However, the current reliance on cloud-based processing and the lack of dedicated accessibility features indicate a need for an improved, more inclusive system that operates efficiently even in offline environments.

## 3.2 LIMITATIONS OF EXISTING SYSTEM

- **Dependence on Internet Connectivity** – Requires a stable internet connection, making it unreliable in areas with poor networks.
- **Latency Issues** – Cloud-based processing causes delays in executing voice commands.
- **Privacy and Security Concerns** – Voice data is stored on external servers, increasing the risk of unauthorized access.
- **Limited Accessibility for Visually Impaired Users** – Lacks sufficient auditory feedback and intuitive command structures.
- **Integration Challenges** – Requires additional hardware or complex setups to work with household appliances.
- **High Cost** – Smart home automation systems and subscription services can be expensive.

## 3.3 IMPLEMENTATION ENVIRONMENT

### A. HARDWARE

a) **Microcontrollers:**
One controls the assistive system, and the other manages home automation functions. They process inputs from sensors and execute commands to control appliances.

b) **GSM Module:**
Sends an SMS alert with the user's exact location to a trusted contact during emergencies. It ensures quick assistance without requiring internet connectivity.

c) **LCD Display:**
Shows real-time status updates, such as confirmation of commands or emergency alerts. It provides users with immediate feedback on system actions.

d) **DC Fan & Light:**
Used to demonstrate the system's ability to control household appliances and they respond to voice commands and gesture inputs.

e) **Arduino Microcontroller:**
Supports offline speech recognition and gesture sensing to process user inputs. It enables the system to function without an internet connection.

f) **Voice Recognition Module:**
Recognizes pre-programmed voice commands to control appliances hands-free. It operates offline, ensuring faster response times and data privacy.

g) **Gesture Sensor:**
Detects hand movements to operate electrical devices as an alternative to voice control. It enhances accessibility for users with speech impairments.

h) **Switch:**
Provides a manual control option for users who prefer traditional operation.

It serves as a backup in case voice or gesture recognition is not preferred.

i) **Relay Board:**
Acts as an interface between the microcontroller and high-power devices. It ensures safe switching and prevents short circuits.

j) **Connecting Wires:**
Establish connections between components, allowing smooth signal transmission. They ensure proper integration of sensors, controllers, and actuators.

## B. HARDWARE COMPONENTS

### a. ESP32 MICROCONTROLLER

ESP32 is a low-cost, low-power System on Chip (SoC) microcontroller developed by Espressif Systems, the creators of the widely popular ESP8266 SoC. One of the key advantages of the ESP32 is its integrated RF (Radio Frequency) components, including a power amplifier, low-noise receive amplifier, antenna switch, filters, and RF balun. These built-in components simplify hardware design, reducing the need for additional external circuitry and lowering overall system cost. This makes ESP32 a preferred choice for developers looking for a compact and efficient wireless microcontroller.

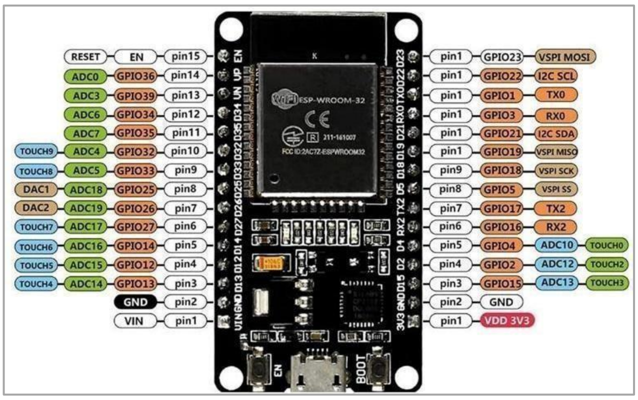



**Fig 3.3.1: ESP32 Microcontroller**

With its robust processing capabilities, extensive connectivity options, and ease of integration, ESP32 has become a versatile microcontroller widely used in home automation, industrial automation, wearable technology, smart agriculture, and other IoT-based applications. Its ability to support both Wi-Fi and Bluetooth simultaneously, along with strong community support and an extensive ecosystem of development tools, makes it a powerful choice for modern embedded systems.

### a. VOICE RECOGNITION MODULE

Voice recognition is a computer technology that recognizes and converts speech signals into editable text or operational commands through analysis. Offline speech recognition sensor is built around an offline voice recognition chip, which can be directly used without an internet connection. It comes with 121 built-in fixed command words and supports the addition of 17 custom command words. The language learning voice recognition module features a dual microphone design with better noise resistance and a longer recognition distance, making it relatively accurate and reliable even in noisy environments.

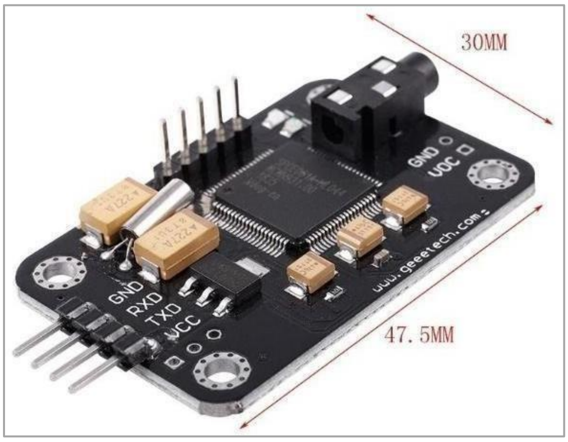



**Fig 3.3.2: Voice Recognition Module**

**SPECIFICATION:**

- Operating Voltage: 3.3 - 5V
- Maximum Operating Current: ≤370 mA (5V)

- Communication: I2C/UART
- I2C Address: 0x64
- Fixed Command: 121
- Fixed Wake-up Command: 1
- Custom Command: 17
- Learning Activation Command: 1
- Onboard Microphone Sensitivity: -28 dB

**b. GESTURE SENSOR MODULE**

A gesture sensor module is a device that detects and interprets hand movements for touchless control of electronic devices. It uses technologies like infrared (IR), time-of-flight (ToF), or capacitive sensing to recognize gestures such as swipes, waves, and rotations. Common modules like APDS-9960 and PAJ7620U2 enable intuitive interaction with smart devices, home automation systems, gaming consoles, and assistive technology for disabled individuals. Gesture sensors enhance accessibility, improve hygiene by reducing physical contact, and provide a seamless user experience in applications ranging from robotics to automotive controls.

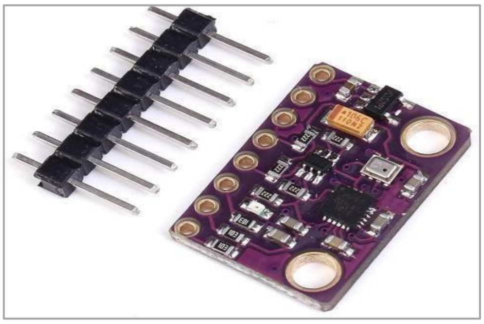


**Fig 3.3.3: Gesture Sensor Module**

## PIN DESCRIPTION

One of the most commonly used gesture sensors includes gesture recognition, proximity detection, ambient light sensing, and color sensing.

| | |
|---|---|
| **1 VCC** | **Power supply (3.3V to 5V)** |
| **2 GND** | **Ground connection** |
| **3 SDA** | **I2C Data** |
| **4 SCL** | **I2C Clock Line (Connect to MCU/Arduino)** |
| **5 INT** | **Interrupt pin** |

## c. RELAY BOARD

A relay is an electromechanical switch which is activated by an electric current. The four-relay board arrangement contains driver, power supply, and isolation circuits. A relay is assembled with that circuit. The driver circuit contains transistors for switching operations. The transistor is use for switching the relay. An isolation circuit prevents reverse voltage from the relay which protects the controller and transistor from damage. The input pulse for switching the transistor is given from the microcontroller unit. It is used for switching of a four device.

## APPLICATIONS

- AC load Switching applications
- DC load Switching applications
- Motor switching applications

**Fig 3.3.4: Relay Board**

## d. LIQUID CRYSTAL DISPLAY

LCD is a type of flat panel display that uses liquid crystals to produce images in colour or monochrome. It is a thin display device that allows displays to be thinner than cathode ray tube (CRT) technology. LCDs consume less power than LED and gas-display displays because they work on the principle of blocking light. They are commonly used in computer monitors, instrument panels, cell phones, digital cameras, TVs, laptops, tablets, and calculators. LCD displays contain a backlight rather than the firing electrons at a glass screen, which offers light to individual pixels arranged in a rectangular grid. The millions of colour combinations can be possible with the help of adjusting individual levels of red, green, and blue light. As LCDs have replaced older display technologies, new display technologies like OLEDs have started to replace LCDs.

## PRODUCT DESCRIPTION

Character LCDs can display characters only and are divided into rows of characters. For example, a 2 by 16 character LCD display has two lines that can display 16 characters each. An example of a 2 × 16 character display is shown below.

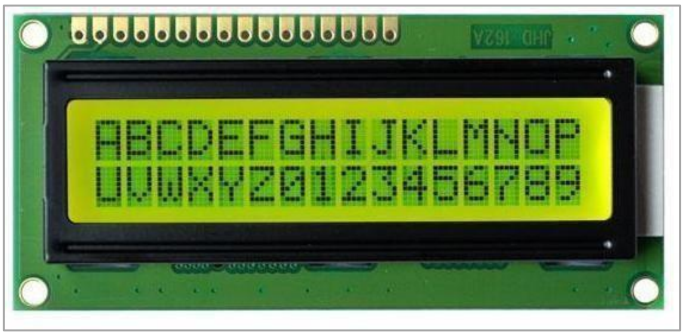



**Fig 3.3.5: Liquid Crystal Display**

## e. DC MOTOR

Geared dc motors can be defined as an extension of dc motors. A geared DC Motor has a gear assembly attached to the motor. The speed of motor is counted

in terms of rotations of the shaft per minute and is termed as RPM .The gear assembly helps in increasing the torque and reducing the speed. Using the correct combination of gears in a gear motor, its speed can be reduced to any desirable figure. This concept where gears reduce the speed of the vehicle but increase its torque is known as gear reduction. A DC motor can be used at a voltage lower than the rated voltage. But, below 1000 rpm, the speed becomes unstable, and the motor will not run smoothly.

## APPLICATIONS:

a) Coin Changing equipment
b) Damper Actuators
c) Fan Oscillators

d) Photocopier

e) Ticket printer

**f. DC FAN**

A DC fan is a device used for cooling purpose in many systems. when a supply is given to a device it starts rotating. The direction of the fan can be changed by reversing the supply. DC or direct current fan works on the principal, when a current carrying conductor is placed in a magnetic field, it experiences a torque and has a tendency to move. The fan has a DC brushless motor, with an operating voltage of 5V, and is rated at 360mA. Keeping the temperature down in your project can often be a necessity, and this fan can definitely help. When designing the electronics that interface to a DC brushless cooling fan, it is critically important to be aware of this behavior.


**Fig 3.3.6: DC Fan**

**g. POWER SUPPLY ADAPTER**

An adapter is a device that converts attributes of one electrical device or system to those of an otherwise incompatible device or system. An electric power adapter may enable connection of a power plug, sometimes called, used in one region to a AC power socket used in another, by offering connections for the disparate contact arrangements, while not changing the voltage. An AC adapter, also called a "recharger", is a small power supply that changes household electric current from distribution voltage) to low voltage DC suitable for consumer electronics. Some modify power or signal attributes, while others merely adapt the physical form of one electrical connector to another. For computers and related items, one kind of serial port adapter enables connections between 25-contact and nine-contact connectors, but does not affect electrical power- and signaling-related attributes.

**APPLICATIONS:**

i. Back-end systems which need to send purchase order data to oracle applications send it to the integration service via integration server client.

ii. SMPS applications.

## C. SOFTWARE AND LIBRARIES

### a) Arduino IDE:

The NodeMCU is programmed using the Arduino IDE. To enable this, the ESP8266 board support must be installed in the IDE.

### b) Arduino Libraries:

Libraries are needed to interface with voice recognition modules, gesture sensors, and the GSM module for communication. Installing these ensures smooth functionality.

### c) NodeMCU Firmware:

Keeping the NodeMCU firmware updated is essential for stability, security, and compatibility with the latest software libraries.

#### d) Programming Language:

The system can be programmed in C, C++, or Python, depending on the project needs. C/C++ is commonly used for microcontrollers.

### D. DEPENDENCIES

#### a. Wiring and Connections:

Proper wiring and connections are essential for the reliable operation of the system. Each sensor and relay must be connected to the appropriate GPIO pins on the NodeMCU according to their specifications. Additionally, ensuring a stable power supply to the NodeMCU, Arduino, and other components is critical to prevent malfunctions. Sensors should be connected to analog or digital pins based on their requirements, ensuring accurate data acquisition and response. Proper wiring practices help prevent short circuits and ensure long-term system stability.

#### b. Testing:

Before deployment, thorough testing must be conducted to ensure system reliability. By monitoring the serial output, developers can debug the code, check sensor readings, and identify any issues in the system. It is crucial to test the system under various conditions, including different lighting environments, distances, and response times, to validate its effectiveness. Comprehensive testing helps identify potential failures early, allowing for adjustments before full deployment.

#### c. Deployment:

Once testing is successful, the system can be deployed in the target environment. Proper sensor mounting is crucial to ensure accurate readings and efficient functionality. Sensors should be placed in strategic positions for optimal performance. After deployment, regular monitoring and maintenance are necessary to keep the system running smoothly. Checking for firmware updates, inspecting wiring connections, and troubleshooting potential issues ensure long-term reliability and efficiency.

## E. SOFTWARE COMPONENTS

### a. ARDUINO IDE

The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards. The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.


**Fig 3.3.7: Arduino IDE**

## b. EMBEDDED C

Embedded C is a specialized programming language used for developing software in embedded systems, including Internet of Things (IoT) devices. It is an extension of standard C language with additional features to interact with hardware, such as memory manipulation, real-time processing, and direct register access.

In IoT applications, Embedded C is commonly used to program microcontrollers

(e.g., ESP32, Arduino, STM32, PIC), enabling devices to process data, communicate over networks (Wi-Fi, Bluetooth, LoRa), and control sensors and actuators efficiently. It provides low-level hardware access, making it ideal for power-efficient and resource-constrained IoT devices.

### KEY FEATURES OF EMBEDDED C

- ✓ **Real-time processing** – Ensures quick response to sensor inputs.
- ✓ **Hardware interaction** – Directly controls microcontrollers, sensors, and actuators.
- ✓ **Low power consumption** – Optimized for battery-operated IoT devices.
- ✓ **Communication protocols** – Supports UART, SPI, I2C, MQTT, HTTP, Bluetooth, and Wi-Fi for IoT connectivity.

```c
#include <stdio.h>
#define FOO 0x0010
int first_var;
int* second_var;

void procedure(int input) {
    if (input >= 42) {
        first_var = first_var + 10;
        procedure(first_var);
    }
}

int main() {
    first_var = 0;
    second_var = (int*) FOO;
    procedure(*second_var);
    printf("%d", first_var);
}
```

**Fig 3.3.8: Embedded C**

### c. MS EXCEL

Microsoft Excel is a powerful spreadsheet software developed by Microsoft that allows users to store, organize, analyze, and visualize data efficiently. It is widely used for performing calculations, creating charts, managing records, and automating tasks using formulas and macros. Excel is part of the Microsoft Office suite and is available for Windows, macOS, and cloud-based platforms like Microsoft 365.

### ADVANTAGES

i. Easy to use
ii. Supports Data Visualization
iii. Includes several functions for complex calculations.
iv. Widely Used & Industry Standard

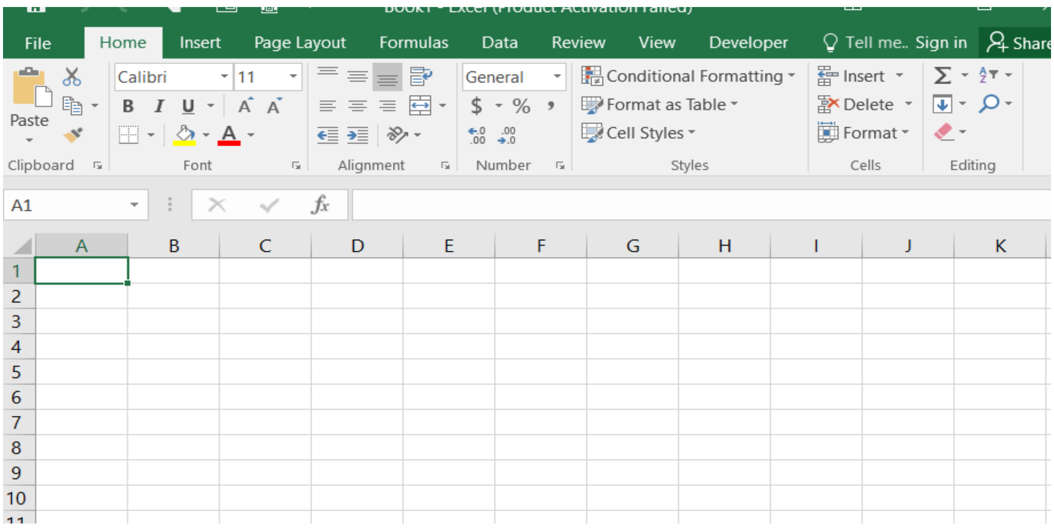



**Fig 3.3.9: MS Excel**

## d. IOT BEGINNER WEBSITE/APPLICATION

IoT Beginner is a platform dedicated to educating individuals about the **Internet of Things (IoT)**, providing resources and insights to help users understand and engage with IoT technologies.

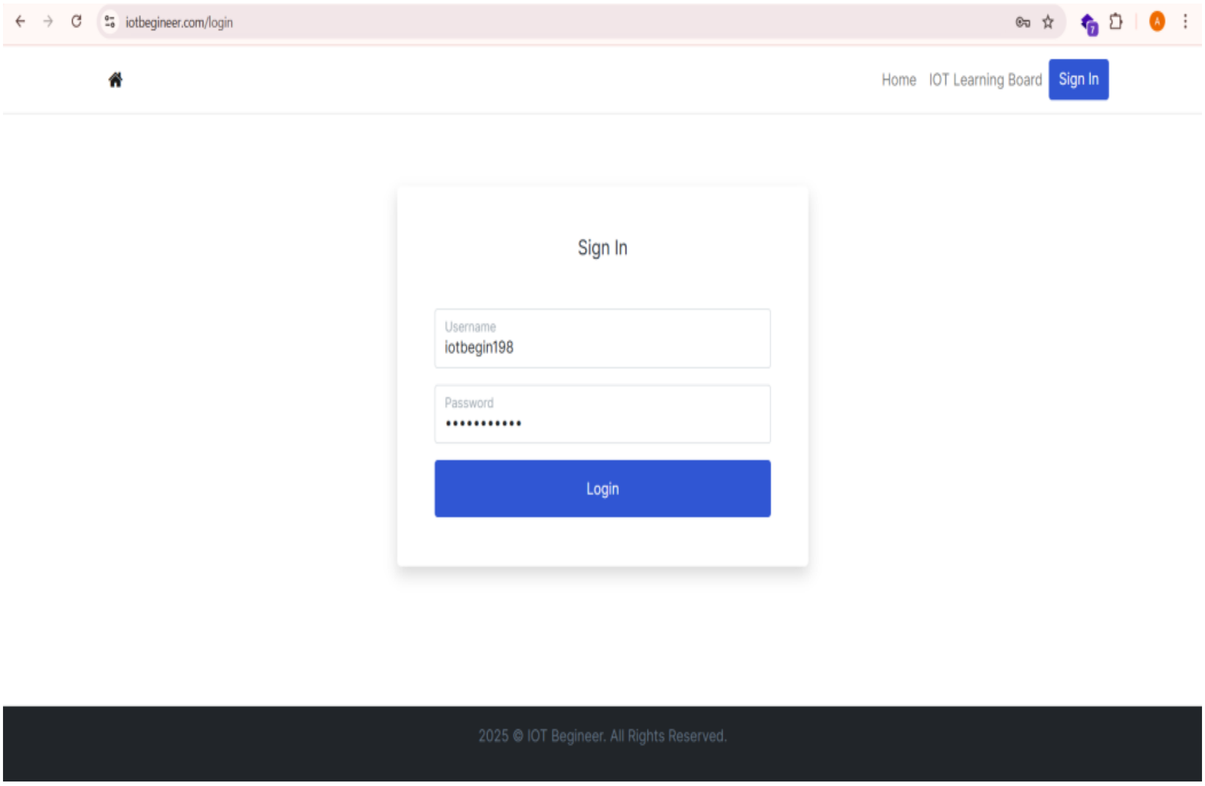



**Fig 3.3.10: IOT Beginner Website**

## 3.4 SYSTEM ARCHITECTURE

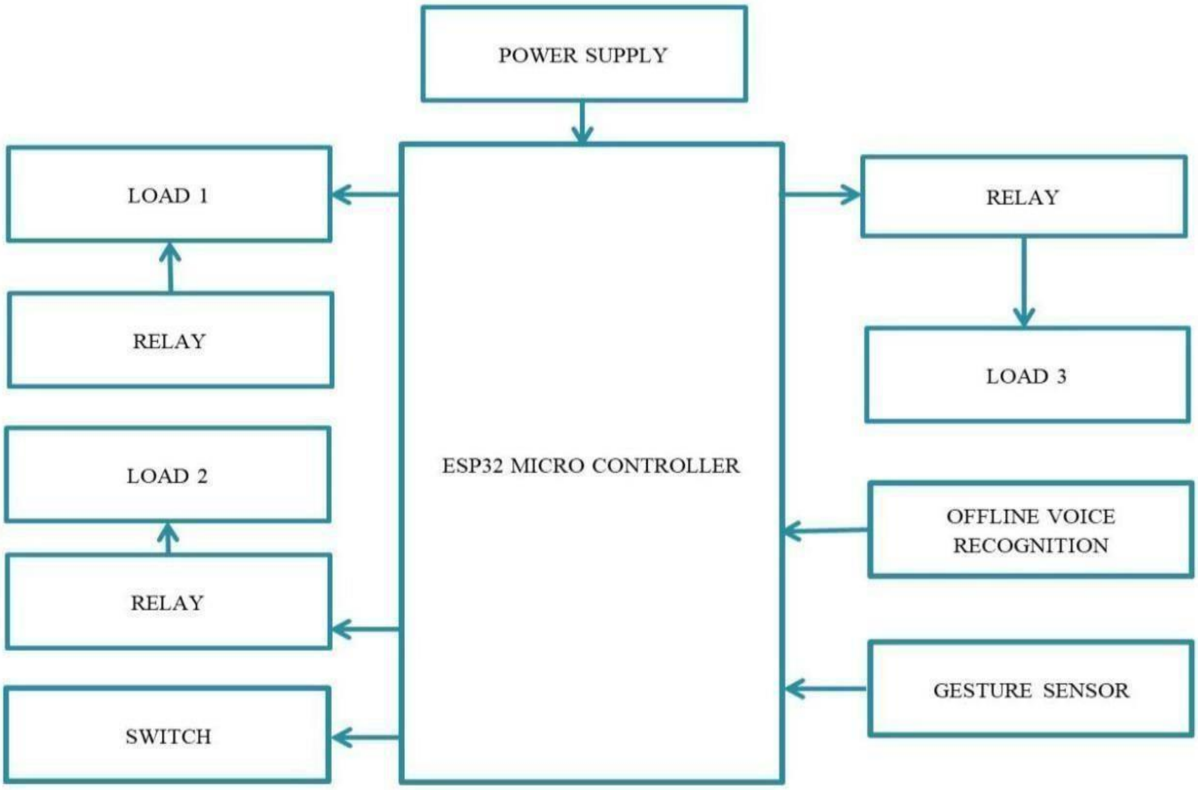



**Fig 3.4.1: Architecture Design**

## 3.5 PROPOSED METHODOLOGY

The system implements a gesture- and offline speech-based system that enables differently abled individuals to interact seamlessly with their surroundings.This system provides two primary modes of control:

1. **Offline Speech Recognition** – Users can operate household appliances using voice commands without requiring an internet connection. Unlike conventional smart assistants that depend on cloud processing, this system uses an embedded voice recognition module, ensuring that commands are processed locally. This approach guarantees faster response times, enhanced privacy, and improved reliability, making it a more practical alternative for real-world applications.

2. **Gesture-Based Control** – For individuals who are unable to speak or prefer a non-verbal communication method, the system incorporates gesture recognition technology. A gesture sensor detects predefined hand movements and translates them into control signals, allowing users to interact with devices intuitively and effortlessly.

The proposed system is designed to assist blind and differently-abled individuals by enabling voice-activated and gesture-based control of household appliances. It operates without an internet connection, ensuring privacy, low latency, and reliability while providing an intuitive and accessible interface.

**1. Offline Voice Recognition for Hands-Free Control**

- Uses an offline voice recognition module to recognize and execute predefined commands.
- Allows users to record commands such as "Turn on the fan" or "Switch off the light."
- Works without an internet connection, ensuring fast and private processing.

**2. Gesture Sensor for Alternative Control**

- A gesture sensor detects specific hand movements to control appliances.
- Allows users to turn devices on/off, adjust fan speed, or dim lights without voice input.
- Provides an alternative for individuals with speech impairments or noisy environments.

**3. Microcontroller as the Central Processing Unit**

- The microcontroller processes inputs from both voice recognition and gesture sensors.
- Sends signals to relays to control electrical appliances efficiently.
- Ensures smooth execution of user commands with minimal power consumption.

**4. Home Automation for Accessibility**

- The system enables users to control home appliances such as lights, fans, and other devices.
- Enhances accessibility for differently-abled individuals by reducing dependence on physical switches.
- Can be expanded to support additional home automation functions.

**5. Emergency Alert System for Safety**

- Integrates a GSM module to send an emergency alert SMS with the user's location.
- Alerts a trusted contact or caregiver in case of emergencies.
- Enhances security by ensuring quick response during critical situations.

**6. Privacy and Security of User Data**

- All data is processed locally, eliminating risks associated with cloud-based systems.
- No personal voice recordings are sent over the internet, ensuring enhanced privacy.
- The system is protected against unauthorized access to prevent misuse.

**7. Energy-Efficient and Uninterrupted Operation**

- Designed for low power consumption, making it cost-effective and efficient.

- Can be powered by a rechargeable battery or a direct power supply.
- Ensures continuous operation even during power failures.

**8. User-Friendly Interface for Easy Operation**

- Simple setup process allowing users to record their own voice commands.
- Easy-to-use LCD display provides status updates and system feedback.
- Minimal learning curve, making it accessible for elderly and disabled users.

**9. Scalable and Customizable System**

- Can be expanded to integrate with smart home devices, medical alert systems, and IoT devices.
- Additional appliances can be connected to the system based on user needs.
- Supports software updates to enhance functionality in the future.

**10. Cost-Effective and Practical Solution**

- Provides an affordable alternative to high-end smart home automation systems.
- Eliminates internet costs while ensuring reliable operation.
- Suitable for homes, elderly care centers, and rehabilitation facilities.

**11. Impact On Autonomy And Quality Of Life**

i. Provide a seamless, internet-independent solution for home automation.
ii. Enable fast and secure device control through gesture and voice commands.
iii. Enhance accessibility and ease of use for individuals with different disabilities.
iv. Offer a built-in emergency response system to improve safety and security.

Ultimately, this innovative assistive technology seeks to improve the quality of life for differently abled individuals by giving them greater control over their surroundings while ensuring that they have a reliable way to seek help in emergencies. This step towards inclusive and adaptive technology ensures that accessibility is not just an afterthought, but a fundamental right for all.

**ADVANTAGES**

- ✓ Provides visually impaired users with greater independence and control over their home environment.
- ✓ Functions effectively without relying on internet connectivity, making it suitable for areas with poor or unreliable internet access.
- ✓ By processing all data locally, the system offers a higher level of security and privacy compared to cloud-based solutions.
- ✓ Affordable hardware and open-source software make the system accessible to a wide range of users.

## 3.6 MODULE DESIGN

The module design includes a Voice Recognition module for hands-free control, a Gesture Control module for touchless interaction, and an Emergency Alert System for safety and quick assistance.

- Voice Recognition module
- Gesture Control module
- Emergency Alert System

### 3.6.1 USE CASE DIAGRAM

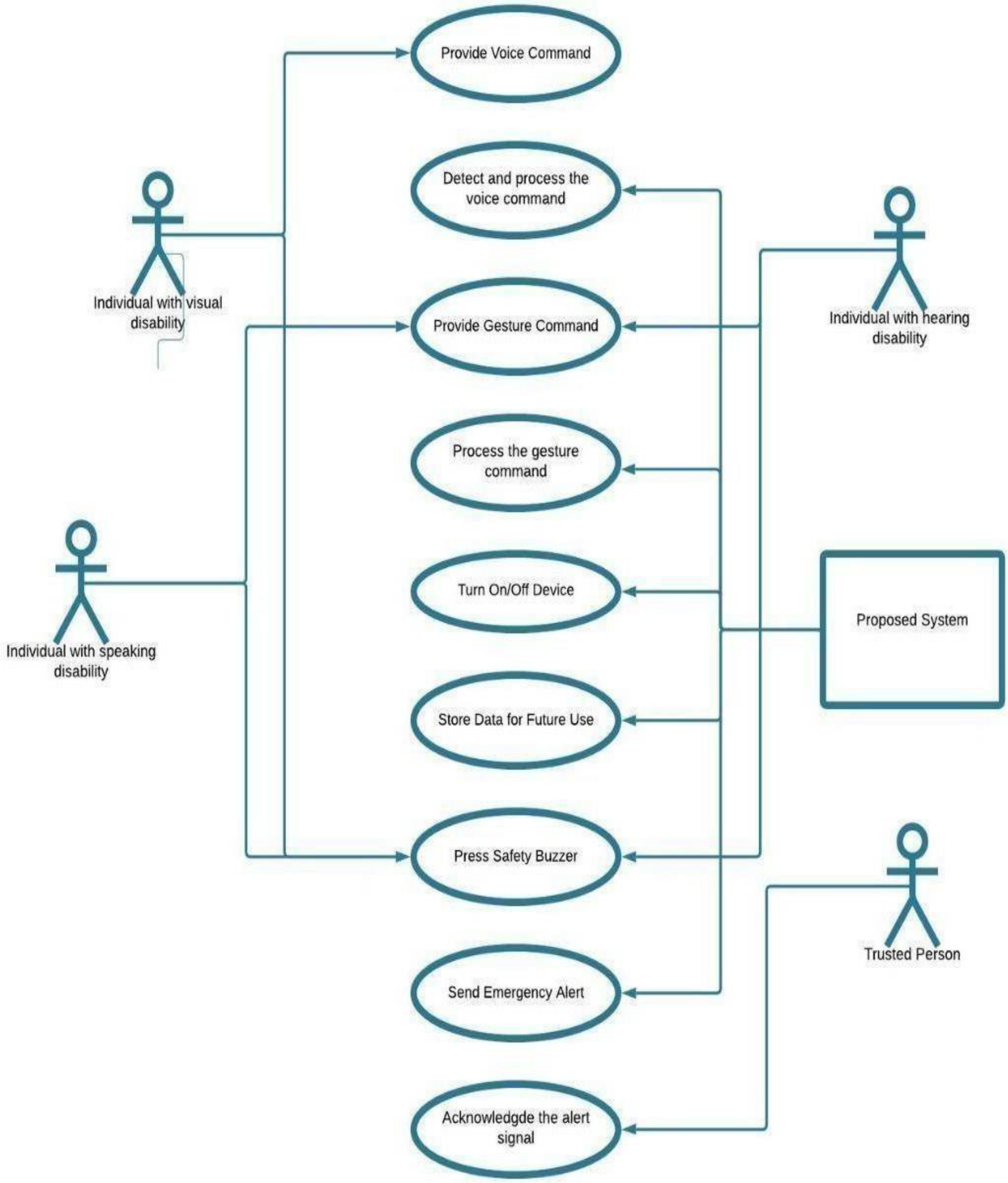



**Fig 3.6.1: Use-case Diagram**

- The diagram represents an assistive technology system designed to enhance accessibility for individuals with visual, hearing, and speaking disabilities by providing multiple interaction methods.
- The system allows users to issue voice commands and gesture commands, which are processed to control various devices by turning them on or off as needed.
- Additionally, the system is capable of storing data for future use, ensuring a more personalized and adaptive experience over time. A crucial safety feature integrated into the system is the emergency alert mechanism, which enables users to send notifications to a trusted person in case of urgent situations.
- This is further reinforced by a safety buzzer, which acts as an immediate auditory warning signal for emergencies.
- By combining multiple input methods and emergency response functionalities, the proposed system makes everyday interactions more seamless and efficient.

### 3.6.2 FLOW DIAGRAM

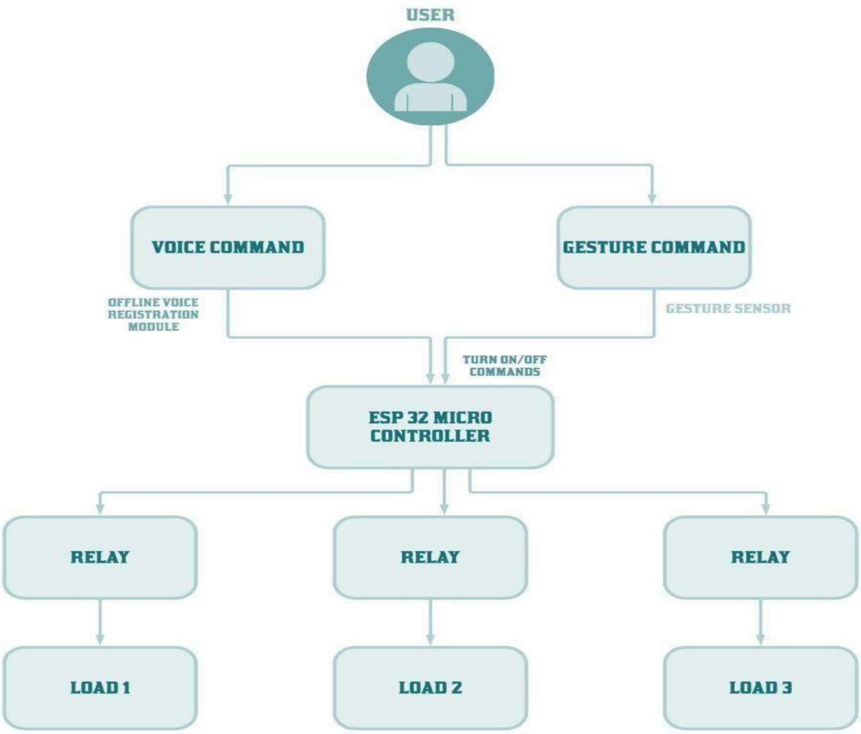



**Fig 3.6.2: Flow Diagram**

- The flowchart illustrates a smart control system where a user can interact with an ESP32 microcontroller using either voice commands or gesture commands.

- The voice command input is processed through an offline voice recognition module, enabling the system to function without requiring an active internet connection. Simultaneously, gesture commands are detected using a gesture sensor, allowing users to control the system with simple hand movements.

- Once the ESP32 microcontroller receives these inputs, it processes the commands and sends corresponding turn on/off signals to connected relays. These relays act as switches, controlling three different loads (Load 1, Load 2, and Load 3).

- This set up ensures seamless and efficient device control, making it particularly useful for automation applications, smart home systems, and accessibility solutions for individuals with disabilities and efficient

# CHAPTER 4
# SYSTEM IMPLEMENTATION

# CHAPTER 4

# SYSTEM IMPLEMENTATION

## 4.1 HARDWARE IMPLEMENTATION

The hardware implementation of the proposed system involves integrating various components such as microcontrollers, sensors, a voice recognition module, relays, and a GSM module to create an efficient, offline speech and gesture-based assistive system. The system follows a structured approach where inputs from the user (voice or gestures) are processed, and appropriate actions are taken to control home appliances or send emergency alerts.

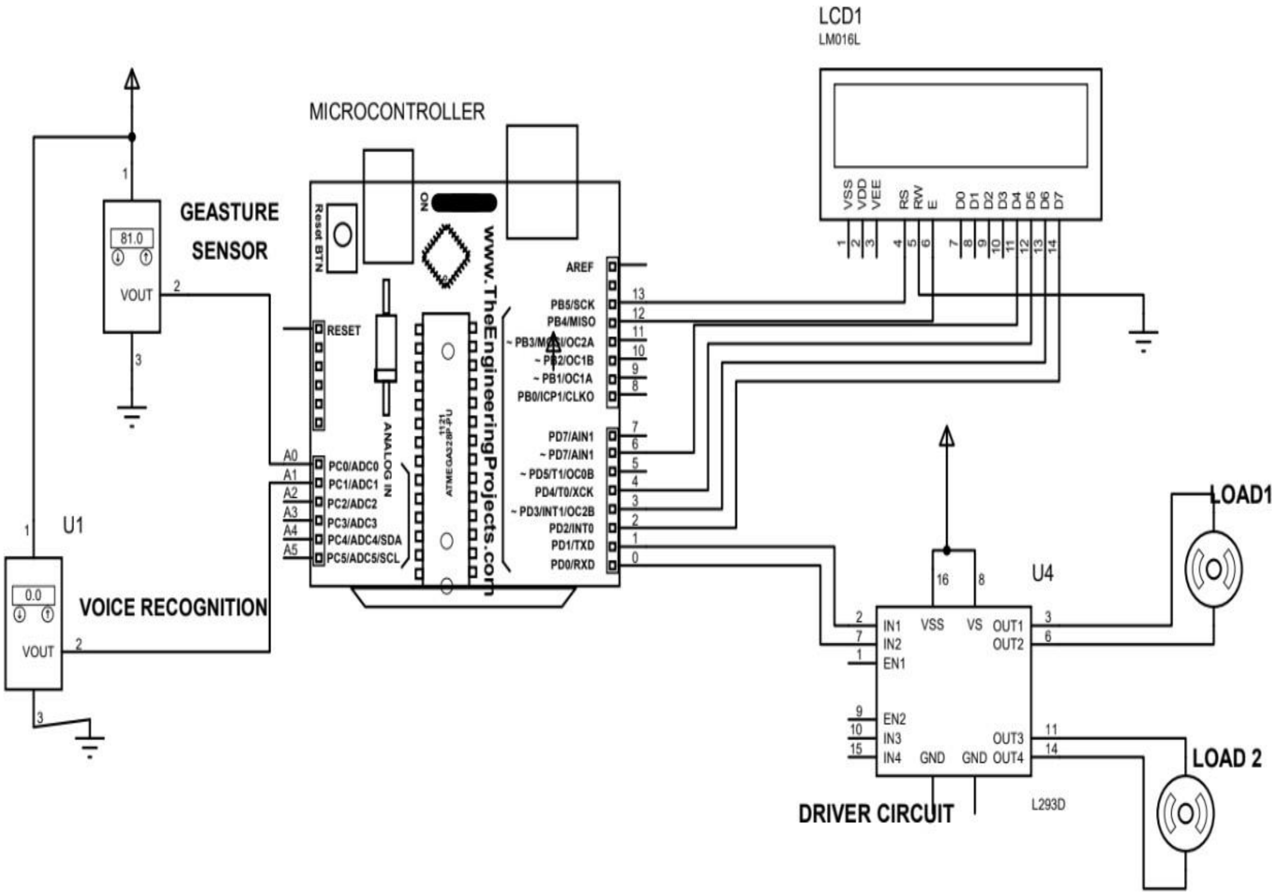



**Fig 4.1: Microcontroller Configuration**

### 4.1.1 FLOW OF HARDWARE IMPLEMENTATION

1. **User Input:**
   - The system accepts voice commands through the voice recognition module.
   - Alternatively, hand gestures are detected via the gesture sensor.

2. **Processing Unit (Microcontroller):**
   - The microcontroller receives input from the voice recognition module or gesture sensor.
   - Based on the recognized command, it processes the request and determines the corresponding action.

3. **Output Execution:**
   - If the command is related to home automation, the microcontroller activates the switching appliances (lights, fan, etc.) ON/OFF.
   - If an emergency signal is detected, the GSM module sends an SMS alert with the user's location to a trusted contact.

4. **Feedback System:**
   - An LCD display provides real-time feedback, confirming the execution of commands or alert messages.

### 4.1.2 HARDWARE FLOW CHART- Home Automation

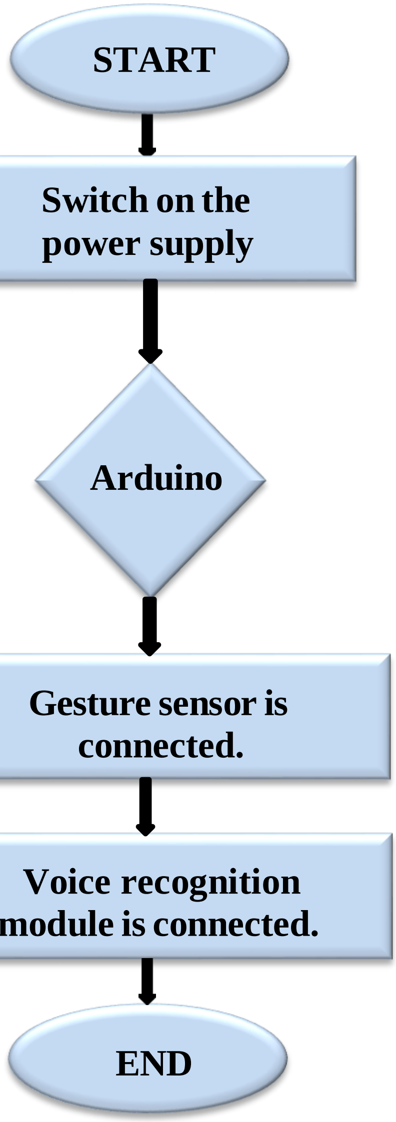



**Fig 4.1.2.a: Home Automation Flowchart**

The flowchart representing the hardware implementation of home automation system.

### 4.1.2 HARDWARE FLOW CHART- Emergency Alert System

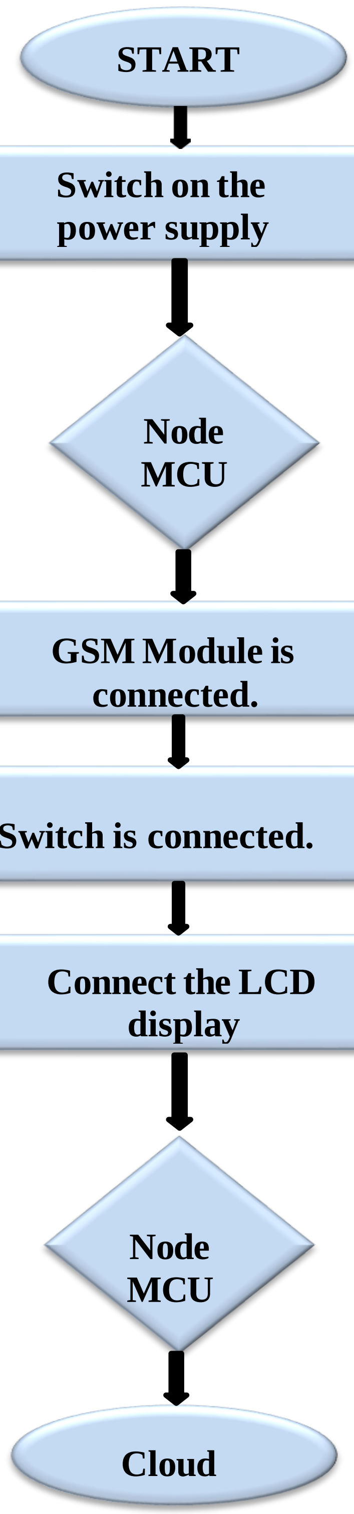



**Fig 4.1.2.b: Emergency Alert Flowchart**

The flowchart representing the hardware implementation of emergency alert system.

### 4.1.3 WORKING MECHANISM

This circuit works as a gesture and voice-controlled system that allows users to control electrical loads (such as motors or appliances) using either hand movements or spoken commands**.** The heart of the system is the microcontroller**,** which processes inputs from **a** gesture sensor and a voice recognition module to determine the appropriate action. Once the input is received, the microcontroller sends signals to an LCD display for user feedback and a motor driver (L293D) that controls the connected loads.

The gesture sensor detects hand movements and sends an output signal to the microcontroller. The microcontroller then processes this signal to interpret whether a specific gesture corresponds to an action, such as turning on or off a motor. Similarly, the voice recognition module captures voice commands, compares them with pre-stored commands, and sends a corresponding output signal to the microcontroller. Depending on the recognized command, the microcontroller decides which load should be activated or deactivated.

Once the microcontroller identifies the required action, it controls the L293D motor driver. Since the microcontroller alone cannot supply sufficient current to drive motors or other high-power devices, the L293D acts as an intermediary that amplifies the signals and provides the necessary power to the loads. The motor driver has multiple input and output pins that allow it to control two separate loads independently. When a control signal is received from the microcontroller, the motor driver supplies the necessary power to the corresponding load, either activating or deactivating it.

An LCD display is included in the circuit to provide real-time feedback to the user. It displays messages indicating whether a command has been recognized, which load has been turned on or off, and other system statuses. For example, if a user waves their hand to the left, the LCD might display "Gesture Recognized: Load 1 ON," indicating that the corresponding motor has been activated. Similarly, if the user gives a voice command such as "Turn off," the LCD might show "Voice Command: Load 2 OFF," confirming that the load has been deactivated.

When the circuit is powered on, the microcontroller remains in a listening mode, continuously monitoring inputs from the gesture sensor and voice recognition module. If a valid gesture or voice command is detected, the microcontroller processes it and updates the outputs accordingly. The loads (such as motors) will remain in their respective states (ON or OFF) until a new command is given.

This system can be used in various applications, including home automation, assistive technology for disabled individuals, industrial automation, and robotics. For instance, in a smart home setup, this circuit could be used to turn on lights or fans with simple hand movements or voice commands. In an industrial setting, it could be integrated into machines to allow hands-free operation. Moreover, for physically challenged individuals, it offers an intuitive way to control appliances without needing to press buttons or use traditional switches.

## 4.2 SOFTWARE IMPLEMTATION

The flowchart depicts the software implementation. The software side of the project consists of a Webpage created using VS Code editor, a cloud database to store the data for future purpose and an automatic SMS service using HTTP and SMTP protocol services. The purpose of this project is not only to automate the driving license test but also to create an efficient database.

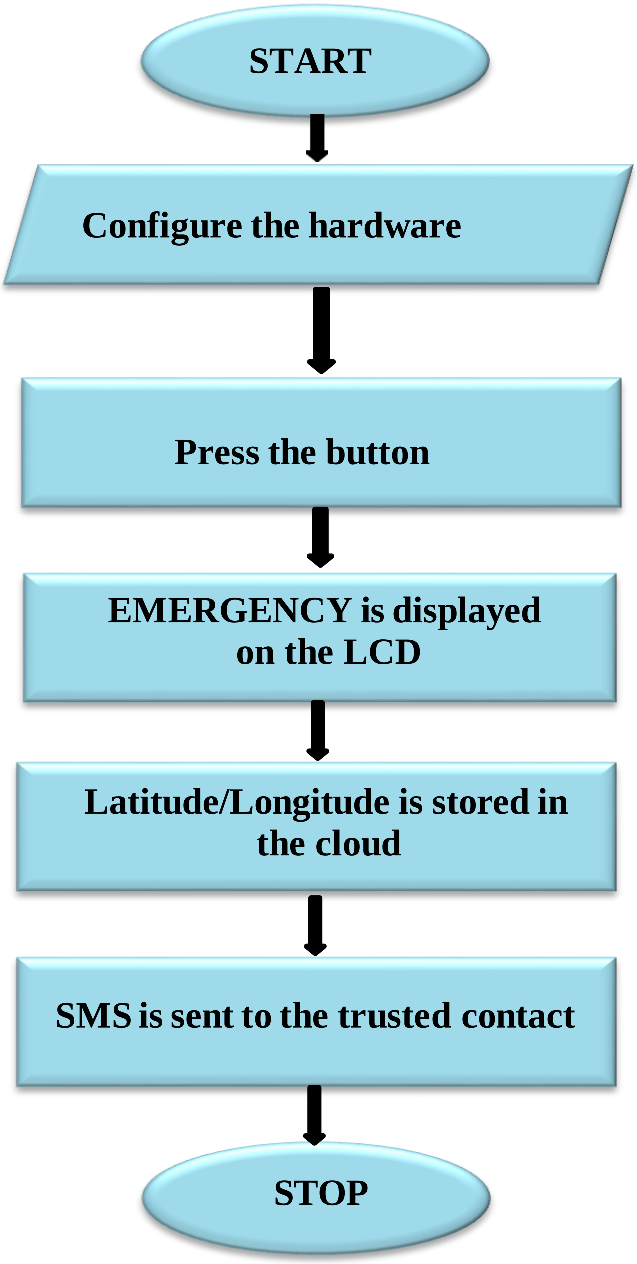



**Fig 4.2: Software Flowchart**

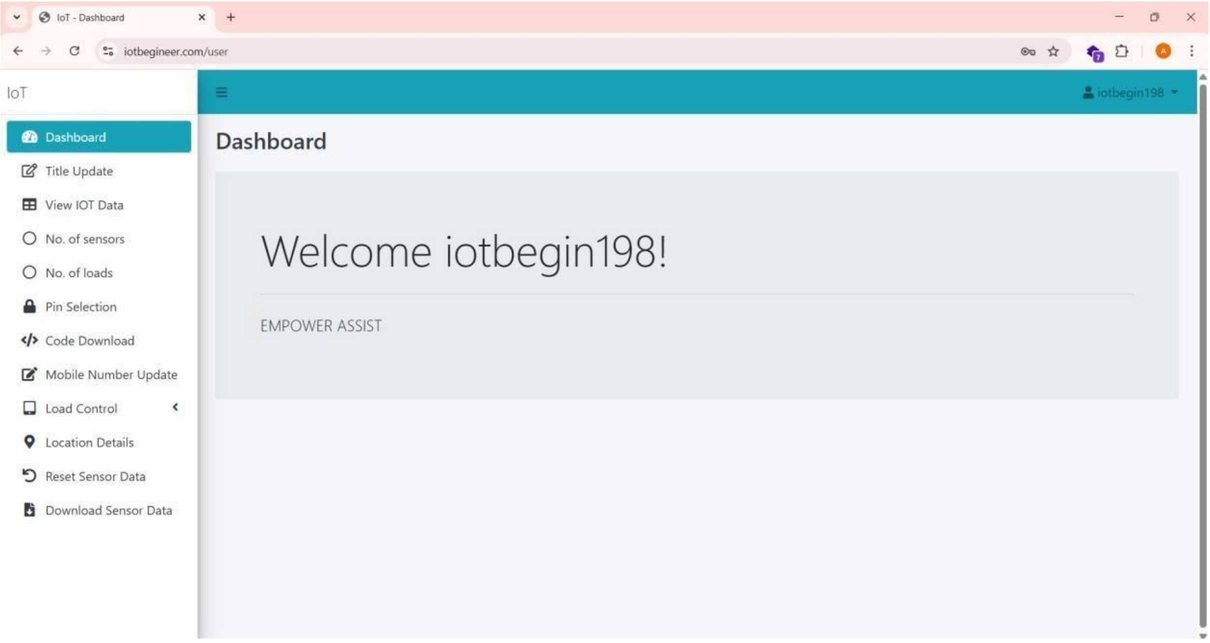



**Fig 4.2.1: User Dashboard**

The image depicts the welcome page of the website that serves as the medium to display the user actions in details.

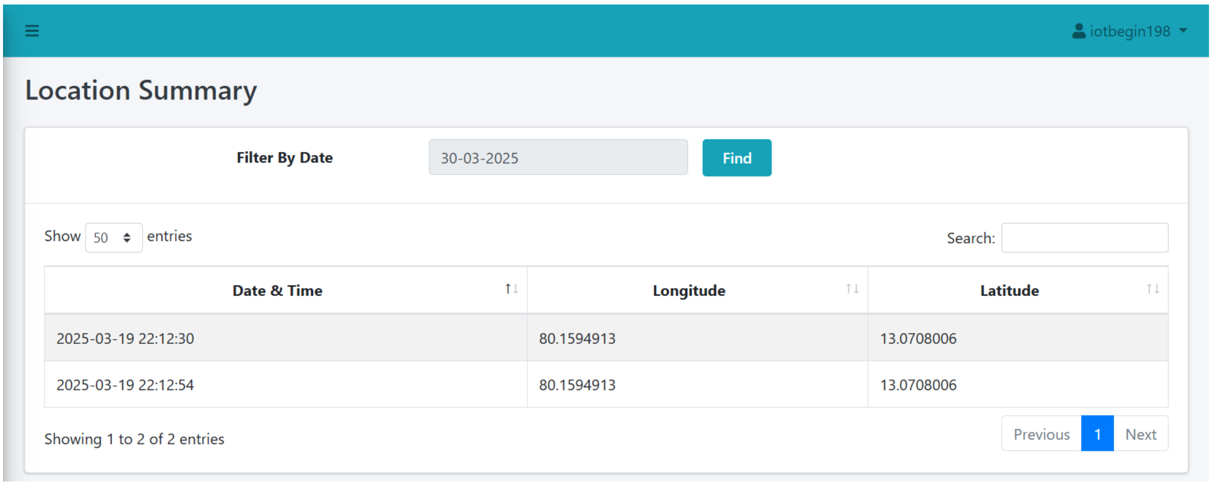



**Fig 4.2.2: Location Summary**

The above image illustrates the front-end design of the webpage. The webpage is designed dynamically using the VS code editor. In the VS code editor, HTML and CSS is used for front-end development of the webpage. JavaScript is used for backend development, wherein the details are retrieved from the cloud and displayed on the webpage. The front end of the web page displays the location summary.

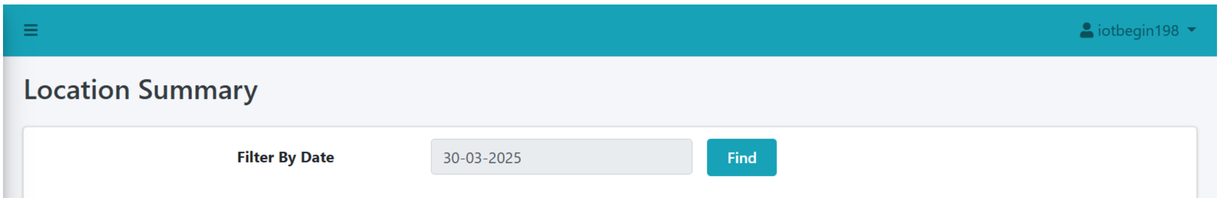



**Fig 4.2.3: Filter By Date**

The website allows the user to filter the records by date in order to enhance usability of the proposed system. This helps the user to traceback the information that has been recorded.

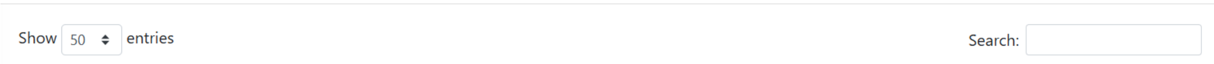
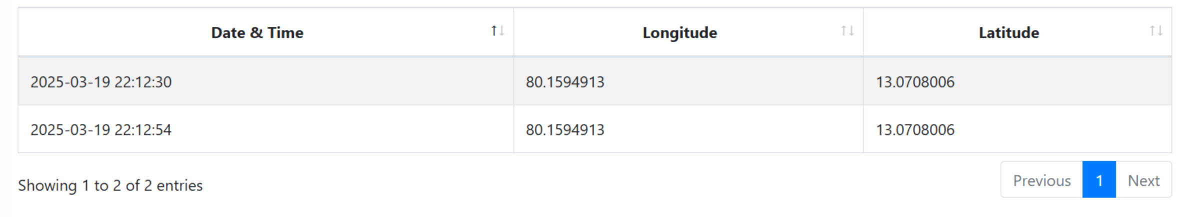



**Fig 4.2.4: Number of Entities**

The feature depicted in the image allows the user to adjust the number of entries the user wants to display accordingly, while the search feature helps the user to search for a particular location. This helps the trusted person navigate the emergency situation effectively.



| Date & Time | Longitude | Latitude |
|---|---|---|
| 2025-03-19 22:12:30 | 80.1594913 | 13.0708006 |
| 2025-03-19 22:12:54 | 80.1594913 | 13.0708006 |

Showing 1 to 2 of 2 entries

Previous 1 Next

**Fig 4.2.5: Date & Time, Lat & Long**

The image represents the activity of the user on 19th March 2025. The website represents the records in the form of a table where the three fields are the Date & Time, Latitude, and Longitude.

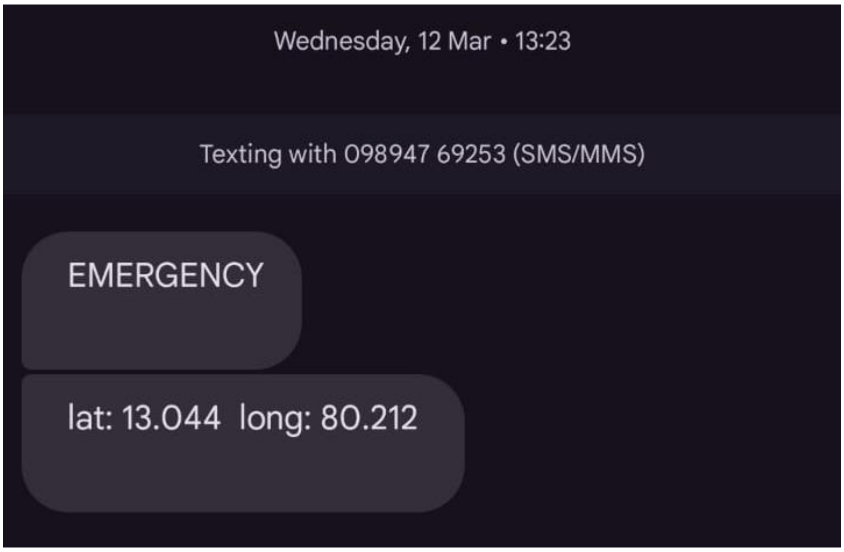
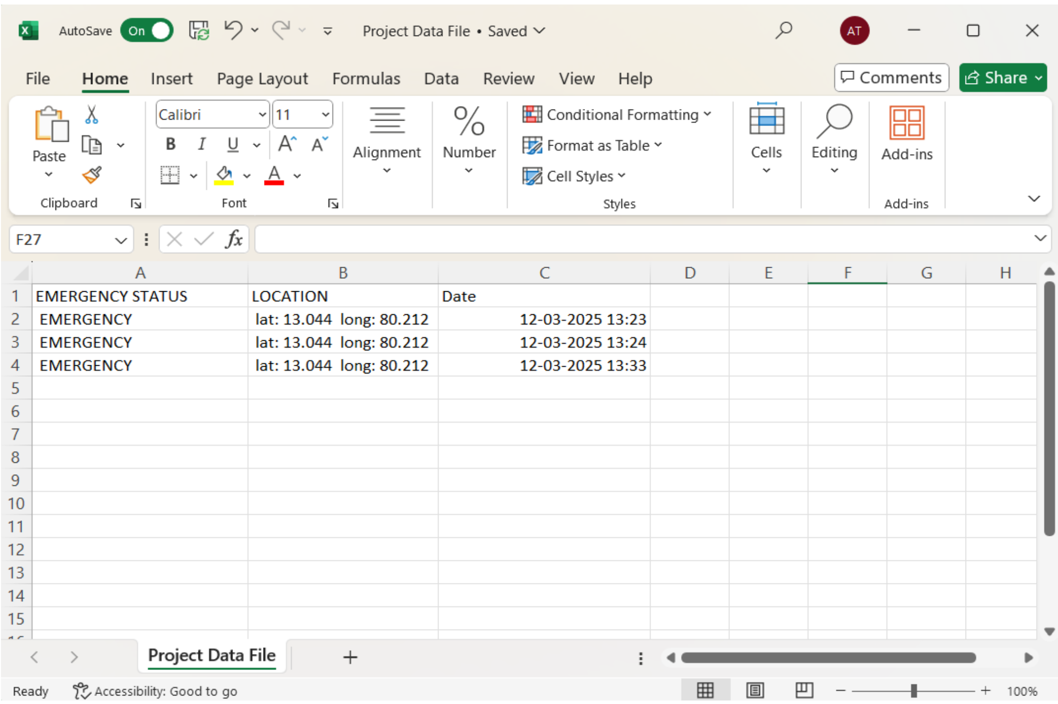



**Fig 4.2.6: Emergency SMS**

The above image is a screenshot of the SMS sent to the trusted contact to assist the user in need of help.

## EXCEL OUTPUT

The actions of the user can also be obtained in the form of an EXCEL file.



| EMERGENCY STATUS | LOCATION | Date |
|---|---|---|
| EMERGENCY | lat: 13.044 long: 80.212 | 12-03-2025 13:23 |
| EMERGENCY | lat: 13.044 long: 80.212 | 12-03-2025 13:24 |
| EMERGENCY | lat: 13.044 long: 80.212 | 12-03-2025 13:33 |

**Fig 4.2.7: Excel Data for Emergency alert**

# CHAPTER 5
# RESULTS & DISCUSSION

CHAPTER 5

# RESULTS AND DISCUSSIONS

## 5.1 PERFORMANCE TESTING

The system was rigorously tested under diverse conditions to assess its performance, accuracy, and reliability. Several critical parameters were evaluated to ensure the system's effectiveness, including response time, accuracy of voice and gesture recognition, reliability of the emergency alert mechanism, and overall power efficiency.

### 5.1.1 SYSTEM TESTING

| TEST CASE ID | ACTION/ SCENARIO | EXPECTED RESULT | ACTUAL RESULT | STATUS |
|---|---|---|---|---|
| TC01 | Activate the Robo | A robot should initialize and respond to user commands | Robot activated successfully | Pass |
| TC02 | Command system to turn on lights | Lights should be turned on | Lights turned on successfully | Pass |
| TC03 | Command system to turn on fan | Fan should be turned on | Fan turned on successfully | Pass |
| TC04 | Command system to turn off lights | Lights should be turned off | Lights turned off successfully | Pass |
| TC05 | Command system to turn off fan | Fan should be turned off | Fan turned off successfully | Pass |
| TC06 | Move hand upwards | Lights should be turned on | Lights turned on successfully | Pass |
| TC07 | Move hand towards the right | Fan should be turned on | Fan turned on successfully | Pass |
| TC08 | Move hand downwards | Lights should be turned off | Lights turned off | Pass |

| | | | | |
|---|---|---|---|---|
| | | | successfully | |
| TC09 | Move hand towards the left | Fan should be turned off | Fan turned off successfully | Pass |
| TC10 | Press emergency button | The emergency system should receive and process the signal | Emergency signal received and processed | Pass |

**Fig 5.1.1 : Test Case Report**

## 5.2 RESULTS & DISCUSSIONS

The proposed system successfully facilitated seamless interaction for differently abled individuals, enabling them to control electrical appliances through voice and gesture commands without internet dependency. The offline speech recognition module provided a secure and efficient alternative to cloud-based solutions, ensuring enhanced privacy, reduced latency, and increased reliability. Gesture-based control further improved accessibility, particularly benefiting users with speech impairments.

The emergency alert feature significantly enhanced user safety by allowing rapid distress signal activation in critical situations. The system's ability to integrate multiple control methods ensured accessibility for a diverse range of users, making it a versatile and inclusive assistive technology. Additionally, the system's cost-effectiveness, energy efficiency, and ease of implementation position it as a practical solution for real-world applications.

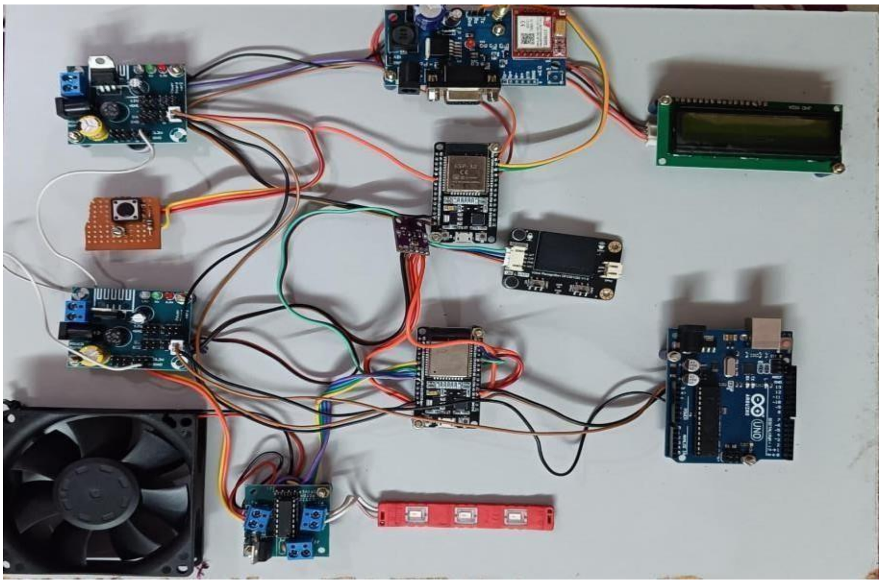


**Fig 5.2.1: Prototype**

17:31 62%

| sensor1 | sensor2 | sensor3 | sensor4 | sensor5 | sensor6 | sensor7 | sensor8 | created_at |
|---|---|---|---|---|---|---|---|---|
| EMERGENCY | lat:13.0708006long:80.1594913 | | | | | | | 2025-03-24 08:51:48 |
| EMERGENCY | lat:13.0708006long:80.1594913 | | | | | | | 2025-03-24 08:42:17 |
| EMERGENCY | lat: 13.044 long: 80.212 | | | | | | | 2025-03-12 13:33:08 |
| EMERGENCY | lat: 13.044 long: 80.212 | | | | | | | 2025-03-12 13:24:58 |
| EMERGENCY | lat: 13.044 long: 80.212 | | | | | | | 2025-03-12 13:23:40 |
| EMERGENCY | lat: 13.044 long: 80.212 | | | | | | | 2025-03-10 15:34:45 |
| EMERGENCY | lat: 13.044 long: 80.212 | | | | | | | 2025-03-10 15:10:57 |

**Fig 5.2.2 : Records of Emergency System**

By integrating offline speech recognition, gesture-based interaction, and an emergency alert mechanism, the system effectively enhances accessibility, autonomy, and safety for differently abled individuals. Its robust performance, cost-effectiveness, and user-centric design underscore its potential for real-world deployment, improving the quality of life for its users and promoting inclusive technology solutions.

# CHAPTER 6
# CONCLUSION & FUTURE SCOPE

# CHAPTER 6

# CONCLUSION

The Offline Speech and Gesture-Controlled Smart System for Accessibility and Safety presented in this research offers an innovative, reliable, and user-friendly solution to enhance the quality of life for individuals with disabilities. By integrating offline voice recognition and gesture control, the system enables users to operate electrical appliances without internet dependency, ensuring faster response times, enhanced privacy, and accessibility in remote areas. The dual-mode control system, consisting of speech and hand gestures, provides flexibility and convenience, allowing users to interact based on their preference. The implementation of the ESP32 microcontroller, voice recognition module, and gesture sensors has proven to be effective in developing a cost-efficient, real- time, and scalable system. Additionally, the safety alert mechanism allows users to notify caregivers or family members in emergencies, enhancing security and independence. Through rigorous testing, the system has demonstrated its ability to improve accessibility, safety, and ease of living for differently-abled individuals. Its offline functionality ensures reliability even in areas with poor connectivity, making it a significant contribution to assistive technologies and bridging the gap between technological advancements and inclusivity in smart home automation.

The Offline Speech and Gesture-Controlled Smart System for Accessibility and Safety has immense potential for further development and enhancement in the field of assistive technology. Future advancements can focus on multi-language support, allowing users from diverse linguistic backgrounds to interact with the system seamlessly. Expanding the system beyond English and Tamil to support additional regional and global languages will improve its adaptability and usability.

# FUTURE SCOPE

Artificial Intelligence (AI) and Machine Learning (ML) can be integrated to enhance the system's efficiency by enabling adaptive learning. By analyzing user behavior and preferences over time, AI-driven automation can optimize voice and gesture recognition, making the system more intuitive. Machine learning Algorithms can also help improve the accuracy of speech commands and gesture detection, reducing errors and improving the overall user experience.

The system can be extended to control a wider range of smart devices, including televisions, security systems, kitchen appliances, and healthcare monitoring devices. By integrating it with wearable smart devices, users can control appliances effortlessly, even while moving around. Additionally, enhancing gesture recognition using advanced 3D sensors and camera-based tracking can provide more precise control, allowing users to perform complex commands with ease.

A battery-powered, portable model can be developed to make the system usable in outdoor environments or for individuals on the move. This will enhance accessibility beyond home automation, supporting users in workplaces, hospitals, and public spaces. Implementing a hybrid IoT-based system that offers both Offline functionality and optional internet connectivity can further expand its capabilities, allowing users to remotely control appliances through mobile applications while maintaining privacy and security.

AI-driven emergency detection can be incorporated to autonomously recognize distress signals and send alerts to caregivers or emergency services. This feature will significantly improve user safety, especially for elderly or disabled individuals living alone. Furthermore, ensuring compatibility with existing smart home ecosystems like Google Home, Amazon Alexa, and Apple HomeKit will increase adoption and make it easier to integrate with current home automation setups.

By implementing these future enhancements, the system can evolve into a fully autonomous, intelligent assistive technology, improving accessibility, independence, and quality of life for individuals with disabilities. As technology advances, integrating smaller, cost-efficient, and AI-powered components will make smart home automation even more inclusive, scalable, and affordable for a global audience.

# APPENDICES

## A.1 SDG GOALS

***SDG 9: Industry, Innovation & Infrastructure***

Sustainable Development Goal 9 emphasizes building resilient infrastructure, promoting inclusive and sustainable industrialization, and fostering innovation. Our project, "Empower Assist: Offline Speech And Gesture-Controlled Smart System For Accessibility And Safety," aligns with SDG 9 by integrating speech and gesture recognition to enhance accessibility and independence for individuals with disabilities. Unlike traditional automation systems that rely on cloud connectivity, our solution operates entirely offline, ensuring reliability in regions with poor internet access. By leveraging advanced microcontrollers, AI- driven speech recognition, and gesture sensors, we create an inclusive, scalable, and cost-effective assistive infrastructure. The project strengthens digital accessibility while promoting industrial growth in the assistive technology sector, demonstrating how emerging technologies like IoT and AI can improve lives. Additionally, the system incorporates an emergency alert mechanism for enhanced safety, particularly benefiting individuals with severe mobility impairments and elderly users. By processing commands locally, our approach reduces energy consumption and reliance on cloud-based solutions, contributing to sustainable energy management. The affordability and adaptability of the system ensure that it can be widely adopted, making smart automation accessible to diverse socio-economic groups. Furthermore, by integrating local languages like Tamil and English, we ensure linguistic inclusivity, enhancing digital accessibility. Future advancements could include AI-driven predictive analytics and integration with smart wearables, further improving user experience. Our project exemplifies how technological innovation can drive social impact, enhance digital infrastructure, and contribute to sustainable development, paving the way for a more inclusive and resilient future.

## A.2 SOURCE CODE

### a. GSM Module

```
#include <HTTPClient.h>
#include <WiFi.h>
#include <ArduinoJson.h>
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 16, 2);
int SW = 32;
int S,z;
int count;

String sensor1_status;
String sensor2_status;
String sensor3_status;
String sensor4_status;
String sensor5_status;
String sensor6_status;
String sensor7_status;
String sensor8_status;
String lattitude_1;
String longitude_1;
String sms_status;

void setup()
{
  lcd.begin();
  lcd.clear();
  lcd.backlight();
  Serial.begin(9600);
  pinMode(SW, INPUT);
  Serial.println("iotbegin198");
  WiFi.begin("iotbegin198", "iotbegin198");
  while (WiFi.status() != WL_CONNECTED)
  {
    lcd.setCursor(0, 0);
    lcd.print("Connecting to ");
    lcd.setCursor(0, 1);
    lcd.print("  iotbegin198");
    Serial.println("Waiting for Wi-Fi connection");
  }
```

```
  Serial.println("Wi-Fi connected");
  lcd.setCursor(0,                    1);
  lcd.println("Wi-Fi      connected");
  lcd.clear();
}
void loop()
{
  S = (1-digitalRead(SW));
  lcd.setCursor(0,           0);
  lcd.print("S:");
  lcd.print(S);
  lcd.print("                  ");
  delay(1000);

  if(S == 1)
  {
    lcd.setCursor(8,         0);
    lcd.print("S: ");
    lcd.print("ON            ");
    lcd.setCursor(0, 1);
    lcd.print("    EMERGENCY    ");
    sensor1_status = " EMERGENCY";
    location();

    eme();
iot();
  }
  else
  {
    lcd.setCursor(8,         0);
    lcd.print("S: ");
    lcd.print("OFF");
    lcd.setCursor(0,       1);
    lcd.print("              ");
  }
}
void location()
{
  HTTPClient http;
  http.begin("http://iotbegineer.com/api/locations");       //Specify request
destination
  http.addHeader("username", "iotbegin198"); //Specify content-type header
  int httpCode_string = http.GET();
```

```
  String payload_string = http.getString();                  //Get the response payload
  http.end();  //Close connection
  delay(500);
  StaticJsonDocument<300>                    parseserial_string;
  deserializeJson(parseserial_string,            payload_string);
  JsonObject  serial_string  =  parseserial_string["data"][0];
  String lattitude = serial_string["latitude"];
  String longitude = serial_string["longitude"];

  if(lattitude == "null")
  {
   lattitude_1="     lat:     13.044     ";
   longitude_1=" long: 80.212 ";
  }
  else
  {
   lattitude_1="lat:"     +     lattitude;
   longitude_1="long:"+ longitude;
  }
  sensor2_status=lattitude_1 + longitude_1;
  //delay(500);
}
void iot()
{
  if (WiFi.status() == WL_CONNECTED)
  {
   DynamicJsonDocument    jsonBuffer(JSON_OBJECT_SIZE(3)    +    300);
   JsonObject root = jsonBuffer.to<JsonObject>();

   root["sensor1"] = sensor1_status;
   root["sensor2"] = sensor2_status;
   root["sensor3"] = sensor3_status;
   root["sensor4"] = sensor4_status;
   root["sensor5"] = sensor5_status;
   root["sensor6"] = sensor6_status;
   root["sensor7"] = sensor7_status;
   root["sensor8"] = sensor8_status;
   root["sms"] =  sms_status;  String
                                   json;
   serializeJson(jsonBuffer,     json);
   if (sensor1_status != "null")
   {
    HTTPClient http;     //Declare object of class HTTPClient
```

```
      http.begin("http://iotbegineer.com/api/sensors");        //Specify request
destination
      http.addHeader("username",  "iotbegin198"); //Specify content-type header
      http.addHeader("Content-Type", "application/json");
      int httpCode = http.POST(json);    //Send the request
      String payload = http.getString();    //Get the response payload
      http.end();
      sensor2_status="                              ";
    }
  }
  else
  {
    Serial.println("Error in WiFi connection");
  }
}
void eme()
{
  Serial.println("AT+CMGF=1");
  delay(1000);
  Serial.println("AT+CMGS=\"+917200386158\"\r");
  delay(1000);
  Serial.println(sensor1_status);
  delay(1000);
  Serial.println((char)26);
  delay(5000);

  Serial.println("AT+CMGF=1");
  delay(1000);
  Serial.println("AT+CMGS=\"+917200386158\"\r");
  delay(1000);
  Serial.println(sensor2_status);
  delay(1000);
  Serial.println((char)26);
  delay(5000);
}
```

**b. Gesture module**

```
#include <Wire.h>
#include "DFRobot_DF2301Q.h"
#include "Adafruit_APDS9960.h"

#define TCAADDR 0x70  // I2C address of TCA9548A multiplexer


#define SDA_PIN 21
#define SCL_PIN 22

int R1 = 32, R2 = 33, R3 = 25, R4 = 26;

Adafruit_APDS9960 apds;
DFRobot_DF2301Q_I2C asr;

void tcaSelect(uint8_t channel) {
  Wire.beginTransmission(TCAADDR);
  Wire.write(1 << channel);
  Wire.endTransmission();
}

void setup() {
  Serial.begin(115200);
  Wire.begin(SDA_PIN, SCL_PIN);

  // Relay setup
  pinMode(R1, OUTPUT);
  pinMode(R2, OUTPUT);
  pinMode(R3, OUTPUT);
  pinMode(R4, OUTPUT);
  digitalWrite(R1, LOW);
  digitalWrite(R2, LOW);
  digitalWrite(R3, LOW);
  digitalWrite(R4, LOW);

  // Select channel 0 for APDS9960 (Gesture Sensor)
  tcaSelect(0);
  if (!apds.begin()) {
    Serial.println("APDS9960 failed to initialize!");
  } else {
    Serial.println("APDS9960 initialized!");
  }
  apds.enableProximity(true);
```

```
  apds.enableGesture(true);

  // Select channel 1 for DF2301Q (Voice Module)
  tcaSelect(1);
  if (!asr.begin()) {
    Serial.println("DF2301Q failed to initialize!");

      } else {
    Serial.println("DF2301Q initialized!");
  }
  asr.setVolume(4);
  asr.setMuteMode(0);
  asr.setWakeTime(20);
}

void loop() {
  tcaSelect(0);
  for (int i = 0; i < 5; i++) {
    uint8_t gesture = apds.readGesture();
    if (gesture == APDS9960_DOWN) {
    Serial.println("DOWN");
    digitalWrite(R1, LOW);
    digitalWrite(R2, LOW);
    digitalWrite(R3, LOW);
    digitalWrite(R4, LOW);
    }
    if (gesture == APDS9960_UP) {
      Serial.println("UP");
      digitalWrite(R1, LOW);
      digitalWrite(R2, LOW);
      digitalWrite(R3, LOW);
      digitalWrite(R4, LOW);
    }
    if (gesture == APDS9960_LEFT) {
      Serial.println("LEFT");
      digitalWrite(R3, HIGH);
      digitalWrite(R4, LOW);
    }
    if (gesture == APDS9960_RIGHT) {
      Serial.println("RIGHT");
      digitalWrite(R1, HIGH);
      digitalWrite(R2, LOW);
    }
    delay(10);
  }
```

```
tcaSelect(1);
uint8_t CMDID = asr.getCMDID();
if (CMDID != 0) {
  Serial.print("CMDID = ");

  Serial.println(CMDID);
  switch    (CMDID)    {
  case 103:
      digitalWrite(R1,           HIGH);
      digitalWrite(R2,           LOW);
      Serial.println("Light       ON");
      break;
    case                         104:
      digitalWrite(R1, LOW);
      digitalWrite(R2, LOW);
      Serial.println("Light      OFF");
      break;
    case 75:
      digitalWrite(R3,   HIGH);
      digitalWrite(R4,   LOW);
      Serial.println("Fan ON");
      break;
    case 76:
      digitalWrite(R3,           LOW);
      digitalWrite(R4,           LOW);
      Serial.println("Fan         OFF");
      break;
  }
}
delay(1);
```

## A.3 SCREENSHOTS

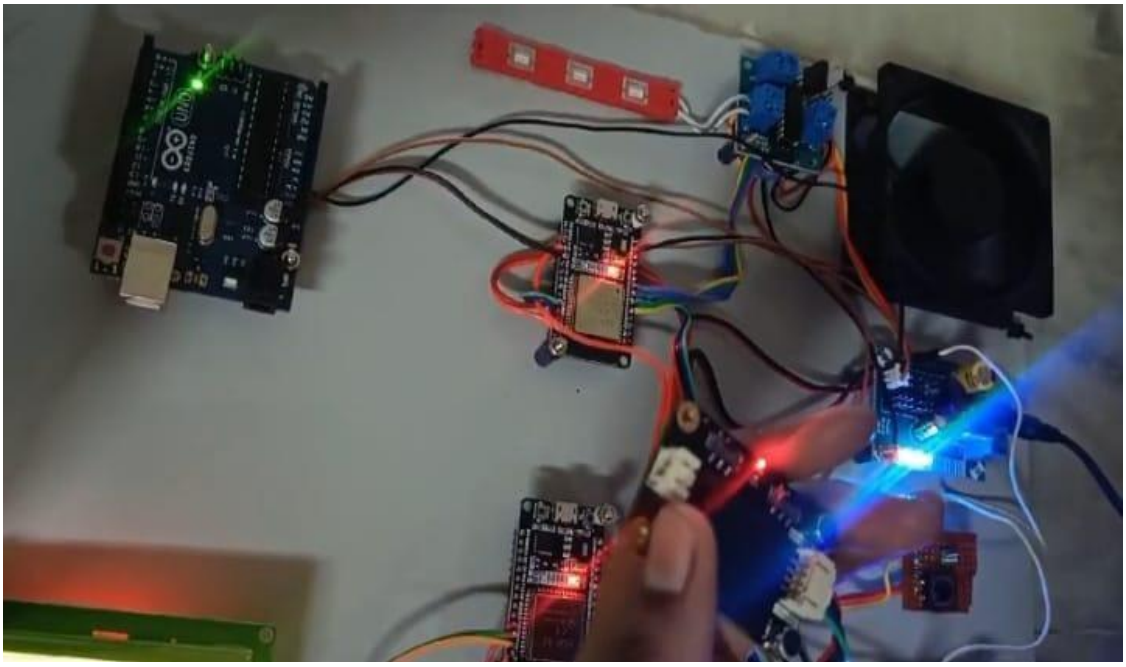


**Fig A.3.1: Lights & Fans (Loads) – Off**

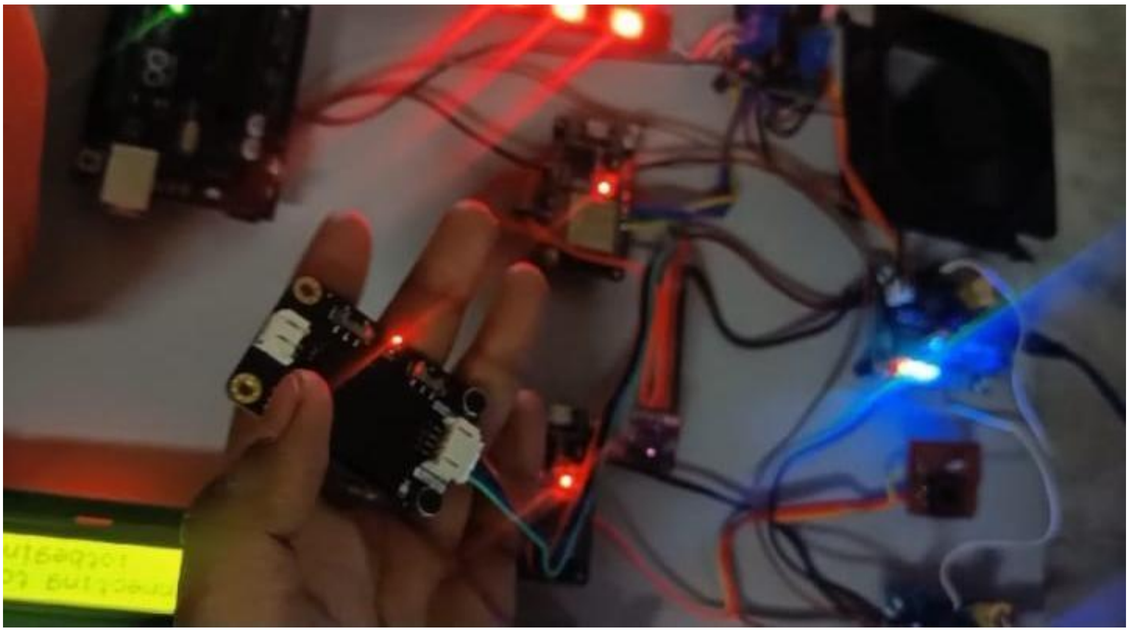


**Fig A.3.2: Lights & Fans (Loads) – On**

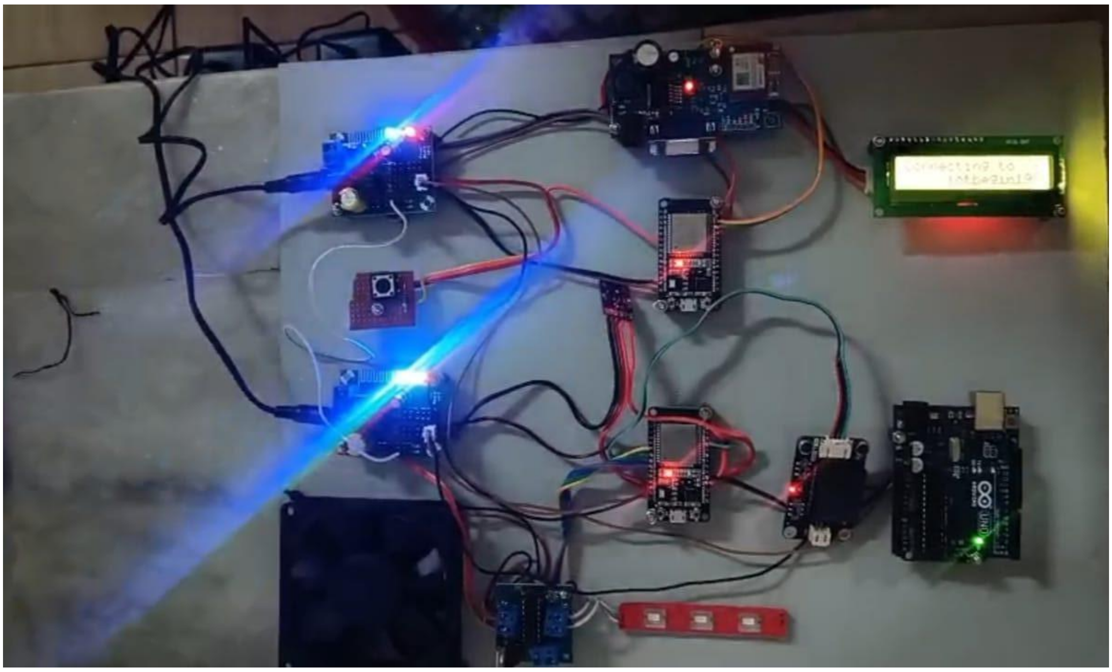
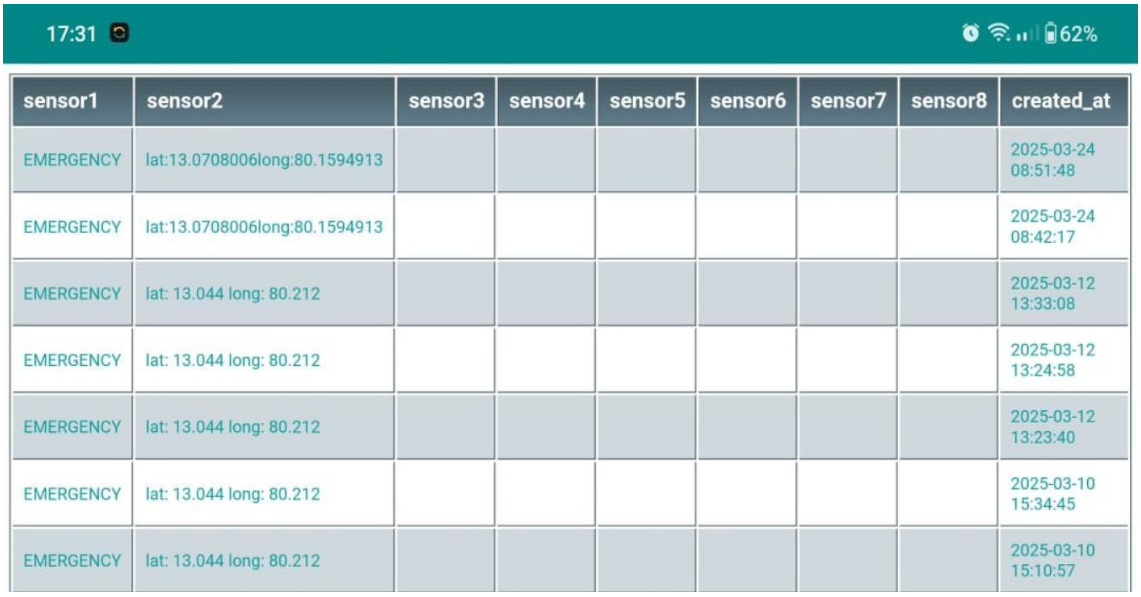


**Fig A.3.3: Emergency Alert Enable**



| sensor1 | sensor2 | sensor3 | sensor4 | sensor5 | sensor6 | sensor7 | sensor8 | created_at |
|---|---|---|---|---|---|---|---|---|
| EMERGENCY | lat:13.0708006long:80.1594913 | | | | | | | 2025-03-24 08:51:48 |
| EMERGENCY | lat:13.0708006long:80.1594913 | | | | | | | 2025-03-24 08:42:17 |
| EMERGENCY | lat: 13.044 long: 80.212 | | | | | | | 2025-03-12 13:33:08 |
| EMERGENCY | lat: 13.044 long: 80.212 | | | | | | | 2025-03-12 13:24:58 |
| EMERGENCY | lat: 13.044 long: 80.212 | | | | | | | 2025-03-12 13:23:40 |
| EMERGENCY | lat: 13.044 long: 80.212 | | | | | | | 2025-03-10 15:34:45 |
| EMERGENCY | lat: 13.044 long: 80.212 | | | | | | | 2025-03-10 15:10:57 |

**Fig A.3.4: Emergency Alert Database**

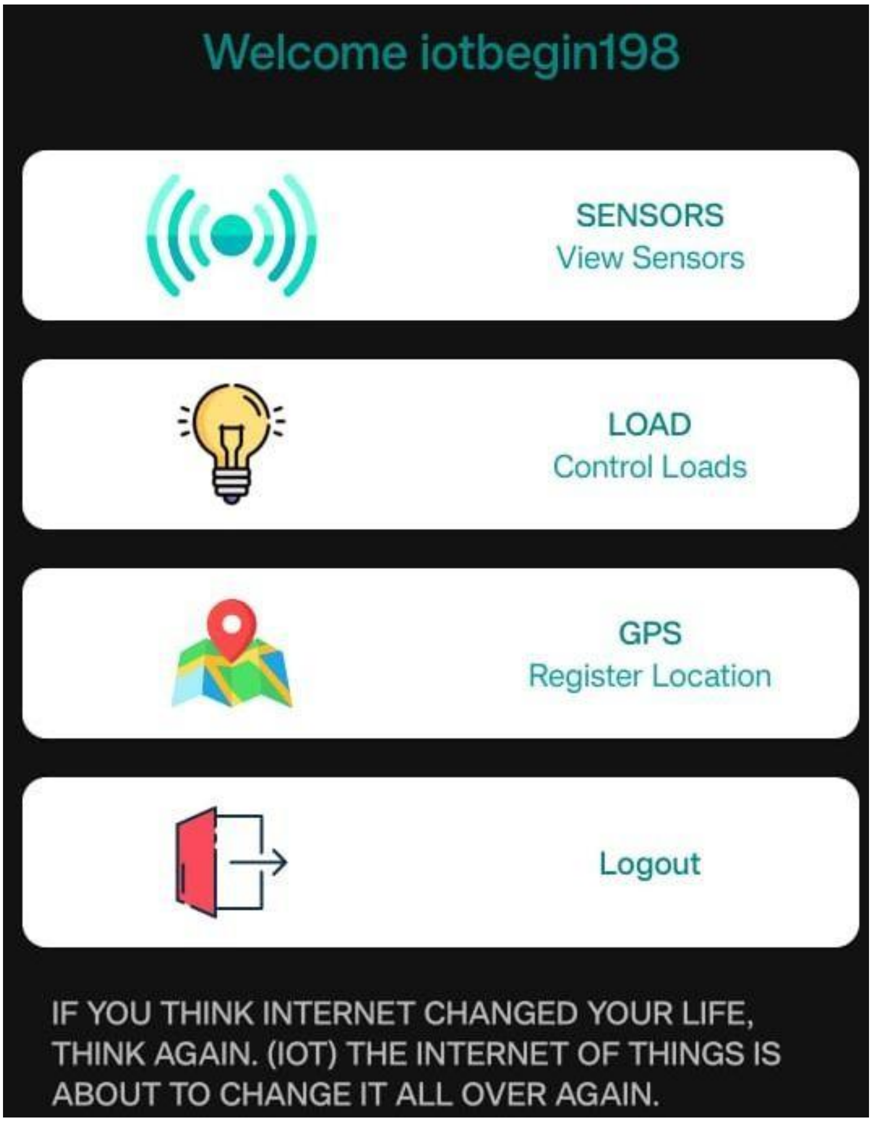



**Fig A.3.5: Emergency Alert Application**

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# Offline Speech and Gesture-Controlled Smart System for Accessibility and Safety

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## ABSTRACT

5 According to a survey census done by the World Health Organization (WHO) An estimated 1.3 billion people worldwide—approximately 16% of the global population—experience significant disability. Despite these substantial discussions surrounding the safety and support of individuals with disabilities often remain unresolved. To address this critical issue, we propose the development of a system that empowers disabled individuals to control electrical devices without the need for internet connectivity. This system will integrate speech and gesture recognition technologies, enabling users to operate appliances through natural interactions, thereby enhancing accessibility and independence. Additionally, the system will feature an emergency safety mechanism, allowing users to alert caregivers, family members, or neighbors in times of distress. By combining intuitive control interfaces with robust safety features, this project proposes a comprehensive and an efficient solution that aims to improve the quality of life for people with disabilities.

6

***Key Words: Sensor, Arduino, IoT, Safety, Equality, Privacy.***

## 1. INTRODUCTION

11 In a world where technology is advancing rapidly, accessibility and inclusivity remain crucial aspects of innovation. Individuals with disabilities, often encounter difficulties in performing everyday tasks such as controlling home appliances. Traditional systems rely heavily on manual switches or mobile applications, which can be inaccessible or inconvenient for such users. Additionally, many smart home automation solutions depend on internet connectivity, limiting their reliability in regions with poor network coverage.

To address these challenges, we propose an Offline Speech and Gesture based Smart Home Automation System designed specifically for individuals with disabilities. This system leverages speech and gesture recognition technologies to enable seamless and natural interaction with home appliances, eliminating the need for physical switches or internet access. By integrating an emergency alert mechanism, the system also enhances user safety, providing a holistic solution for independent living.

By prioritizing accessibility, reliability, and ease of use, this system bridges the gap between technology and inclusivity. It contributes to a future where smart home automation is accessible to everyone, regardless of their physical abilities.

## 2. RELATED WORKS

M. Periša et al, proposed a paper [1] that introduces an innovative approach to assistive technologies for individuals with disabilities. It emphasizes the importance of collecting and storing data in well-structured databases to generate predictive user information based on user profiles. The paper highlights the role of AI and ML in improving accessibility and autonomy by providing predictive insights into user preferences, habits, and potential incidents while also discussing a conceptual mathematical model for generating user-specific information, virtual assistants to manage home devices through speech.

Y. B. Anwaraly et al, developed a system [2] that integrates various hardware components, including a gesture sensor, Bluetooth module, Arduino, LCD display, and a 4-channel relay module to manage devices such as fans, lights, etc. Voice commands and hand gestures are processed via Arduino, activating or deactivating appliances through relay modules. The Bluetooth module allows remote operation via smartphones, enhancing convenience and accessibility. A LCD display provides real-time feedback and status updates, improving user experience with clear and concise information.

N. Chumuang et al, designed an assistance system for aged people [3] using voice commands by implementing speech recognition technology. This system is designed in a way it is useful for elderly individuals and also reduces their labour costs associated with hiring trustworthy care-takers. It also implements the principles of the Internet of Things (IoT) to control various household electrical devices through voice commands. Through the Natural Language Processing (NLP), the system interprets the voice commands, allowing users to control lights, applications, make phone calls etc.

R. Manjesh et al, published a paper [4] explores the development and potential of hand and face gesture recognition systems, which use machine learning (ML) and other computer-vision techniques for effective communication and interaction for individuals with physical disabilities. The paper stresses upon the importance of user-centered design and accessibility standards for real-world deployment, emphasizing the significant impact of gesture recognition technology in improving the quality of living.

P. R. Bagane et al, developed a system [5] enhances mobility, safety, and independence by utilizing advanced sensors like ultrasonic and infrared to detect obstacles and hazards in real-time. It provides timely audio and haptic feedback through Bluetooth-enabled earpieces or wearable devices, ensuring users can navigate safely without excessive information. The system also incorporates machine learning techniques to differentiate between stationary and moving objects, and its GPS and voice-command features assist with navigation.

## 3. PROPOSED WORK

This paper presents a system that utilizes voice commands and gestures as input through voice recognition and gesture sensors to enable disabled individuals to control electrical devices seamlessly. The proposed system aims to enhance accessibility and independence by providing an intuitive interface for device control. Additionally, the system incorporates a safety alert mechanism designed to offer immediate assistance when necessary, ensuring the well-being and security of users in critical situations.

### 3.1 The Architecture of the project

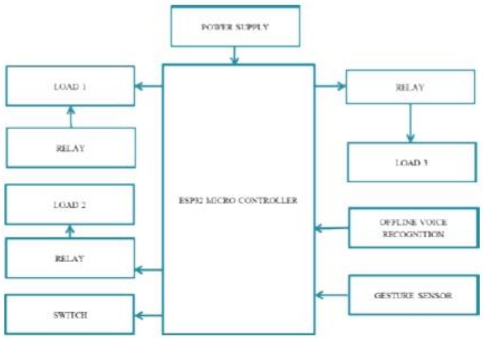


**Fig.1 Architecture of the Proposed Work**

## HARDWARE REQUIREMENTS

### 3.1.1 VOICE RECOGNITION SENSOR

Voice recognition, a sophisticated technology that analyzes and converts speech commands into editable texts or other forms of input. This speech recognition sensor works in offline mode and is built on a customized microprocessor that allows voice recognition without an internet connection. Its twin microphone design improves noise resistance high accuracy and dependability even in noisy conditions.

**Fig.2 Voice Recognition Module**

### 3.1.2 GESTURE SENSOR

A gesture sensor detects and converts hand gestures into commands for a variety of applications, including smart home automation, robotics, and gamingThe operating idea is based on infrared (IR) technology, with an IR LED generating light and four directional photodiodes sensing reflected IR light from hand movements in four directions (UP, DOWN, LEFT, and RIGHT). The sensor uses an algorithm to determine the gesture direction, then transfers the data to a microcontroller via I2C, where it can interpret and execute actions based on the identified gestures.


**Fig.3 Gesture Sensor**

### 3.1.3 ESP32 Microcontroller

Espressif Systems developed the ESP32, a powerful and adaptable SoC microcontroller for IoT,
2 embedded, and real-time applications. With up to 34 programmable GPIOs, motor and LED PWM, the ESP32 is an excellent solution for IoT developers and hobbyists seeking great performance, connectivity, low battery consumption, and better security.

13

**Fig.4 ESP32 Microcontroller**

### 3.1.4 Power Supply Adapter

An AC adapter, sometimes known as a "recharger," transforms high-voltage AC from a household power supply (220-230VAC) to low-voltage DC (12VDC) suited for powering or charging consumer
8 electronics, assuring safe operation of devices with varying power requirements. They also allow smooth data exchange between front-office and back-office systems and provide access to consistent, reliable information.

### 3.1.5 Relay Board

A relay board is an electromechanical switch that can be controlled both electrically and physically. A relay is made up of an electromagnet and a set of contacts, with the electromagnet acting as a switch. A four-relay board configuration consists of a driver, a power supply circuit, and an isolation circuit, with which the relay is integrated into an arrangement. With a 12VDC input voltage, the relay board enables quick switching and allows for tasks such as motor forward and reverse control. Its uses include AC and DC load switching and motor control, which is an integral component in many industrial and electronic systems.

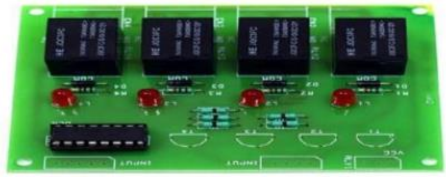

**Fig.5 Relay Board**

**SOFTWARE REQUIREMENTS**

### 3.1.8 Arduino IDE

Arduino- Integrated Development Environment (IDE) is a cross-platform application for Windows, macOS, Linux that is built using the functions of C and also C++. This IDE is used not only to write and upload programs to Arduino-compatible boards, and also other vendor development boards.


**Fig.6 Arduino IDE**

### 3.1.9 Embedded C

Embedded C is a C programming language extension designed specifically for the embedded systems, connecting high-level programming and low-level hardware control. It is widely used in automotive, IoT, and signal processing and provides high-level abstraction for low-level processes, making it an effective tool for developing embedded applications.

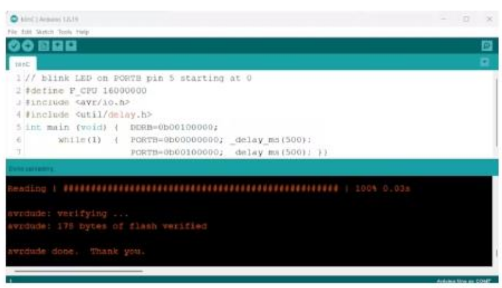

**Fig.7 Embedded C**

### 3.2 Working of the Proposed System

The offline speech and gesture-controlled system is designed to assist people with any sort of disability in operating required electrical items without physical involvement. The system runs entirely offline, removing the need for an internet connection, hence increasing privacy, reaction time, and reliability by processing commands locally. The core of this system is the ESP32 microcontroller, which incorporates an offline voice recognition module that can store and match predefined speech commands such "turn on," "turn off," "fan," and "light." During the initial setup, consumers record their voice for particular requests, which the system recognises and performs promptly.

The system also contains a PAJ7620 gesture sensor for spoken commands, providing an alternate control mechanism based on programmed hand gestures. This allows users to control appliances with simple hand gestures like swiping left to turn on the light, right to turn it off, up to start the fan, and down to deactivate it. This dual-mode control method increases accessibility by allowing users to switch between speech and gesture-based interactions based on their preferences or convenience. The ESP-32 micro-controller acts like the central processing unit(CPU), communicating with the speech recognition module, gesture sensor, and the relay modules to operate electrical appliances. The relay functions as switching devices, enabling the system to turn lights and fans on and off when needed.

Its offline nature protects user privacy because no data is sent to other servers. This makes the system appropriate for residential settings, aged care institutions, and rural places with minimal internet connectivity. The system is also expandable, allowing users to extend control to many appliances by including more relay modules.

### 3.3 Experimental Results


**Fig.8 Alert Message Database**

Fig.8 represents the application output. When the user gives a specific command, after the execution of the command, the action is recorded on the app.

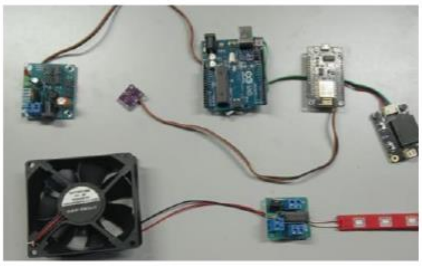

**Fig.9 Hardware Setup**

Fig. 9 demonstrates the overall setup of the electrical components the proposed system.

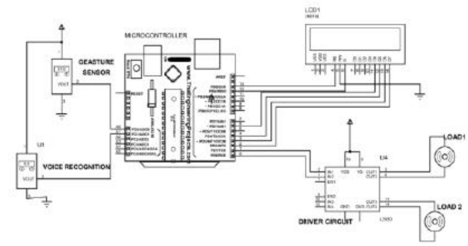


**Fig.10 Load Control**

Fig. 10 uses gesture and voice recognition to operate electrical loads via a microcontroller and motor driver circuit.

### 4. CONCLUSION

To sum up, this project effectively illustrates a complete offline enabled-home automation system designed to improve the disabled people's standard of living. The technology ensures accessibility and convenience without depending on internet connectivity by combining voice recognition and gesture-based controls to provide an easy-to-use interface for controlling household appliances. The system's usefulness is further enhanced by the addition of an emergency safety mechanism, which gives users more security and freedom.

### 5. FUTURE SCOPE

To achieve better results and advance the technological capabilities of our project, we plan to incorporate key features and functionalities inspired by Amazon Alexa and Google Assistant. This integration will enhance

10 overall performance, improve functionality, and significantly increase ease of use, particularly for individuals with disabilities. By leveraging voice-controlled technology, intelligent automation, and personalized assistance, our project will provide a more accessible and user-friendly experience, empowering disabled users with greater independence and convenience.

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## A.5 PAPER PUBLICATION

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