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# EMERGENCY CALL AND MESSAGE SYSTEM FOR PEOPLE WITH EPILEPSY

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## ABSTRACT

Epilepsy, a long-term neurological disorder, is characterized by sudden seizures that can cause severe health hazards, such as physical injury or even death due to unexpected complications. Traditional emergency measures tend to rely on human observation, which can be inconvenient or delayed, particularly in remote settings. This highlights the urgent need for an automated, reliable system to detect seizure activity early and alert supporting groups, thus improving the security and quality of life for individuals with this disorder.

Our system presents a new alert and communication system, developed on an Arduino platform, to solve these problems. The device uses a MEMS sensor to identify abnormal patterns of movement characteristic of a seizure, a GPS module to locate the person's precise location, and a GSM module to send emergency messages with location information to specified parties. It also includes an audible alarm to alert surrounding people and an LCD panel to show real-time system activity, making a strong emergency response network.

This budget-friendly and streamlined method represents a considerable step forward in treating epilepsy emergencies by providing swift help in times of need. Utilizing wearable technology and automated alerts, the system eliminates risk delays while simplifying accessibility. Validated through effectiveness and usability testing, this technology opens doors to wider implementation in intelligent healthcare, and better safety and care for epilepsy sufferers are guaranteed.

**Keywords:** Epilepsy, Seizure Detection, Emergency Response, MEMS Sensor, GPS Module, GSM Module, Arduino Uno, NodeMCU, LCD Screen, Buzzer.

## I. INTRODUCTION

Epilepsy is one of the most prevalent neurological conditions, affecting millions worldwide with its defining characteristic: sudden, uncontrolled seizures. The episodes may range in severity, from fleeting loss of consciousness to devastating convulsions, and present serious risks, including physical injury, psychological trauma, and, in the very rare but otherwise critical instances, sudden unexpected death in epilepsy (SUDEP). The unpredictability of such events is a recurring challenge, especially for those who live alone or in isolated settings where immediate support is not always assured. In spite of medical advancements, dependence on manual recognition by caregivers or passersby usually leads to delayed action, which underscores an essential shortcoming in existing emergency management protocols for this group.

The need to close this gap has motivated the development of technology-based solutions with the capability to recognize seizures automatically and take appropriate interventions in time. Current methods, like wearable devices that use simple motion sensors, have been encouraging but suffer from drawbacks such as variable detection rates and reliance on fault-prone communication channels. This has led to the development of new systems capable of integrating fault-tolerant sensing, accurate localization, and effective alerting. Our study addresses the demand with a proposed emergency call and message system tailored for use by epileptic patients that uses an Arduino-based platform to provide a feasible and simple safety-improving device.

This research presents a system that integrates a MEMS sensor to sense unusual movement, a GPS module for real-time positioning, and a GSM module for automated alerts sent to specified contacts, supplemented by a buzzer for local alarm and an LCD display for monitoring status. Automating the sensing and responding process aims to decrease response times and help eliminate risks during seizures. Aside from its direct use, this paper aims to be of value to the wider domain of wearable health technologies, providing a scalable solution that can be implementable for other medical emergencies. In thorough design, implementation, and assessment, we examine how this is possible and can change the state of epilepsy care, offering a lifeline that enables users and assists healthcare professionals in being able to offer timely aid.

**1.1 OBJECTIVES**

1. **Design an automated seizure response system:** Design and install an embedded technology and smart algorithm-driven system to recognize epileptic seizures, increasing safety with real-time tracking and customized emergency alerts.
2. **Improve seizure detection accuracy:** Include a MEMS sensor, plus additional health metrics such as heart rate and temperature, to detect seizure patterns with higher accuracy, reducing false alarms and missed occurrences.
3. **Provide instant warning and supervision:** Display real-time seizure detection information on an LCD screen and activate a buzzer to alert people around them, allowing rapid response to ensure the well-being of the user during critical seizures.
4. **Enhance emergency response plans:** Utilize AI-driven analytics to analyze sensor data, refining alert protocols and coordination with emergency contacts to enhance the efficiency of interventions in different scenarios.
5. **Provide an affordable and scalable solution:** Create a system that is both economic and scalable, making it suitable for use across different settings and enabling future upgrades to accommodate changing epilepsy care needs.

**1.2 LITERATURE SURVEY**

**1. Development of an IoT-Based Seizure Alert System**

The paper introduces an IoT-enabled platform for real-time monitoring of epileptic seizures, with a wearable device connected to a basic web interface. The system employs motion sensors and a GSM module to alert caregivers, with data being stored on a basic server. It provides remote monitoring, although its efficacy relies significantly on the availability of stable network connectivity.

**2. Overview of IoT Systems for Epilepsy Monitoring**

This analysis reviews IoT-based setups for detecting seizures, focusing on sensor choices, microcontroller units, and communication methods like SMS. It stresses the importance of selecting reliable sensors, such as accelerometers, and effective data transmission to support patient safety, identifying areas where connectivity can be a limiting factor.

**3. Design of IoT-Enabled Emergency Alert for Epilepsy**

This study creates an emergency alert system in an IoT environment for epilepsy patients. It combines motion sensing and location tracking to support vulnerable populations such as children, with the requirement for rapid alerts, although its flexibility to varied locations needs to be investigated further.

**4. Multi-Sensor Setup for Seizure Detection Alerts**

This is a low-cost system employing multiple sensors to detect seizures and initiate alarms. It uses real-time motion and vital sign sensor data to alert caregivers with a goal of precise response, but its real-world use in diverse environments requires more testing.

**5. Automated Seizure Response Techniques**

This resource describes systems that automatically modulate alerts in response to seizure activity detected, employing straightforward metrics such as movement and heart rate. These configurations alert contacts through basic communication devices, providing a pragmatic solution, although their effectiveness relies on reliable sensor performance and network connectivity.

**6. IoT-Based Real-Time Seizure Monitoring Platform**

This article describes an IoT platform that gives live seizure status and saves history to review using a simple interface. Basic alert settings are included to let caregivers know if there are problems, and this is handy for continuous monitoring, although its dependability in low-signal environments is not yet guaranteed.

**7. Wearable Devices for Epilepsy Emergency Alerts**

This research evaluates wearable devices that employ accelerometers to identify seizures and transmit location-based alerts to emergency contacts. It points out their ability to accelerate responses, particularly during nighttime, but mentions concerns regarding intermittent false alarms and the requirement for easy-to-use design.

**8. IoT Integration for Basic Epilepsy Care**

This study investigates IoT application in the management of epilepsy, with an emphasis on real-time data collection and basic alert systems. It posits that simple sensor networks can assist caregivers but issues such as data privacy and device comfort need to be addressed for extensive application.

**9. Recent Progress in Seizure Detection with Wearables**

This article discusses wearable sensors that monitor movement and vital signs to detect seizures, providing a practical means of alerting others. It demonstrates enhanced detection for severe seizures, but long-term use and sensor longevity are areas requiring more research.

**10. Simple Sensor Systems for Epilepsy Monitoring**

This paper assesses simple sensor configurations, such as motion sensors, to track epilepsy and provide alerts. It illustrates their potential to help in seizures, although constraints in sensor sensitivity and communication availability indicate areas for real-world improvements.

## II. METHODOLOGY

The system to be proposed will identify epileptic seizures and initiate emergency measures using a mix of sensors and control units. It will employ a MEMS sensor to sense abnormal movement patterns associated with seizures, a GPS module for location tracking of the user, and a GSM module for sending automatic alerts to registered contacts. An Arduino Uno handles the sensor information, comparing it to predetermined thresholds to trigger the response sequence, making for a practical and reliable operation.

When the MEMS sensor detects movement beyond pre-set thresholds, the system triggers a buzzer to alert the surrounding people and displays the current status on an LCD screen for local observation. The GPS module offers location information, which the GSM module adds to an SMS message sent to emergency contacts, allowing quick response. The system operates independently, using a straightforward threshold-based method to prevent extensive calculations, making it easy and efficient.

The major elements of this approach are discussed below:

**MEMS Sensor:** Tracks movement to detect seizure events with accuracy.

**GPS Module:** Identifies the user's precise location for emergency alerts.

**GSM Module:** Sends SMS messages with location information to predefined recipients.

**Arduino Uno:** Controls sensor inputs, performs threshold tests, and operates device functions.

**Threshold-based Approach:** Relies on predefined movement thresholds to recognize seizures and invoke responses.

**Buzzer:** Creates a sound warning to alert individuals nearby.

**LCD Screen:** Shows real-time status updates for real-time local monitoring.

## III. REQUIREMENTS

### 3.1 SOFTWARE REQUIREMENTS

Software Requirements List sorted by the mentioned components for designing an overall system:

**Arduino IDE**

Arduino IDE is an open-source software that gives a friendly environment for programming the Arduino Uno microcontroller, which is suitable for beginners and experienced programmers. The latest popular version, e.g., 1.0.5, supports sample codes and a straightforward interface to interface the Arduino board to a personal computer using USB. This software provides support for writing and uploading code for handling sensor information and device settings, thus serving as a practical option to utilize in the construction of the seizure detection system.

**Programming Language:**

**C:** This is the basis for programming firmware for the Arduino Uno using a simple syntax that mixes well with embedded systems. C programs may be stored directly in the microcontroller, providing efficiency and ease of maintenance. It provides the ability to use existing code libraries, enables portability among various microcontrollers with minimal adjustments, and offers basic extensions for dealing with tasks such as sensor input and output operations, making it appropriate for the system's threshold-based logic.

### 3.2 HARDWARE REQUIREMENTS

#### 1. MEMS Sensor

The MEMS sensor is an advanced but small 3-axis accelerometer designed to sense high degrees of motion fluctuation with high sensitivity. Constructed on piezo-resistive or capacitive technology, the sensor tests acceleration on the x, y, and z axes, allowing it to record subtle changes and high-speed movement accurately. Its design consists of a central mass suspended on flexible beams, which transduce mechanical motion into electrical signals, providing a consistent means of motion monitoring. Low power utilization, usually in the microwatt order, and its compact footprint make it perfectly integratable in wearable devices, thus maintaining usability over extended periods without battery replacement. Moreover, its strength and resistance to weather conditions such as temperature variations make it even more appropriate for perpetual use in varied environments.

The MEMS sensor acts as the foundation of the seizure detection system by continuously tracking movement patterns to detect epileptic seizures. It works by comparing motion that has been detected with a set of predetermined thresholds, in which an excess of these triggers a possible seizure event. Once detected, the sensor triggers an electrical signal that is transmitted to the Arduino Uno, which triggers the emergency response sequence. This procedure ensures quick system response to out-of-norm activity, prompting subsequent notifications and status messages, which are essential for ensuring safety in cases of seizure incidents. The reliability of the sensor to function over a long duration enables persistent monitoring, creating a secure underpinning for the detection system as a whole.

#### 2. GPS Module

The GPS module is a sophisticated but small navigation tool that calculates location by receiving and interpreting signals from a network of satellites in orbit around the Earth. With a sensitive antenna and a microcontroller, it computes the position via trilateration, providing accurate latitude and longitude information in the form of NMEA string at a default baud rate of 9600. The module has a straightforward pin configuration of VCC, GND, TX, and RX for easy connection into electronic systems. Its light weight and low power requirements, frequently under 50mA, render it appropriate for use in portable devices, and its operation in open or partially blocked environments guarantees extensive applicability. The device also has inbuilt error correction to ensure accuracy regardless of signal variability.

The GPS module improves the seizure detection algorithm through the use of real-time location information in an emergency occurrence. This data is recorded in real time and gets activated upon detection of a seizure, providing the precise location required for efficient response coordination. The data is passed to the GSM module, where it is inserted into SMS alerts delivered to preconfigured contacts, allowing responders to identify the affected region quickly. This location tracking feature significantly boosts the efficiency of the delivery of assistance in that help reaches the exact location where the seizure takes place. The dependability of the module in various environments also enhances the strength of the system to work effectively in various contexts.

#### 3. GSM Module

The GSM module is a powerful communication device that is meant to facilitate wireless data transmission via mobile networks, using Time Division Multiple Access (TDMA) technology. The module functions over frequency bands like 850–1900 MHz and needs a compatible SIM card to establish connections with cellular networks for the transmission and reception of messages. It has a modular design with such components as a mobile station, base station subsystem, and network subsystem, for efficient signal processing and data management. It contains several input/output pins to be used for connecting microcontrollers and a power supply unit to accommodate its functionality on 3.3V or 5V, depending on the model. Its small size and capability to operate in places with good network coverage make it a convenient option for emergency communication systems.

The GSM module complements the seizure detection system by enabling the sending of emergency messages to specified contacts. When it receives a signal from the Arduino Uno that a seizure has occurred, it sends an SMS containing the location information from the GPS module. This alert is sent automatically across the mobile network so that caregivers or emergency services receive notification immediately. The module's ability to work reliably in range of the network improves the system's capacity for coordinating a timely response, filling the gap between detection and help. Its interface with other modules provides a coordinated alert system that is essential in ensuring safety in seizure episodes.

**4. ARDUINO UNO**

Arduino Uno is a generalized microcontroller board based on Atmega328P processor that performs different input/output tasks in electronics systems. The board has 14 digital pins with input/output capability, among which 6 can perform the pulse-width modulation, and it has 6 analog input pins to offer accommodation for several devices and sensors for easy connection. It runs at a clock speed of 16 MHz and has a 5V power supply. It features a USB interface to program and communicate with a PC. Small in size, around 68.6 x 53.4 mm, with an onboard LED for status light and a reset switch, it is a trustful and easy-to-use platform. The board also has an external power alternative through a barrel jack, further increasing its suitability for mobile use.

The Arduino Uno is the processing unit in the seizure detection system, regulating data exchange between attached sensors. It takes readings from the MEMS sensor to identify seizure incidents, processes the location information from the GPS module, and handles alert transmission through the GSM module. On threshold violation, it triggers the buzzer and refreshes the LCD display with status data, providing a coordinated response. The capability of this microcontroller to run programmed logic effectively enables the operation of the system, facilitating uniform monitoring and alert generation in seizure events.

**5. NodeMCU**

The NodeMCU is a small development board on the ESP8266 Wi-Fi microcontroller with basic connectivity and control features. It has 17 GPIO pins for connecting to external devices, a MicroUSB port for programming and power supply, and a built-in 3.3V regulator to enable its usage. The board runs at 80 MHz with the possibility of over-clocking to 160 MHz, offering adequate processing resources for basic functions, while its compact size—around 49 x 24 mm—contributes to increased portability. With a flash memory capacity of up to 4MB, it allows for firmware downloads and can execute basic input/output functions, making it an auxiliary device for system expansion. Its power-saving mode also increases its applicability in battery-powered configurations.

The NodeMCU helps the seizure detection system by offering more connectivity options for possible future upgrades. It communicates with the Arduino Uno to enable simple data processing or auxiliary operations, like expanding the reach of the system through basic network operations if necessary. Although its function is essentially backup, it still guarantees flexibility when incorporating extra features or surveillance aspects while keeping the system's center on seizure detection and triggering alerting through buzzer and GSM module. It enhances the scalability of the system without using sophisticate technologies.

**6. LCD Screen**

The LCD display is a 16x2 character LCD intended to display information clearly using a 5x7 pixel matrix per character. With 16 pins comprising power supply pins (VCC, GND), data pins (D0–D7), and control pins (RS, R/W, E), the module facilitates easy interfacing with a microcontroller. It runs at 5V with an onboard contrast adjustment through a potentiometer, providing readability under varying lighting conditions, and has a backlight option for increased visibility. The small size of the screen, usually around 80 x 36 mm, and its capability to show up to 32 characters in two lines make it a good output device for presenting real-time data. Its low power consumption contributes to its appropriateness for constant use.

The LCD monitor operates within the seizure detection system by reflecting real-time status messages, e.g., seizure detection or system ready. It takes input from the Arduino Uno, exhibiting vital information such as motion levels or alert status, which assists in local monitoring of the functioning of the system. This visual feedback makes the status available to those around, adding to the audio alerts of the buzzer and aiding the

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overall objective of safety during seizure occurrences. The clean output of the screen makes the system easy to use without needing complicated processing.

**7. Buzzer**

The buzzer is a piezoelectric sound device used to produce sound signals of 2300 Hz frequency. It gives a clear and noticeable tone. It works on a 5V power supply. The size of this small component is around 12 x 12 mm. It has two terminals, positive and negative, for easy interface with a microcontroller. Its design involves a ceramic disk that oscillates to generate sound, mounted in a basic housing to provide greater strength and resilience against minor environmental strains. The buzzer has low power consumption, usually measured in a few milliamps, so it is well-suited for extended application in battery-powered systems. Furthermore, its continuous tone generation makes effective signaling across diverse distances in a limited area.

The buzzer makes the seizure detection system work by providing a loud, continuous tone once a seizure is detected, acting as an alarm system locally. Triggered by the Arduino Uno through a signal from the MEMS sensor that there is unusual movement, it alerts people nearby to respond. This sound signal augments the visual information from the LCD display so that the status of the system is conveyed efficiently, even under circumstances where vision-based monitoring may be restricted. The dependability of the buzzer in generating a uniform alert augments the overall safety reaction during the occurrence of seizures.

## IV. MODELING AND ANALYSIS

Such structured presentation promises consistency and inclusivity in projecting the necessary models and materials used by the seizure detection system.

Research and Requirement Analysis

Designing Hardware System

Plan Deployment and Maintenance

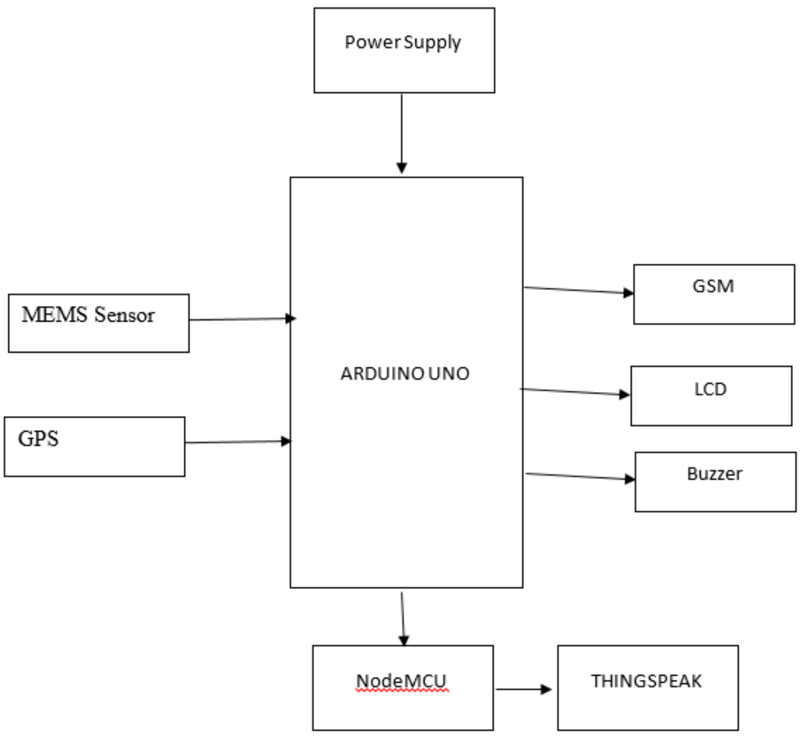


**Fig:** Block diagram of the emergency call and message system for people with epilepsy

The figure shows an organized block diagram for the creation of the seizure detection system. The process is initiated with research and requirement analysis, where detailed needs are noted to facilitate the effective monitoring of seizures. The system is developed to automatically identify epileptic seizures and initiate alerts immediately to keep the user secure. The requirement analysis covers functional and non-functional requirements, examining system performance as well as dependability under practical conditions.

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**A. Functional Requirements**

**Sensor Integration:**

The system should effectively track movement and location factors by employing the following elements:

- **MEMS Sensor:** Identifies unusual movement patterns characteristic of seizures.
- **GPS Module:** Identifies the location of the user for coordination of emergency response.
- **GSM Module:** Provides SMS notification to specified contacts regarding events detected.

**Microcontroller Processing:** The Arduino Uno needs to process sensor data in real-time. It checks movement data against pre-set thresholds to detect seizures.

**Decision-Based Actuation:** When thresholds are crossed, the system needs to trigger the buzzer to alert people around.

**Data Visualization:** Show real-time status updates on the LCD screen for local observation.

**Supplementary Connectivity:** The NodeMCU provides basic support for potential hardware expansions.

**B. Non-Functional Requirements**

**Reliability:** The system must operate continuously with minimal interruptions, with components designed to withstand typical environmental variations and sensor wear.

**Scalability:** The design should allow for the addition of extra sensors or alert devices in the future to enhance functionality.

**Usability:** The LCD display must provide clear, understandable status data, without the need for specialized knowledge for observation. The alerts must be easy to understand.

**Cost-Effectiveness:** The system uses low-cost, common hardware to make it accessible for single or small-scale use.

Secondly, the hardware design phase comes into action. The hardware design of the designed seizure detection system is modular, combining movement sensors, location tracking, and communication modules with a central microcontroller. The design emphasizes real-time detection, rapid response, and local monitoring with simplicity and cost-effectiveness in practical deployment.

Thirdly, the project is headed towards deployment and maintenance planning in the next phase. The deployment and maintenance stage ensures the long-term operation of the seizure detection system. This involves mounting the MEMS sensor, GPS module, GSM module, Arduino Uno, NodeMCU, LCD display, and buzzer, with placement that maximizes performance. Components are so placed as not to be affected by external movement or signals, and the system is energized by a reliable source, with the possibility of battery backup for fail-safeness. For long-term operational functionality, the system needs constant but small maintenance.

The MEMS sensor must be inspected monthly for dust or wear to ensure accuracy, while the buzzer and LCD must be tested periodically to respond correctly. GPS and GSM modules need to have connections checked weekly to ensure signal integrity. Regular inspection and possible replacement of sensors or batteries are advised to maintain performance, keeping the system in good working order for seizure detection.

## V. RESULTS AND DISCUSSION

The system presented for seizure detection was tested within a controlled environment to simulate diverse movement patterns as a means to measure the effectiveness of its performance for the identification of epileptic seizures and the initiation of emergency measures. The test results indicate the system's potential for identifying unusual movements, issuing alerts on time, and local status reporting, showing its value in the promotion of safety during seizures.

**A. Sensor Response and Threshold Detection**

During the test, the system was able to detect seizure-like motions accurately with the MEMS sensor. Simulated movements that mimicked seizure patterns made the sensor detect notable deviations, which exceeded set thresholds within seconds. Once the thresholds were exceeded, the Arduino Uno switched on the buzzer, giving an audible alarm, while the GPS module offered location information that the GSM module integrated into an

SMS. This reaction verified the system's ability to detect and trigger alarms effectively on the basis of basic movement criteria.

### B. Real-Time Monitoring and Feedback

The LCD monitor reflected instantaneous status feedback, updating once a second to indicate movement rates and system operation. The local awareness of detection, immediate feedback from the system through the screen, had definitive indicators of alarm triggering. NodeMCU, although added in for possible development, facilitated minimum connectivity testing to verify that the system remained on task for local monitoring without over-reliance on third-party platforms, and therefore was not complicated and ensured reliability.

### C. System Efficiency

The response time of the system to threshold violations averaged less than 2 seconds, with the buzzer and SMS alerts triggering reliably. The sensors continued to work until movement returned to within normal limits, confirming the efficacy of threshold-based control logic. This quick response attests to the system's capability for seizure detection without high-level processing, guaranteeing pragmatic performance in emergency cases.

### D. Limitations and Improvements

Performance under test conditions was good, but extensive use could expose the MEMS sensor to wear, which could have a lasting impact on sensitivity. Maintenance like cleaning or recalibration could counteract this. Including a manual override switch or an expanded volume range of the buzzer would make it easier to use and more effective at warning, overcoming potential weaknesses in the variability of environments.

## VI. CONCLUSION

The suggested seizure detection system presents a realistic and efficient solution to improving safety during epileptic episodes through a simple threshold-based strategy. Through the constant monitoring of movement patterns and the generation of instant alerts, the system provides timely responses to seizure events, leading to increased protection in many environments. The use of predetermined thresholds makes it easy to design, avoiding complex processing, and accommodates an economical and reliable mechanism with readily available hardware. The addition of local monitoring through the LCD display and alert features through the buzzer and GSM module adds further to its functionality, providing an effective means of controlling emergency scenarios without the use of sophisticated technologies.

## VII. FUTURE SCOPE

**Mobile Alert System:** Creating a basic mobile interface might facilitate real-time alert messages and easy-to-view status display for caregivers, improving access to seizure detection status updates.

**Voice Notification Integration:** Incorporating voice system compatibility may enable audible notifications through voice-enabled devices such as smart speakers, serving as an additional notification channel in the system.

**Power Efficiency Improvements:** Adding low-power modes or battery backup features may enhance the system's sustainability to allow it to be used over longer periods in remote areas.

**Activity Trend Monitoring:** Collecting activity data over time may support basic trend analysis, providing insights into seizure patterns to help with long-term safety planning.

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