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Epilepsy Monitoring Based on IOT Communities

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ABSTRACT

Epilepsy is a neurological disorder characterized by recurrent seizures, which can be unpredictable and life-threatening. Traditional seizure detection methods, such as Electroencephalography (EEG), require clinical supervision and are not feasible for continuous real-time monitoring. To overcome these limitations, this project proposes an IoT-based Epilepsy Monitoring System that enables continuous, real-time health tracking and automated seizure detection.

The system uses biometric sensors to monitor key physiological parameters, including heart rate variability (HRV), body temperature, and motion activity. These sensors are integrated with a NodeMCU microcontroller, which processes the collected data and transmits it to a cloud platform (ThingSpeak or Firebase) for remote monitoring. In case of abnormal fluctuations that may indicate an impending seizure, the system triggers instant alerts via SMS, email, or a mobile application, ensuring timely intervention by caregivers and healthcare professionals.

This cost-effective, non-invasive, and real-time monitoring solution enhances patient safety, reduces hospitalization risks, and provides an efficient alternative to traditional monitoring methods. Future enhancements may include AI-based seizure prediction, smartwatch integration, and edge computing to improve accuracy and expand functionality. The implementation of this system significantly contributes to early seizure detection, emergency response, and improved quality of life for epilepsy patients.

INTRODUCTION

In today's world, health monitoring is a major issue. Patients suffer from serious health problems as a Result of a lack of proper health monitoring. There are many IoT devices available these days to monitor A patient's health over the internet. Health professionals are also using these smart devices to keep tabs on Their patients. IoT is rapidly revolutionizing the healthcare industry, with hundreds of new healthcare

Technology start-ups using patient health monitoring systemIn this project, we will create an IOT-based Health Monitoring System that will record the patient's pulse Rate and surrounding temperature. This system not only record these data but also update them in IOT Platform. The IOT platform used in this project is Thing Speak. Thing Speak is an open-source Internet Of Things (IoT) application and API to store and retrieve data from things using the HTTP protocol overThe Internet or via a Local Area Network.

Heart rate variability (HRV) is highly identified in seizures, it reflects autonomous nervous system

Disturbance and it can provide useful clinical information that can be used for seizure detection. For Decades, Electroencephalography (EEG) was the first device used to monitor brain signals and seizures.

However, using EEG is not practical cause it requires to attach electrodes to the head scalp and it takes Time to get results and it usually used during or after seizures occurred. To avoid EEG problems we need A detection system that can provide understandable data, easy to be used and capable of early intervention

So the patient have the chance to prevent seizures and its related side effects.

In this study, we plan to design epileptic seizure detection system by the heart rate monitoring with the Internet of things (IoT) based. The sensor used is a pulse sensor, it is used as a heart rate detector processed By NodeMCU, the test results and measurements will be real-time displayed on LCD and transmitted to ThingSpeak platform which it will be accessible to doctors, family members to follow the patient status. And temperature sensor used to deduct body temperature.

Some can detect changes to heart rate that can happen with some epileptic seizures. They work by sending

An alert to a mobile phone or in some cases, a call centre. You would usually wear the device around your Wrist, so they should work at home or while you're out and about .

OBJECTIVE OF THE STUDY

The primary objective of this study is to design and implement an IoT-based epileptic seizure detection System using heart rate variability (HRV) monitoring. This system aims to provide an early warning Mechanism for seizures by detecting irregular heart rate patterns, enabling timely intervention and Reducing potential complications.

The specific objectives of the study include:

1. Developing a Non-Invasive, Real-Time Monitoring System

Utilize a pulse sensor to measure heart rate variability and a temperature sensor to monitor body Temperature.Process and analyze real-time data using NodeMCU, a Wi-Fi-enabled microcontroller.Display live heart rate and temperature readings on an LCD screen for immediate visibility.

2. Providing IoT-Based Remote Access to Patient Data Transmit heart rate and temperature readings to ThingSpeak, a cloud-based IoT platform.Enable real-time data access for doctors, caregivers, and family members via a web dashboard or mobile Application.

Ensure continuous monitoring, even when the patient is not in a clinical setting.

3. Offering an Alternative to EEG for Seizure Detection

Address the limitations of traditional EEG-based monitoring, which requires electrode attachment and is Often used post-seizure.Provide a wearable, user-friendly, and cost-effective alternative for detecting seizure symptoms before They occur.

4. Enabling Early Intervention and Emergency Alerts

Detect abnormal fluctuations in heart rate and temperature, which are potential indicators of seizures.Develop a notification system that alerts caregivers and medical professionals via IoT platforms, allowing For timely intervention.

5. Enhancing Future Healthcare Applications

Lay the groundwork for AI-based seizure prediction models that can improve detection accuracy.

SOFTWARE DESCRIPTION

The software for the IoT-based epileptic seizure detection system is designed to ensure seamless data Acquisition, processing, and transmission in real time. It consists of embedded firmware running on the NodeMCU microcontroller, cloud-based storage via ThingSpeak, and a user-friendly interface for remote Monitoring. The firmware, written in C programming using the Arduino IDE, is responsible for reading Data from the pulse sensor and temperature sensor, filtering noise, and calculating heart rate variability (HRV). The ESP8266 Wi-Fi module embedded in NodeMCU enables wireless data transmission to the Cloud.

ThingSpeak is used as the cloud platform for storing, analyzing, and visualizing patient data. It provides A real-time dashboard accessible by doctors and caregivers, allowing them to monitor heart rate trends And temperature fluctuations remotely. The software integrates HTTP-based communication between NodeMCU and ThingSpeak, ensuring secure and reliable data transfer. Additionally, a mobile app or web Dashboard (developed using Flutter or Kodular) enhances user experience by providing live health Monitoring, historical data tracking, and emergency alerts. If the system detects abnormal physiological Patterns that indicate a potential seizure, it can automatically trigger notifications to caregivers, enabling Early intervention.

To enhance efficiency, the software utilizes various libraries such as ESP8266WiFi.h for internet Connectivity, ThingSpeak.h for cloud communication, and PulseSensorPlayground.h for heart rate signal Processing. The system workflow involves continuous sensor data collection, real-time display on an LCD Screen, cloud storage via Wi-Fi, and remote access through a mobile app or web interface. This ensures a Comprehensive, real-time, and accessible health monitoring solution, providing an alternative to EEG-Based seizure detection while improving patient safety and response time.

1.Arduino uno Board microcontroller

2.LCDDisplay16x2LCDDisplay1

3.Potentiometer10K1

4.ESP8266-01Wifi Module1

5.Pulse SensorPulseSensor.

6.LM35Temperature Sensor1

7.Connecting wiresjumper wiresome

8.BreadboardNormal1

SYSTEM STUDY

EXISTING SYSTEM

Traditional epilepsy monitoring systems rely on hospital-based Electroencephalogram (EEG) Monitoring, caregiver observation, and wearable motion-based devices. EEG is the most Commonly used method for diagnosing epilepsy, as it records abnormal brain activity through Electrodes placed on the scalp. However, this method is limited to hospital settings, requires Specialized equipment, and is not suitable for continuous real-time monitoring. Additionally, EEG Monitoring can be uncomfortable for patients due to prolonged electrode attachment and is Expensive, making it inaccessible to many individuals.

Another common approach involves caregiver-based observation, where family members or Healthcare providers monitor the patient for visible seizure symptoms. While this method allows For immediate assistance, it is unreliable, especially for nocturnal seizures or when the patient is Alone. Human errors and delays in response time further reduce its effectiveness. Additionally, Many caregivers rely on manual seizure diaries, which require patients or their families to Document seizure occurrences. However, this method is prone to inaccuracies, missing data, and Inconsistent tracking, leading to challenges in medical diagnosis.

Wearable devices such as smartwatches and wristbands have been developed to detect seizures Using accelerometers and motion sensors. These devices monitor sudden jerky movements Associated with seizures and send alerts to caregivers. However, they are limited to detecting Convulsive seizures and cannot identify non-motor seizures, such as absence seizures .

PROPOSED SYSTEM

The proposed IoT-based Epileptic Seizure Monitoring System is designed to provide real-time Health monitoring, automated seizure detection, and instant emergency alerts to caregivers and Medical professionals. This system overcomes the limitations of traditional epilepsy monitoring Methods by integrating biomedical sensors, a microcontroller (NodeMCU ESP8266), cloud-based Storage (ThingSpeak/MQTT), and a mobile application (Flutter/Kodular) to ensure continuous Monitoring and remote access to patient data. The system uses a pulse sensor to monitor heart rate Variability (HRV) and a temperature sensor to track body temperature changes, as both parameters Exhibit significant fluctuations during seizures.When a seizure is detected based on abnormal HRV And temperature variations, the NodeMCU processes the data and transmits it to the ThingSpeak Cloud platform for remote monitoring. Simultaneously, the system sends an instant emergency alert To caregivers and doctors through a mobile application and SMS notifications. The mobile app Allows caregivers to remotely access real-time patient health data, reducing the response time for Medical intervention. Additionally, the cloud-based storage of seizure data enables long-term Health pattern analysis, helping doctors make informed treatment decisions.Unlike traditional EEG-based methods, which require hospital visits and specialized equipment, this IoT-basedSystem is portable, cost-effective, and suitable for continuous home monitoring.

SYSTEM DESIGN AND DEVELOPMENT

FILE DESIGN

The system stores real-time health data collected from sensors, including heart rate variability (HRV) and body temperature, in structured files. These files help in detecting seizure patterns and Ensuring quick medical intervention. The sensor data file continuously logs time-stamped readings From the sensors, storing critical health parameters along with their status (normal or abnormal). If a seizure is detected based on abnormal fluctuations in HRV and temperature, an entry is created In the alert log file, which records the patient ID, the nature of the alert, and the contact details of The caregiver who received the emergency notification. Additionally, a patient record file maintains Personal and medical details, such as patient ID, name, age, history of epilepsy, and emergency Contact information, which is crucial for long-term monitoring and treatment planning.For cloud Integration, the system transmits sensor readings to ThingSpeak/MQTT, where the data is stored And displayed for remote access by caregivers and doctors. This ensures that medical professionals Can review past seizure occurrences and analyze trends for better treatment strategies. The mobileApplication retrieves data from both local storage and the cloud, allowing users to view real-time Updates and receive emergency alerts.By implementing a well-structured file design, the system Ensures efficient data logging, quick retrieval, and secure remote access, making the seizure Monitoring process reliable, scalable, and user-friendly.

INPUT DESIGN

The main inputs come from the pulse sensor (which monitors heart rate variability) and the Temperature sensor (which tracks body temperature). These sensors continuously capture data and Send it to the NodeMCU microcontroller, where it is processed to detect abnormal fluctuations that May indicate a seizure. The microcontroller then transmits this data to ThingSpeak/MQTT for Cloud storage, enabling remote monitoring.Additionally, the mobile application provides an Interface where caregivers and medical professionals can input patient details, medical history, and Emergency contact information. This data is stored securely in a cloud database for easy access During emergencies. The system also allows caregivers to set alert preferences, such as choosing Whether to receive SMS notifications, mobile alerts, or email notifications when a seizure is Detected.To ensure data accuracy and reliability, the system applies preprocessing techniques to Filter out noise or incorrect sensor readings before analyzing the data for seizure detection. With An intuitive and structured input design, the system guarantees real-time monitoring, accurate data Collection, and seamless communication between patients, caregivers, and healthcare providers.

OUTPUT DESIGN

The output design of the IoT-based Epileptic Seizure Monitoring System focuses on delivering Real-time health data and emergency alerts to caregivers and medical professionals. The system Generates output through multiple channels, ensuring efficient and immediate access to critical Information. The LCD display provides real-time feedback by showing the patient's heart rate and Body temperature, enabling quick local monitoring. Simultaneously, the microcontroller (NodeMCU ESP8266) processes sensor data and transmits it to ThingSpeak or MQTT cloud Storage, where it is stored and visualized for remote access. If abnormal readings indicating a Potential seizure are detected, the system activates an emergency alert mechanism, sending SMS, Emails, or push notifications to caregivers via a mobile application. The app also displays live Health statistics and historical trends, allowing users to analyze the patient's condition over time. This structured output design ensures that critical information is accessible through multiple Interfaces, improving response times and enhancing patient safety

DESCRIPTION OF MODULES

A. Data Collection Module (Sensor Module)

This module is responsible for gathering real-time physiological data from the patient using

Sensors. It includes:

Pulse Sensor – Monitors heart rate variability (HRV), detecting abnormal spikes or drops that may Indicate a seizure.

Temperature Sensor – Measures body temperature to identify fluctuations that may be linked to Seizure episodes.

B. Communication Module

This module enables real-time data transmission between the IoT device and remote cloud storage. It ensures that sensor data is sent securely and efficiently for processing and monitoring. It

Includes:

Wi-Fi Module (ESP8266 in NodeMCU) – Connects to the internet and sends patient data to the Cloud platform (ThingSpeak).

API Integration – Uses ThingSpeak APIs for secure data transmission and retrieval.SMS/Email Notification System – Sends instant alerts to caregivers and doctors if an anomaly is detected.

C. Control, Processing, and Display Module

This module is the core of the system, handling data processing, decision-making, and user

Interaction. It consists of:

NodeMCU Microcontroller – Acts as the brain of the system, processing sensor readings and Detecting seizure patterns.Data Processing Algorithm – Applies threshold-based analysis and machine learning models (if Implemented) to detect abnormal HRV and temperature fluctuations.

LCD Display – Provides real-time visualization of heart rate and temperature values, ensuring Local monitoring of patient data.

TESTING AND IMPLEMENT

Testing Phase

The testing phase is a critical stage in the development of the IoT-based epileptic seizure detection System to ensure its reliability, accuracy, and efficiency. It involves systematically evaluating Hardware components, software functionalities, and overall system performance. The testing phase Is divided into different levels to ensure the system operates correctly under various conditions.

1. Component Testing

Component testing is a crucial step in the IoT-based epileptic seizure detection system to verify That each hardware and software component functions correctly before system integration. This Phase ensures that all individual modules work as expected, minimizing errors during the later

2. Integrated System Testing

Integrated system testing ensures that all components of the IoT-based epileptic seizure detection System work together as a unified system. After individual components pass their respective tests,they are connected and tested as a complete unit to verify proper data flow, communication, and Functionality.

3. Field Testing

Field testing is the final phase of testing, where the IoT-based epileptic seizure detection system is Deployed in a real-world environment to evaluate its accuracy, reliability, and usability under actual Operating conditions. This testing ensures that the system performs effectively when monitoring Patients outside of a controlled lab setting.

Implementation Phase :

The implementation phase involves the actual deployment of the IoT-based epileptic seizure Detection system in a real-world environment after successful testing. This phase ensures that the Hardware, software, and cloud integration work seamlessly to provide continuous monitoring and Early warning alerts for seizure detection. The process begins with the installation of sensors, Where the pulse sensor is securely placed on the patient's finger or wrist to monitor heart rate Variability (HRV), and the temperature sensor (DHT11/LM35) is attached to the body to track Temperature fluctuations. These sensors are then connected to the NodeMCU (ESP8266) Microcontroller, which processes the collected data in real-time.

CONCLUSION

The IoT-based epileptic seizure detection system provides a reliable and real-time monitoring Solution for individuals with epilepsy, helping caregivers and medical professionals respond Promptly to potential seizures. By integrating pulse and temperature sensors with a NodeMCU Microcontroller and cloud-based data storage, the system ensures continuous tracking of vital Signs. The use of ThingSpeak or Firebase enables remote access to patient data, allowing doctors And caregivers to monitor health conditions from anywhere. Additionally, the alert system ensures That emergency notifications are sent instantly via SMS, email, or a mobile app, reducing the risk Of delayed medical intervention.Through rigorous component testing, integrated system testing, and field testing, the system has Demonstrated its effectiveness in detecting abnormal physiological changes that may indicate a Seizure. The implementation of a user-friendly dashboard further enhances accessibility, making it Easier for caregivers to interpret the data. With its real-time monitoring, automated alerts, and cloud Integration, this system represents a significant advancement over traditional epilepsy Management methods. Future enhancements, such as AI-based seizure prediction, smartwatch Integration, and edge computing, can further improve its accuracy and reliability. Ultimately, this IoT-based solution provides a proactive approach to seizure detection, enhancing patient safety And improving the quality of life for individuals with epilepsy.

BIBLOGRAPHY

1. M. Shoeb, "Application of Machine Learning to Epileptic Seizure Detection," Massachusetts Institute of Technology (MIT), 2009.
2. S. K. Sharma, R. K. Gupta, and P. Mishra, "IoT-Based Health Monitoring System for Epileptic Seizure Detection," International Journal of Biomedical Engineering and Technology, 2021.
3. J. Pan, W. Wu, and Y. Liu, "Real-Time Epilepsy Monitoring Using Wearable Sensors and Cloud Computing," IEEE Internet of Things Journal, 2020.
4. A. Kumar and B. Singh, "A Review on IoT-Based Smart Healthcare Systems," Journal of Medical Systems, 2022.
5. S. Patel et al., "Wearable Technology for Epilepsy Monitoring: Current Trends and Future Prospects," Neuroscience Journal, 2023