IOT-BASED SEIZURE MONITORING AND ALERT SYSTEMS IN HOSPITALS

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Abstract—— ***Seizures demand immediate clinical response, particularly in patients with epilepsy or neurological disorders. Traditional monitoring methods in hospitals, such as manual observation and EEG machines, are often limited by cost and continuity. This paper presents a low-cost, IoT-based seizure monitoring system designed for hospital environments. It employs wearable sensors—MPU6050 for motion detection, MAX30100 for heart rate and So_2 monitoring, and DS18B20 for temperature measurement—interfaced with an ESP32 microcontroller. The system continuously analyzes patient data in real time, and when predefined thresholds are exceeded, it sends instant alerts via WiFi using the Blynk platform to notify medical personnel through mobile devices or dashboards. This solution improves response time, ensures patient safety, and reduces the dependency on continuous manual supervision.***

Keywords— ***Seizure Detection, IoT, ESP32, Accelerometer, MAX30100, DS18B20, Blynk Platform, Real-Time Monitoring, Patient Safety, Hospital Automation***.

INTRODUCTION

Seizures are abrupt and erratic electrical disturbances in the brain that can result in involuntary movements, confusion, loss of consciousness, or convulsions. These episodes are particularly prevalent among patients suffering from epilepsy, traumatic brain injuries, or various neurological disorders. In hospital environments, such conditions necessitate uninterrupted monitoring to ensure immediate medical intervention. However, conventional monitoring approaches—such as the use of EEG machines or periodic nurse visits—are either resource-intensive or too costly for continuous and large-scale application. The integration of Internet of Things (IoT) technologies into healthcare offers a promising solution by enabling real-time, automated patient monitoring without the need for constant human oversight. This paper proposes a cost-effective, wearable seizure detection system that utilizes multiple biomedical sensors and wireless communication modules to track patient health continuously. The system architecture is built around an ESP32 microcontroller connected to an MPU6050 accelerometer to identify abnormal body movement, a MAX30100 sensor to monitor heart rate and SpO_2 levels, and a DS18B20 digital sensor for body temperature measurement. These sensors collect real-time physiological data, which is processed onboard. When any predefined abnormal condition—such as rapid motion, elevated temperature, irregular pulse, or low oxygen saturation—is detected, the ESP32 triggers an alert through the Blynk IoT platform. These alerts are immediately transmitted via Wi-Fi to caregivers through smartphones or hospital dashboards, ensuring a timely response. This system enhances patient safety, reduces manual workload on healthcare staff, and provides a scalable, affordable solution that can be integrated into existing hospital infrastructure for continuous seizure monitoring and early warning systems

I. LITERATURE SURVEY

This study offers the creation of a clever, wearable device meant to identify epileptic seizures in actual time with inexpensive components. During a seizure, the system uses sensors such an accelerometer and heart rate monitor to monitor unusual body movements and physiological changes. An Arduino microcontroller processes data; should a seizure be noted, a GSM module transmits an alert to caregivers. Particularly for unsupervised patients, the wearable design guarantees ongoing monitoring. The main objectives are to improve patient safety, shorten response time, and enable seizure monitoring to be available in resource-limited or rural situations. The appliance is small, inexpensive, and easy to operate. [1].

A machine learning-based approach for detecting epileptic seizures through EEG signal analysis, utilizing Support Vector Machines (SVM) and Random Forests to recognize seizure-prone patterns. The method involves preprocessing EEG data, extracting key features, and training classifiers to predict seizures before their onset, allowing for early warnings and preventive actions. It enables real-time alerts and remote patient monitoring, enhancing epilepsy management. Highlighting the potential of intelligent systems in healthcare, the study suggests that accurate seizure prediction can lead to timely intervention, reduced risks, and an improved quality of life for epilepsy patients. [2].

Employing EEG datasets, this study introduces a high-performance epileptic seizure prediction system that integrates machine learning algorithms such as K-Nearest Neighbors (KNN) and Decision Trees with IoT capabilities. The data undergoes signal preprocessing and feature extraction before classification, and the results are linked to IoT-enabled devices for real-time monitoring and remote alerts. This integration enables quick seizure detection and continuous patient monitoring, significantly reducing the risk of harm. Designed for smart healthcare environments, the system offers high prediction accuracy, scalability, and cost-effectiveness. Ultimately, intelligent automation enhances patient care and supports proactive epilepsy management. [3].

The development of a low-cost, IoT-enabled wearable device for real-time epilepsy seizure monitoring. The system utilizes sensors to collect biometric and movement data, such as body posture and pulse, which are processed by a microcontroller. When abnormal patterns are detected, alerts are sent to caregivers via cloud-based services. With real-time tracking and remote access, the device is well-suited for use in both homes and hospitals. Emphasizing portability, affordability, and accessibility—especially in rural areas—the proposed system aims to deliver continuous, accurate, and reliable seizure monitoring, thereby enhancing patient safety, clinical response times, and overall healthcare efficiency. [4].

This study introduces a hybrid epileptic seizure detection system that combines unsupervised and supervised learning to minimize data labeling efforts while maintaining high accuracy. The unsupervised module identifies seizure segments using silhouette coefficients, isolation forest anomaly detection, and amplitude-integrated EEG (aEEG). To refine uncertain cases, a supervised EasyEnsemble classifier is applied, trained on time-frequency features extracted from EEG signals. Achieving 92.62% accuracy, 95.55% sensitivity, and a 100% seizure detection rate on the CHB-MIT scalp EEG dataset using only 25% of the training data, the system demonstrates a strong balance between performance and efficiency, making it a promising solution for large-scale, effective seizure screening. [5].

This paper introduces BRAINFUSENET, a compact seizure detection model designed for portable, low-power devices by integrating EEG, PPG, and accelerometer (ACC) signals through sensor fusion.

To address imbalanced datasets, it employs a novel Sensitivity-Specificity Weighted Cross Entropy (SSWCE) loss function. Validated on CHBMIT and PEDESITE datasets, the model achieves up to 93.5% seizure detection using just four EEG channels and enhances accuracy to 95% when incorporating PPG and ACC data, with fewer than one false alarm per day.

Optimized for edge deployment, BRAINFUSENET runs efficiently on microcontrollers like GAP9, consuming only 0.11 mJ per inference. Its scalability, real-time processing, and energy efficiency make it highly suitable for long-term, personalized seizure monitoring in real-world medical settings.

[6].

II. PROBLEM STATEMENT

. Epileptic patients as well as those with neurologic diseases are continually at danger of seizures needing quick medical treatment to avoid major consequences including death, brain damage, or injury. But because of little staff availability, high equipment expenditures, and the inefficiency of manual observation, which is subject to delays and human error, continuous real-time monitoring is challenging in most hospital settings.

Although effective, EEG devices are costly and unsuitable for daily bedside use. Thus, there is a great need for a lowcost, automated, and noninvasive system that can continuously monitor important physiological signals—such as heart rate, oxygen saturation, temperature, and aberrant motion—and give real-time alerts to healthcare providers via a wireless communication platform to guarantee prompt response.

II. IMPLEMENTATION AND DESIGN

The IoT-based seizure monitoring and warning system is centered around the integration of smart biomedical sensors, real-time data processing, wireless communication, and an intuitive alert mechanism, all managed by the ESP32 microcontroller. Chosen for its superior processing power, built-in WiFi, low power consumption, and compatibility with diverse sensors and cloud platforms, the ESP32 serves as the system's core.

Designed to continuously monitor patients at risk of seizures, the system analyzes key physiological signals and movement patterns to detect abnormalities indicative of seizure activity. Core sensors include the MPU6050 accelerometer and gyroscope, MAX30100 pulse oximeter and heart rate sensor, and DS18B20 digital temperature sensor.

Each sensor contributes uniquely to the system's overall accuracy and responsiveness: the MPU6050, worn on the wrist or chest, detects sudden body movements such as jerks or tremors, providing multiaxial acceleration and angular velocity data; the MAX30100, in wearable format, continuously tracks heart rate and blood oxygen saturation to identify common cardiovascular changes during seizures such as tachycardia or hypoxia; and the DS18B20 monitors body temperature to flag hyperthermia, a known trigger or exacerbating factor in seizures.

These sensors work in concert to form a robust and sensitive detection mechanism. The ESP32 is programmed using the Arduino IDE, where it executes algorithms that compare real-time sensor values against clinically validated threshold limits.

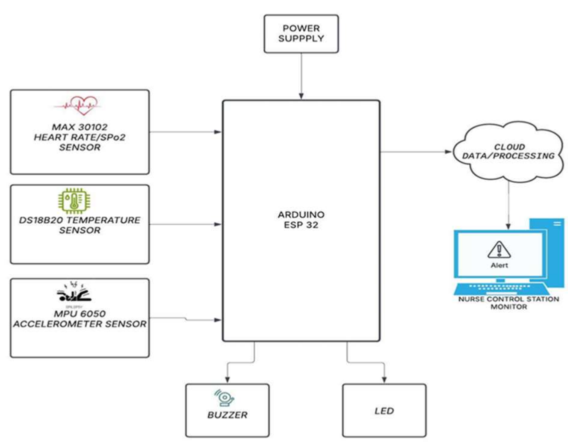

Fig. 1. Block Diagram

For instance, a seizure may be indicated when acceleration exceeds 3g, temperature rises above 38°C, heart rate falls below 50 bpm or exceeds 120 bpm, or SpO_2 levels drop below 90%. Using conditional logic, the ESP32 identifies when one or more thresholds are breached and interprets it as a potential seizure episode.

Upon detection, the ESP32 triggers its communication module to immediately notify caregivers via the Blynk IoT platform, a cloud-based mobile system that supports the creation of custom interfaces for data display and alert delivery.

WiFi connectivity enables the ESP32 to send real-time alerts and stream live data to caregivers' or hospital staff's smartphones. In addition to real-time notifications, the Blynk platform offers continuous monitoring of all sensor outputs—heart rate, SpO_2, temperature, and movement—and maintains historical data logs useful for tracking seizure trends and aiding medical diagnosis.

The system is powered through either a rechargeable lithium-ion battery or USB, supporting wearable deployment with attention to energy efficiency using the ESP32's sleep modes and optimized sensor polling during patient rest. The compact size of the ESP32 and its sensors ensures minimal patient discomfort, enabling integration into lightweight wearables like wristbands or chest straps.

Hardware-wise, the prototype is constructed on a PCB or breadboard with all sensors securely connected to the ESP32, utilizing noise-reducing layouts and pull-up resistors to ensure reliable signal acquisition. LEDs are included for hardware debugging during testing.

The system's modular and scalable nature allows for future upgrades, such as incorporating cloud-based dashboards, advanced machine learning algorithms for predictive analysis, or additional sensors like ECG or EEG for comprehensive monitoring. With an emphasis on clinical relevance, reliability, and simplicity, the system is envisioned as a cost-effective solution for real-time seizure detection in hospitals, reducing dependence on manual observation, enhancing response times, and improving overall care for seizure-prone patients

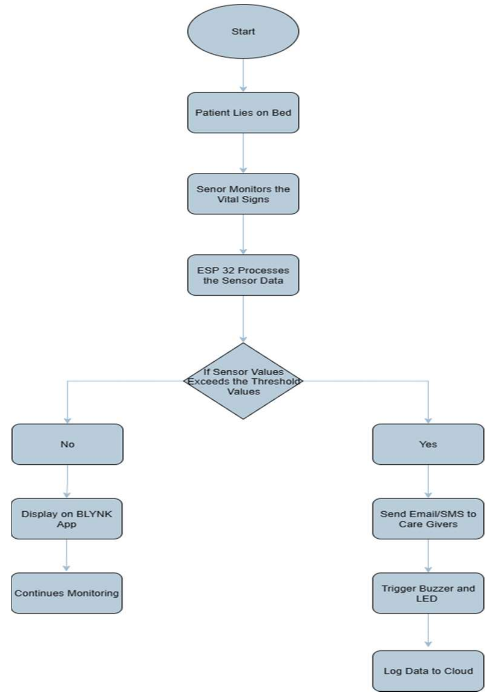

Fig. 2. Flowchart of Iot-Based Seizure Monitoring And Alert Systems

III. RESULTS AND OUTPUT

Developed and tested in a controlled setting, the prototype of the IoT-based seizure monitoring and alarm system was designed to assess its accuracy, responsiveness, and general performance. Simulated seizure conditions were produced by manually triggering aberrant sensor values, including sudden motions, high temperature, erratic heart rate, and reduced SpO_2, during the testing phase.

As intended, the alert mechanism was activated when the system correctly recognized combinations of these thresholds. With minimal latency, the ESP32 microcontroller handled sensor data, and the decision-making logic consistently differentiated between ordinary and abnormal readings. Once a seizure condition was detected, the Blynk app swiftly sent a notification to the caregiver's phone, demonstrating efficient real-time communication. Live readouts from each sensor were also displayed on the Blynk dashboard, allowing continuous observation of the patient's vital signs.

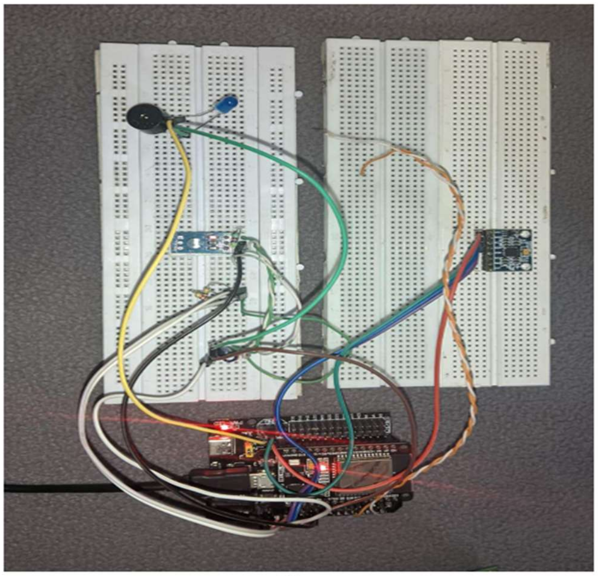

Fig. 3. Implementation of the Iot-Based Seizure Monitoring And Alert Systems

Alerts were triggered within two to three seconds of abnormal readings, showcasing the system's capacity for rapid and effective response. Moreover, by requiring multiple parameter violations before raising an alarm, the system helped to prevent false positives and ensure accuracy.

The hardware setup remained stable during extended usage, maintaining reliable data transmission and consistent sensor readings. Power consumption was minimized through the use of sleep modes and optimized polling algorithms, making the device suitable for portable, battery-powered applications.

Overall, the results confirmed the system's ability to simultaneously monitor multiple physiological parameters and deliver timely alerts with precision..

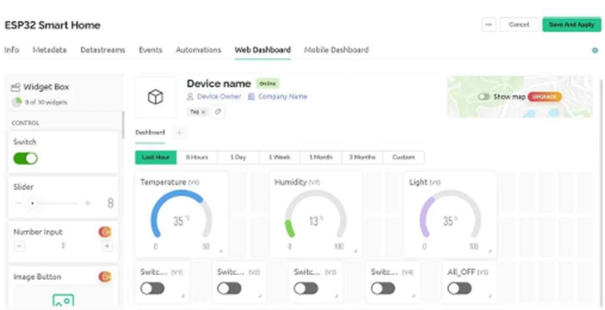

Fig.4 Seizure Monitoring In Blynk App

This validates the practical viability of the solution for hospital applications, where constant monitoring and rapid response to seizure episodes are critical for improving patient outcomes

IV. CONCLUSION

Presented in this project, the IoT-based seizure monitorin and alarm system offers a good, affordable option for continuous patient monitoring in hospital environments. The system monitors important physiological indicators and precisely identifies seizure occurrences by combining several biomedical sensors with the ESP32 microcontroller and Blynk IoT platform. Instant alerts let carers react quickly, therefore increasing patient safety and lowering reliance on manual supervision. The noninvasive nature of the system, its portability, and its wireless communication enable it to fit very well into already in place hospital facilities. Additional clinical verification will help this solution to greatly improve emergency response and neurological patient care.

V. REFERENCE

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