AN EDGE COMPUTING PLATFORM FOR LOW-LATENCY AND LOW-WEARABLE MEDICAL DEVICES FOR EPILEPSY

IOT Based Module for Fall Detection

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***Abstract*- Epilepsy is a chronic neurological disorder with several different types of seizures, some of them characterized by involuntary recurrent convulsions, which have a great impact on the everyday lives of the patients. In fact, falls exponentially increase with age-related biological changes, which is leading to a high incidence of falls and fall-related injuries in aging societies. Several solutions have been proposed in the literature to detect this type of seizure and to monitor the patient; however, these approaches lack ergonomic issues and suitable integration with the health system. This research makes an in-depth analysis of the main factors that an epileptic detection and monitoring tool should accomplish. Furthermore, we introduce the architecture for a specific epilepsy detection and monitoring platform, fulfilling these factors. In this context, assistive devices that could help alleviate this major health problem are a social necessity. The system makes use of an Arduino controller; the accidents are determined with the help of an accelerometer sensor, a temperature sensor, a MAX30100 sensor, an emergency switch, OLED display and a GPS location and SMS to an ambulance, caregiver, or hospital using an IOT module. The fall detection method presented here is more precise, sensitive and definite system with improved user friendliness.**

***Keywords*: Neurological disorder, Fall detection, MAX30100 sensor, IOT module, Easy access.**

I. INTRODUCTION

Epilepsy is a neurological disorder which causes the sudden increase in brain activity, this causes disturbance in brain and cause seizures [1]. Many people in this world suffers from epilepsy and needed treatment for their sufferings so we use IOT frame work to overcome their need for diagnosis this device gains the bio signal from the body and transmits into a coded signal. The receiver gains the coded signal as decode signal and sends message to alert the doctors and guardians hence the patient can be saved before the occurrence of epilepsy by using this gadget. Imbalance in the nervous system causes epilepsy disease which may lead to death. The most common symptoms of epilepsy disease are sudden fluctuations in heart beat rate and involuntary muscular movements (seizures). Since the occurrence of seizures is unpredictable, it will be difficult to leave the patient alone [2]. The electronic system used here is a wearable device which predicts the occurrence of epilepsy disease. The signals from human body are used to detect the occurrence of epilepsy disease. When the device detects the symptoms, it transmits a coded signal to produce control signals for switching an alarm device to intimate doctor or relatives mobile phone using wireless communication with help of GPS This helps to trace out the exact location of the patient. The Internet of Things (IoT) is a popular paradigm which has been applied to different areas such as smart cities, medicine or business processes [3]. One of the main drawbacks of an IoT system is the amount of information it has to manage and to monitor. This information arrives as events that need to be processed in real-time in order to make correct decisions. The Event Processing Languages (EPLs) were designed to handle this information by defining event patterns which describe relevant situations to be detected and filter the information [4]. In the majority of the relevant situations to detect, the events have a specific behaviour which must be analysed not only to define the event patterns but also to simulate them to test the IoT system. Moreover, in several situations it is quite difficult to obtain test events with specific values: adverse environment conditions, rise or fall in blood pressure, heart attack, falls, among others. Fall detection systems vary in the components they use. One of the most common sources for the sensor data is a smartphone. The data are collected, analysed, and stored on the smartphone itself. Most of the research studies we have discussed so far are performed through such a device. Because of their limited computational power and storage, advanced machine learning techniques are difficult to implement on smartphones. Internet of Things (IoT) is a prominent technological paradigm that gains attention from vast research

fields in the past few years [5]. Internet of Things is a network of devices which is built with embedded systems, electronic things, actuators, sensors and network connectivity and which enables these objectives to exchange and collect the data from the sensor [6]. In simple words, IoT refers to a network of objects all connected to the internet at the same time. The main principle of Internet of things (IoT) is that the objects/things i.e. sensor nodes identify, sense, process and communicate with each other. Internet of Things is used for an object can be sensed and controlled from the existing network. In simple words, IoT refers to a network of objects all connected to the internet at the same time. The main principle of Internet of things (IoT) is that the objects/things i.e. sensor nodes identify, sense, process and communicate with each other. Internet of Things are used in many application areas like Smart Home, Smart Phone, Smart Farming, Smart Grid, Industrial Internet, Connected Health, Smart Supply Chain etc [7]. The homecare is provided instead of the expensive clinical care and prevention is provided by the efficient healthcare applications. This service can help every individual by following the basic healthcare, which leads to more advantageous results. IoT make the healthcare services by maintaining digital identity for each patient due to which many health problems have been getting undetected in conventional healthcare systems are reduced. Hence the importance of healthcare on IoT is increasing to support the quality of care, improve the access to care and finally to decrease the cost of care.

II. RELATED WORK

1. Epileptic seizure detection by using interpretable machine learning models

Xuyang Zhao, Noboru Yoshida et al. discussed in Journal of Neural Engineering in February 2023 [8] about the detection of epileptic seizures using electroencephalogram (EEG) data is essential for epilepsy diagnosis, but the visual diagnostic process for clinical experts is a time-consuming task. In this study, they follow the visual diagnosis mechanism used by clinical experts that directly processes plotted EEG image data and apply some commonly used models of LeNet, VGG, deep residual network (ResNet), and vision transformer (ViT) to the EEG image classification task. Before using these models, we propose a data augmentation method using random channel ordering (RCO), which adjusts the channel order to generate new images. The Gradient-weighted class activation mapping (Grad-CAM) and attention layer methods are used to interpret the models. Since the method follows the visual diagnosis mechanism of clinical experts, the model interpretation results can be presented to clinical experts intuitively. The classification results, model visualization, and seizure quantification score from the experiments are effective reference information for clinical experts.

2. Generalized epileptic seizure prediction using machine learning method

Zarqa Altaf, Mukhtiar Ali Unar et al. investigated in International Journal of Advanced Computer Science and Applications in June 2023 [9] about the electroencephalography (EEG) signal identification of epileptic seizures has developed into a routine procedure to determine epilepsy. Since physically identifying epileptic seizures by expert neurologists becomes a labor-intensive, time-consuming procedure that also produces several errors. Thus, efficient, and computerized detection of epileptic seizures is required. The disordered brain function that causes epileptic seizures can have an impact on a patient's condition. Electroencephalogram (EEG) signals are utilized to predict epileptic seizures by using machine learning algorithms and complex computational methodologies. Furthermore, two significant challenges that affect both expectancy time and genuine positive forecast rate are feature extraction from EEG signals and noise removal from EEG signals. As a result, they suggest a model that offers trustworthy preprocessing and feature extraction techniques. To automatically identify epileptic seizures, a variety of ensemble learning-based classifiers were utilized to extract frequency-based features from the EEG signal. The algorithm mentioned in this paper offers a higher true positive rate and diagnoses epileptic episodes with enough foresight before they begin.

3. ***Epileptic seizure detection using machine learning: taxonomy, opportunities, and challenges***

Muhammad Shoaib Farooq, Aimen Zulfiqar and Shamyla Riaz discussed in Journal of Diagnostics in March 2023 [10] about epilepsy a life-threatening neurological brain disorder that is due to abnormal chemical changes in our brains. For that, several studies entail machine learning methods for early predicting epileptic seizures. Mainly, feature extraction methods have been used to extract the right features from the EEG data generated by the EEG machine. Then various machine learning classifiers are used for the classification process. This study provides a systematic literature review of the feature selection process and classification performance. This review was limited to finding the most used feature extraction methods and the classifiers used for accurate classification of normal to epileptic seizures. We also studied the nature of different benchmark and unbiased datasets and gave a rigorous analysis of the working of classifiers. Finally, we concluded the research by presenting the gaps, challenges, and opportunities that can further help researchers predict epileptic seizures. Furthermore, it is suggested to study the most relevant predictive models in the future to perform quality research along with a suggestion on the absence of epilepsy in children and generate a separate dataset for this type of epileptic seizure.

4. ***Vision-based mouth motion analysis in epilepsy: a 3d perspective***

Ahmedt-Aristizabal, Kien Nguyen et al. discussed in IEEE Journal in July 2019 [11] detailed about epilepsy monitoring involves the study of videos to assess clinical signs (semiology) to assist with the diagnosis of seizures. Recent advances in the application of vision-based approaches to epilepsy analysis have demonstrated significant potential to automate

this assessment. Nevertheless, current proposed computer vision-based techniques are unable to accurately quantify specific facial modifications, e.g. mouth motions, which are examined by neurologists to distinguish between seizure types. 2D approaches that analyse facial landmarks have been proposed to quantify mouth motions, however, they are unable to fully represent motions in the mouth and cheeks (ictal pouting) due to a lack of landmarks in the cheek regions. 3D approaches, on the other hand, retain rich information about the shape and appearance of faces, simplifying alignment for comparison between sequences. In this they proposed a novel network method based on a 3D reconstruction of the face and deep learning to detect and quantify mouth semiology in our video dataset of 20 seizures, recorded from patients with mesial temporal and extra-temporal lobe epilepsy. The proposed network is capable of distinguishing between seizures of both types of epilepsy. An average classification accuracy of 89% demonstrates the benefits of computer vision and deep learning for clinical applications of non-contact systems to identify semiology commonly encountered in a natural clinical setting.

5. ***A novel cardiac auscultation monitoring system based on wireless sensing for healthcare***

Haoran Ren, Hailong Jin et al. investigated in IEEE Journal of Translational Engineering in Health and Medicine in July 2018 [12] about the wireless cardiac auscultation offers continuous cardiac monitoring of an individual without manual healthcare care services. In this paper, they discussed about the novel wireless sensing system to monitor and analyze cardiac condition is proposed, which sends the information to the caregiver as well as a medical practitioner with an application of the Internet of Things (IoT). An integrated system for heart sound acquisition, storage, and asynchronous analysis has been developed, from scratch to information uploading through IoT and signal analysis. Cardiac auscultation sensing unit has been designed to monitor cardiovascular health of an individual. Bluetooth protocol is used to offer power efficiency and moderate data transmission rate. The Hilbert–Huang transform is used to eliminate interference signals and to help to extract the heart sound signal features. Subsequence segmentation algorithm based on double-threshold has been developed to extract physiological parameters. Preprocessing, segmentation, and clustering technique were performed for significant health information interpretation. It is expected that the health care system will be further aimed to implement more experiments under different detailed anomaly diseases and give more accurate results.

III. PROBLEM STATEMENT

Nowadays, the aging society problem is getting serious, especially in Asia. It leads to the critical situation that more and more elderly people have to live alone. Due to the lack of sufficient nursing staff and resource, the elderly people cannot always be taken good care of. As a consequence, they may face the injuries caused by the accidents, such as fall from bed. The same danger also happens to the patients in hospital. If not being detected and handled in time, fall from bed may even cause death. However, effectively detecting fall from bed is not a trivial task and it is still far from being well solved.

In existing system, multiple view approach to achieve this goal, where motion is modeled using a layered hidden Markov model. The posture classification is performed by a fusion unit, merging the decision provided by the independently processing cameras in a fuzzy logic context. In each view, the fall detection is optimized in a given plane by performing a metric image rectification, making it possible to extract simple and robust features, and being convenient for real-time purpose.

Disadvantages of existing system

The main disadvantage associated with the existing system is image-based detection system is used for epilepsy patient, communication system about patient status was not developed, low accuracy resulting in injury of patient, the fall detection is optimized in a given plane by performing a metric image rectification, low accuracy and IOT module is not used.

Based on the above drawbacks associated with current research on sign language we develop an intelligent system that eliminate all the above disadvantage. In our proposed model patient's data is gathered via sensors. The sensor like accelerometer sensor, temperature sensor, MAX30100 sensor are used to collect patient's vital signs and IOT module for communication. This research develops a more affordable and adaptable system that is necessary for retirement homes and clinics to build a smart city powered by IoT.

IV. METHODOLOGY

Hardware components

Power supply, Accelerometer sensor, DHT 11 Sensor, MAX30100 Sensor, ARDUINO controller, GPS, Switch, IOT, OLED Display

Software components

Arduino IDE – ARDUINO Microcontroller Programming, Sketch IDE – IoT Module Programming Software, Blynk Server – Sewer Clogging monitoring System using IoT module

An effective fall detection system would detect a fall and send an alarm to the appropriate authorities. In this method we automated the method of gathering patients' data via accelerometer sensor that can be used to continuously monitor

the patient repeated actions; a temperature sensor that can be used to monitor the patient's body temperature; a MAX30100 sensor that can be used to monitor the patient pulse and Spo2 level. It includes an emergency switch that is connected to medical devices. If you press the emergency switch, the GPS location and SMS to the ambulance, caregiver, or hospital are sent using an IOT module, and the sensor data is displayed in the OLED display (Fig.1).

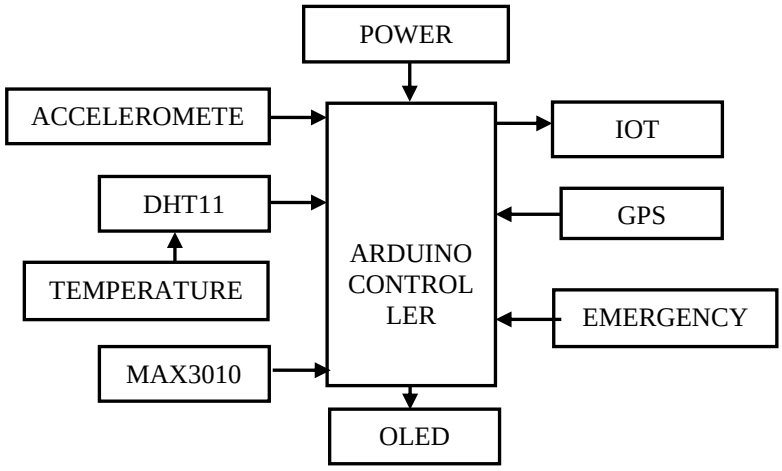

Fig 1. Block Diagram for Fall Detection

V. RESULT

The proposed fall detection system aims to tackle the healthcare challenge of falls among the elderly, who represent over 50% of injury-related hospitalizations. Commercial devices are often costly with monthly fees, creating a need for a more accessible solution. Our system, utilizing accelerometer, temperature, and SPO2 sensors, coupled with an emergency switch, offers an affordable alternative. In the event of a fall, the emergency switch triggers an alert, sending GPS location and sensor data through an IoT module. The OLED display provides real-time information. Cost-effectiveness makes it suitable for retirement homes and clinics, contributing to the vision of smart cities. Despite its promise, further research is required for algorithm refinement and ensuring power efficiency and data security. Nonetheless, the system's adaptability and affordability mark a significant stride in addressing fall-related healthcare challenges.

VI. CONCLUSION

In conclusion, the proposed fall detection system, integrating accelerometer, temperature, and SPO2 sensors, along with an emergency switch, offers an affordable and effective solution for continuous monitoring of elderly individuals in healthcare settings. The system's ability to transmit critical information, including GPS location, through an IoT module and display sensor data on an OLED screen enhances its usability. With a focus on affordability and adaptability, this system addresses the pressing issue of falls among the elderly, providing a practical alternative to expensive commercial devices. Its simplicity, coupled with the inclusion of an emergency switch, ensures quick response times and improved safety for elderly individuals in retirement homes and clinics.

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