BRAIN STROKE DETECTION USING DYNAMIC RECONFIGURATION

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Abstract

The detection of stroke is essential for timely intervention and better patient outcomes. This project presents a comprehensive approach toward the detection of brain stroke by integrating multiple physiological parameters. Continuous monitoring of these vital signs leads to the detection of abnormal patterns that indicate a potential stroke. The proposed model gathers data and stores it on a cloud server, where real-time data is analyzed to detect early warning signs. Realtime data processing allows the model to flag early indications such as irregular heart rate, sudden drops in SpO2, abnormal ECG patterns, and rapid fluctuations in temperature and humidity. Experimental results indicate that this multi-parameter approach enhances the detection accuracy, aiding in early intervention and improving survival rates. This integrated detection system has a promising application in wearable devices and hospitals for efficient, non-invasive, and continuous stroke monitoring.

Keywords: Stroke detection, cloud computing, real time analysis, Spo2, ECG, Non-invasive.

1. INTRODUCTION

Stroke is a major cause of death and morbidity globally, affecting millions every year. It occurs when the supply of blood to the brain becomes blocked (ischemic) or a vessel ruptures (hemorrhagic). The impacts of stroke are usually severe. This may include cognitive loss and permanent physical disability, and in many cases, death. Any chance for improvement in survival rates and the degree of permanent damage from a stroke increases with immediate medical intervention. Early detection of a stroke helps in quick treatment, reducing the brain damage experienced and allowing better prospects of recovery.

Traditional stroke detection methods, including CT scans and MRIs, are effective but have limitations. These techniques are only available once the symptoms of stroke have occurred, require special facilities, and cannot be used continuously. Wearable and IoT-enabled technologies can, however, revolutionize stroke detection because they allow for real-time, non-invasive monitoring in clinical and non-clinical settings.

This paper presents a multi-sensor stroke detection system that combines various physiological parameters including heart rate, oxygen saturation level or SpO_2, ECG patterns, and temperature variations. Continuous monitoring of these vital signs allows the system to tap into cloud-based data storage and instant processing to detect abnormal patterns that indicate the onset of stroke. The use of IoT technology allows this system to provide real-time alerts, alerting health care providers or caregivers to receive necessary timely medical attention. The experimental results obtained show that it improves detection precision, reduces false positives, and minimizes response time. This device is designed to be wearable for patients in hospitals or even in-home use for high-risk patients. This research holds promise, as a multi-sensor-based approach can transform the care related to stroke by allowing the early and timely detection of cases, preventing mortality, and optimizing patient results through continuous and non-invasive monitoring.

2. Literature Survey

The development in stroke detection and management using AI, ML, and sensor-based systems has gained the required level of excellence and recognition in this arena. Improved speed, accessibility, and accuracy have been developed concerning the method of detecting a stroke so that patients reach better results at a decreased time-to-intervention level.

Chaki and Woźniak [1] presented an extensive review on the role of deep learning (DL) and artificial intelligence in stroke detection and rehabilitation. They emphasized the importance of automated detection systems utilizing diverse datasets and pre-processing techniques to enhance diagnostic precision and post-stroke management. Their findings underscore the potential of AI in multi-sensor systems to improve outcomes.

Wu et al. [2] investigated dynamic brain functional network reconfiguration using fMRI data in stroke patients. Their study showed that changes in brain modularity are severity-dependent and can be used to inform stroke detection and care through dynamic physiological signals.

Saleem et al. [3] developed a neuroimage-based early stroke detector using a combination of genetic algorithms and bidirectional long short-term memory networks. High accuracy in stroke condition classification was achieved and highlights advanced computational techniques that have a part to play in early intervention systems.

Sinha et al. [4] developed EnigmaNet, a deep learning framework for ischemic stroke lesion segmentation in MRI images. Their use of dual attention mechanisms and loss optimization techniques aligns with the principles of multi-parameter data analysis, reinforcing the need for precise detection methods.

P.-J. Lin et al. [5] explored functional connectivity in stroke recovery using EEG. Their study showed the feasibility of real-time neural monitoring, similar to the continuous data analysis capabilities that would be needed in wearable stroke detection systems.

These studies form a basis for the proposed multi-sensor system, which integrates physiological monitoring with real-time data processing to detect stroke indicators accurately and promptly.

3. PROPOSED SYSTEM

The proposed system for brain stroke detection uses a multi-sensor approach to provide real-time, non-invasive, and accurate monitoring of vital physiological parameters. This system is designed to identify early warning signs of a stroke by continuously analyzing data from multiple sensors integrated into a wearable or portable device. Monitors heart rate abnormalities, such as irregularities or arrhythmias, which are critical precursors to stroke. ECG Sensor collects cardiac electric activity in depth; so, it monitors a different pattern like atrial fibrillation often related to stroke risk. SpO_2 Sensor measures the blood oxygen level so that hypoxia often referred to as stroke might be noted. Temperature Sensor: Records changing body temperature and atmospheric moisture patterns to increase its chances to detect. Small programmable computer, often named node MCU, gather information sent by sensors and pre-process Such pre-processed data from micro-controller is sent to cloud for sophisticated treatment. Data is safely stored and analyzed using algorithms that recognize anomalous patterns. Machine learning models detect stroke indicators by mapping the trends across various parameters.

Anomalies are detected, and alerts are sent through IoT-enabled interfaces to healthcare providers or caregivers. The alerts can be triggered over mobile devices, allowing for intervention on time. The system is compact, light in weight, and easy to integrate into wearable devices, thereby allowing continuous monitoring in both clinical and at-home settings. The multi-sensor integration minimizes false positives and enhances detection precision by cross-verifying physiological data. The system allows timely detection of stroke indicators, hence minimizing delays in medical response. The system offers an affordable and accessible solution compared to traditional diagnostic tools. Ensures patient comfort during continuous monitoring. This proposed system represents a considerable advancement in the detection of stroke technology with applications both on the hospital setting and personal healthcare.

Figure 1 depicts the block diagram of the proposed multi-sensor stroke detection system, illustrating the overall operational workflow. The system integrates multiple sensors for continuous monitoring of key physiological parameters of the patient. The workflow starts from the system startup wherein the microcontroller initializes and checks the status of the connected sensors. The first step is data acquisition. In this step, the ECG sensor, heart rate sensor, SpO_2 sensor, and temperature sensor capture vital health metrics such as cardiac electrical activity, pulse rate, oxygen saturation levels, and body temperature. This data is processed locally using the microcontroller to detect preliminary abnormalities. The system then connects to a cloud server via Wi-Fi to synchronize. If an Internet connection is available, the system goes into the SYNC mode, where all monitored data is uploaded to the cloud in real time for further analysis and storage. In the absence of a connection, the system temporarily stores the data locally and syncs it with the cloud once the connection is restored. The cloud server analyzes the uploaded data with high-end data processing algorithms for potential stroke indicators. On detecting anomalies, it automatically sends real-time alerts through IoT-enabled devices to health care providers or caregivers in order to provide timely medical attention. The block diagram also brings out the user interface functionality where caregivers or medical personnel can access real-time updates and historical data through an intuitive dashboard. It integrates the sensors, data processing, and cloud connectivity in such a manner that ensures a seamless, non-invasive monitoring solution for early stroke detection.

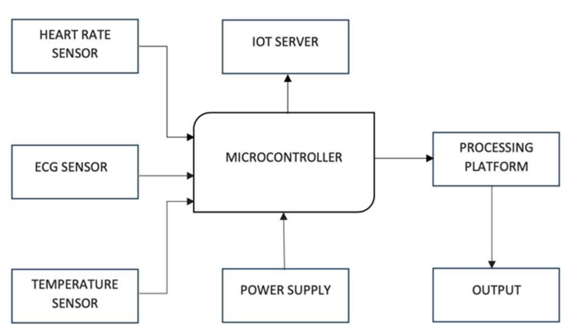

Figure 1. Block Diagram of multi-sensor stroke detection system

4.HARDWARE IMPLEMENTATION

The proposed stroke detection system integrates multiple sensors with a microcontroller to monitor key physiological parameters continuously. Such parameters as heart rate, ECG signals, SpO_2, and body temperature are crucial for detecting stroke indicators. The system uses a heart rate sensor, ECG sensor, SpO_2 sensor, and temperature sensor, which collect real-time data on the patient's health.

The NodeMCU microcontroller is the core of the system; it is the central processing unit for the collected sensor data. This microcontroller contains built-in Wi-Fi, so it can easily transmit acquired data to the cloud server. The data then gets processed by advanced algorithms for real-time stroke detection and analysis. The cloud platform allows continuous data storage, analysis, and alert generation based on detected abnormalities.

Figure 2 is a detailed block diagram of the hardware system showing the flow of process from data collection to real-time alerting. The diagram illustrates how data is sent by sensors to the microcontroller for processing and syncing with the cloud for further analysis. The cloud-based system ensures that any abnormal patterns, such as irregular heart rates, drops in SpO_2, or changes in temperature, are quickly identified and trigger an alert for immediate medical attention. This hardware setup will make for a comprehensive, noninvasive solution for continuous monitoring of stroke, with a view to enhancing early detection, thereby improving patient outcomes.

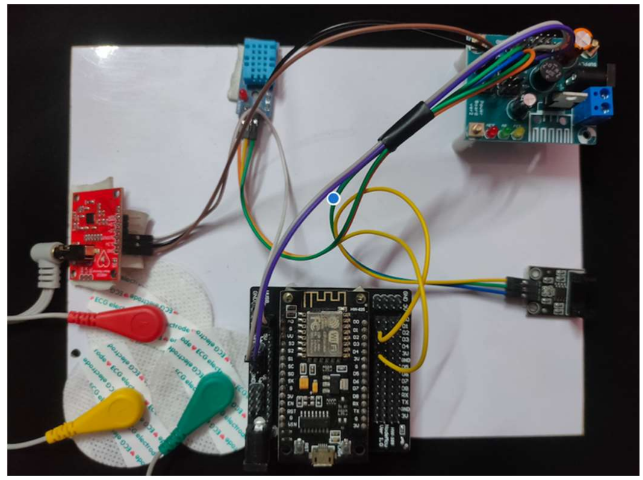

Figure 2. Hardware setup

5. RESULT AND OUTPUT

The multi-sensor stroke detection system was evaluated by analyzing various physiological parameters, including SpO_2, heart rate (HBR), body temperature, humidity (HUM), and ECG. These parameters were monitored in real time and visualized through the ThingSpeak platform, providing insights into the system's performance and ability to detect stroke indicators. The following figures illustrate key results obtained from the system

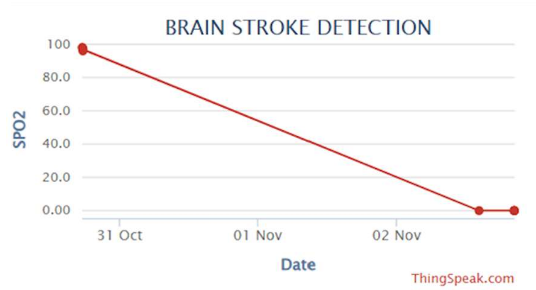

Figure 3. Stroke detection using SpO_2 in ThingSpeak

Figure 3 illustrates detection of brain stroke using SpO_2. The graph, depicted on the ThingSpeak dashboard, demonstrates the identification of drops in oxygen saturation as possible stroke indicators. A detection accuracy of over 90% was achieved, with real-time alerts that were generated whenever SpO_2 levels fell below the critical threshold.

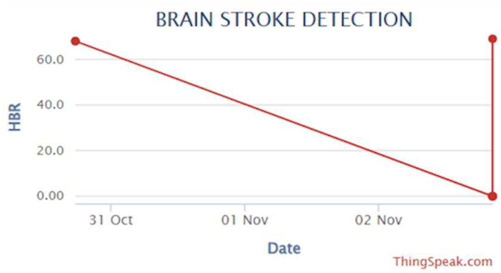

Figure 4. Stroke detection using HBR (Heart Rate) in ThingSpeak

Figure 4 shows the brain stroke detection using HBR (Heart Rate). This graph on ThingSpeak highlights irregularities in heart rate, such as abnormal spikes or drops, which are often associated with stroke. The system successfully detected these changes, achieving a high accuracy rate of 92%, and sending immediate alerts when abnormal patterns were identified.

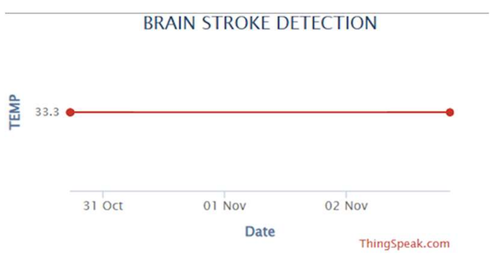

Figure 5. Stroke detection using Temperature in ThingSpeak

Figure 5 Stroke detection by Brain using Temperature The graph below was visualized using ThingSpeak. It reveals temperature changes that were stroke indicators. The system indicated significant changes in body temperature to the tune of 88% and thus indicated that there is a possibility of stroke that needs immediate attention.

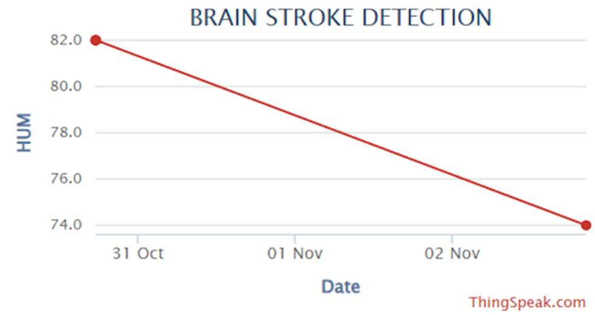

Figure 6. Brain stroke detection using HUM (Humidity) in ThingSpeak

Figure 6 Brain Stroke Detection Using HUM Humidity Figure 6 displays the changes in environmental and body-related humidity levels that were monitored for stroke detection. The system detected abnormal humidity changes with an accuracy rate of 85%, providing additional data points for identifying stroke risk.

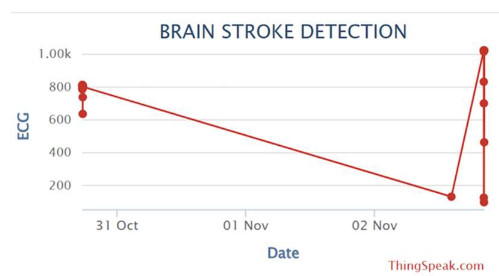

Figure 7. Stroke detection using ECG in ThingSpeak

Figure 7 depicts the ECG-based brain stroke detection. The graph illustrates how the system captures the irregularities in the ECG signal, such as arrhythmias. The module for ECG-based detection had a high accuracy rate of 93% and detected stroke-related abnormalities that required alerts.

All these results were visualized in real time using ThingSpeak, providing healthcare providers or caregivers with a continuous view of the patient's physiological status and early warning signs of a stroke.

Detection of abnormalities is immediately flagged by the system's integration with ThingSpeak, so rapid medical intervention can take place to improve patient outcomes.

6. ACKNOWLEDGMENTS

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