AI Based Stroke Disease Prediction System Using ECG & PPG Bio Signals

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Abstract*— Over the last few decades, the most common death in worldwide because of cardiovascular disease. It is the unpredictability and random time of the occurrence that makes the disease more dangerous. The death rate will be reduced by regular supervision of clinicians and early detection of cardiac diseases. Unfortunately, people suffering from sudden cardiac arrests have low survival rates. During the COVID-19 pandemic, the personalized patient care is modernized are mostly incorporated in cardiovascular community and clinical applications to achieve medical breakthroughs. The sensors built in textiles, wrist watches, ECG patch recorders and vests patches are targeted at the healthcare professions for the early detection of acute decompensation and improved prognostication. We proposed by which it is used for adaptive fall detection for paralyzed patients/elders and heart stroke prediction. A real-time data of the patient such as blood pressure, body temperature, heart rate and humidity can be monitored and analyzed by System. Our proposed wearable device saves the lives of patient and reduces the death rate by taking immediate care.

I. INTRODUCTION

The heart is the capital part of the cardiovascular system. It also comprises the lungs and muscular organ that used to plumb the blood into the body network. The cardiovascular system incorporates of blood vessels like arteries, veins, capillaries and these blood vessels form a network to transport blood in through the body. Cardiovascular diseases (CVD) are a group of heart diseases caused due to irregularities in usual blood flow from the heart. [Shadman Nashif]. Also, 80% of the deaths might occurred in account of CVDs owing to stroke and heart attack. The 0.54 degrees increase in the average global land-ocean surface temperature compared to the past 10 years advisable that the universal temperature is increasing significantly in recent decades. These high temperatures accelerate to increase heart strokes and which in turn can lead to cardiovascular diseases.

Nowadays lots of patient data is easily available due to the development of advanced healthcare systems which can be used for designing predictive models for cardiovascular diseases. Therefore, in this paper we proposed the patient fall detection using acceleration sensors and heart stroke detection is predicted using the IOT.

The best part of this project is that it can be used by everyone and make our health management easier than available systems. It provides a solution for measurement of body parameters like, Temperature Sensor and Heartbeat, Blood Pressure. This system also generates an alert when it required that means at the time of any critical conditions.

II. LITERATURE SURVEY

Teo Wil Son et.al discussed the system of non-invasive methods, such as sensors embedded in the environment, to monitor health metrics. This innovation aims to enhance patient comfort and convenience by integrating health monitoring seamlessly into everyday home environments.

Shadman Nashif, Md et.al discussed in this system is designed to continuously monitor patients' vital signs and health parameters using wireless technology. The primary objective is to provide real-time data to healthcare providers, enabling better and more immediate medical responses. The system likely includes features such as remote monitoring, alerts for abnormal readings, and possibly integration with mobile devices for ease of use.

O. Vermesan et.al discussed about Converging Technologies for Smart Environments and Integrated Ecosystems, River Publishers Series in

Communications. In their book Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, did not invent a specific device or system. Instead, they edited a comprehensive volume that explores the convergence of technologies within the Internet of Things (IoT) framework.

R. Clarke, et.al discusses enhance patient care by providing continuous, real-time monitoring without the need for BB wired connections, thus improving mobility and comfort for patients while ensuring that healthcare providers have timely access to critical health information.

D. Evans, et.al discussed in publication serves as a strategic analysis and forecast of the IoT landscape, highlighting the broad and transformative impacts of IoT on society and industry. It aims to provide readers with a deeper understanding of how IoT technologies are changing the world, rather than detailing an invention by the author

III. METHODOLOGY

1st Reference based on Development and Clinical Evaluation of a Home Healthcare System Measuring in Toilet, Bathtub and Bed without Attachment of Any Biological Sensors

Daily monitoring of health condition at home is important for an effective scheme for early diagnosis, treatment, and prevention of lifestyle-related diseases such as adiposis, diabetes and cardiovascular diseases. While many commercially available devices for home health care monitoring are widely used, those are cumbersome in terms of self-attachment of biological sensors and self-operation of them. From this viewpoint, we have been developing a non-conscious physiological monitoring system without attachment of any sensors to the human body as well as any operations for the measurement. We developed some devices installed in a toilet, a bath, and a bed and showed their high measurement precision by comparison with simultaneous recordings of ordinary biological sensors directly attached to the body. To investigate that applicability to the health condition monitoring, we developed a monitoring system in combination with all the monitoring devices at hospital rooms and previously carried out the measurements of patients' health condition. Further, in this study, the health conditions were measured in 10 patients with cardiovascular disease or sleep disorder. From these results, the patients' health conditions such as the body and excretion weight in the toilet, the ECG during taking the bath and the pulse and respiration rate during sleeping were successfully monitored in the hospital room, demonstrating its usefulness for monitoring the health condition of the subjects with cardiovascular disease or sleep disorder.

2nd Reference based on Intelligent wireless mobile patient monitoring system we get to know that Nowadays, Heart-related diseases are on the rise. Cardiac arrest is quoted as the major contributor to the sudden and unexpected death rate in the modern stress filled lifestyle around the globe. A system that warns the person about the onset of the disease earlier automatically will be a boon to the society. This is achievable by deploying advances in wireless technology to the existing patient monitoring system. This paper proposes the development of a module that provides mobility to the doctor and the patient, by adopting a simple and popular technique, detecting the abnormalities in the bio signal of the patient in advance and sending an SMS alert to the doctor through Global System for Mobile(GSM) thereby taking suitable precautionary measures thus reducing the critical level of the patient. Worldwide surveys conducted by World Health Organization (WHO) have confirmed that the heart-related diseases are on the rise. Many of the cardiac-related problems are attributed to the modern lifestyles, food habits, obesity, smoking, tobacco chewing and lack of physical exercises etc. The post-operative patients can develop complications once they are discharged from the hospital. In some patients, the cardiac problems may reoccur, when they start doing their routine work. Hence the ECG of such patients needs to be monitored for some time after their treatment. This helps in diagnosing the improper functioning of the heart and take precautions. Some of these lives can often be saved if acute care and cardiac surgery is provided within the so-called golden hour. So, the need for advice on first-hand medical attention and promotion of good health by patient monitoring and follow-up becomes inevitable. Hence, patients who are at risk require that their cardiac health to be monitored frequently whether they are indoors or outdoors so that

emergency treatment is possible. Telemedicine is widely considered to be part of the inevitable future of the modern practice of medicine.

3rd Reference based on The real-time monitoring system for in-patient based on ZigBee we get to know that The system is made up of two sub-systems: patient physical states data acquisition and communication system based on ZigBee technology, and hospital monitoring and control center. The patient physical states data acquisition and communication system monitors the main physical parameters and movement status continuously. The information from data acquisition system is sent to hospital monitoring center by ZigBee wireless communication module. The monitoring center receives the information from each patient and save them to the database, and then judges the states of the patient by fuzzy reasoning. The data from the patient can be displayed as a graph or numeric on the monitor if it is necessary, and then the doctor can diagnose the patient according to the recorded continuous data. Wireless sensor network is made up of a lot of wireless sensors based on ZigBee technology. The ZigBee technology provides a resolution for transmitting sensors' data by wireless communication. ZigBee technology can transmit data with a rate of 250kbps, and then it is enough for the physical parameters of the patient. The communication distance of ZigBee node can be over 200 meters and can be spread by add route node, and then ZigBee technology is suited to a short distance wireless sensors network. ZigBee technology owns many virtues, such as low power consumption, low cost, small size, free frequency, etc. To know the physical states of in-patient, the physical parameters need to be monitored real-time. The traditional medical test instrument is a large size and connected by wire often, and the patient is required to be quiet during the test. In most of the hospital, the medical instruments need to be read by doctor or nurse, and the physical parameters are tested and recorded one or two times each day, the real-time monitoring is expensive for most of the patients, and can be only acquirable for ICU by a nurse. For this reason, the worsening of patient can't be found in time, and then the patient can't be helped in time. For most of the patients can be monitored real-time in hospital, we should find a new method. Consider that the movement of the patient is limited in hospital, we adopted the ZigBee and wireless sensors network to acquire the physical parameters of the patient.

IV. BLOCK DIAGRAM

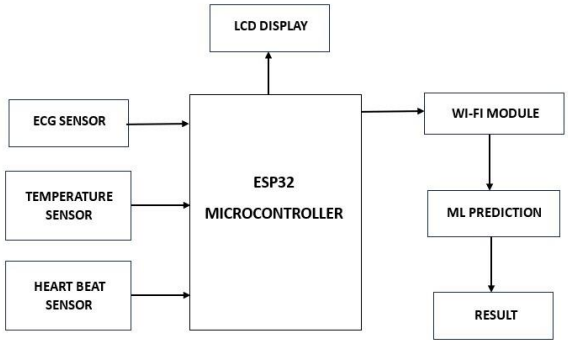


Fig. Stroke disease prediction system

The usage of wireless communication is the strength of our system to have highest liberation of movement to users in their physical activities. Also, we have used user-friendly, thin, small, smart IOT devices like wristbands and smartphones.

Embedded sensors were worn by the subjects, and smartphones are carried in the pockets or held in hands by their caretakers.

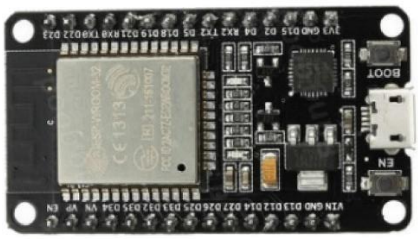
While the patient is living in a usual life, the heart parameters are constantly collected by the embedded Pulse Sensor, Accelerometers, and temperature sensors. After receiving the data to the cloud through a Wi-Fi

A premature warning system is designed to observe those parameters for detecting the symptoms of cardiac arrest during any activity. When the body temperature and Pulse sensor patterns reach a certain threshold level, the planned design triggers a warning, where the subject might feel the potential heart stroke. A warning to the subject in the form of a alert or notification or call is transmitted by the system at that moment.

The IOT device continuously receives data from the user and sends it to a smartphone via a Thing speak cloud. All the operations and data examination take place in the cloud (Thing Speak).

V. HARDWARE COMPONENTS

A. ESP32



When considering the ESP32 for stroke disease prediction applications, it's essential to understand its specifications and capabilities in relation to the requirements of the system.

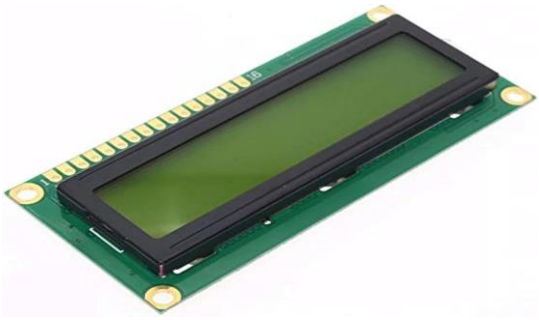
While the ESP32 may have more processing power and memory capacity compared to the Arduino Uno, it can still be a viable option for developing prototype stroke prediction systems, particularly those focused on real-time monitoring, data acquisition, and basic signal processing tasks. For more complex applications or larger datasets, it may still be necessary to offload computationally intensive tasks to external processing units or utilize more powerful microcontrollers.

B. Power Supply

Power supply considerations are crucial in the development of stroke disease prediction systems, particularly those involving remote monitoring solutions.

By addressing these considerations, developers can design robust and reliable power supply solutions tailored to the specific requirements of stroke disease prediction systems, enabling continuous monitoring of patients' health status while ensuring optimal energy utilization and user convenience.

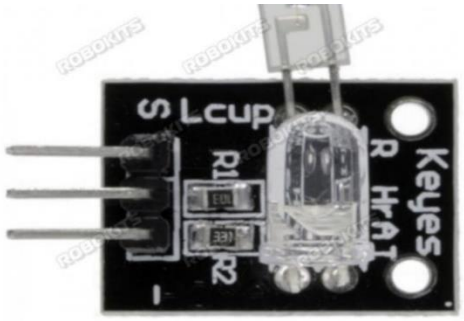
C. LCD Display



Integrating an LCD (Liquid Crystal Display) into a stroke disease prediction system can provide a valuable interface for displaying real-time data, alerts, and user feedback.

By incorporating an LCD display into a stroke disease prediction system, developers can enhance user engagement, facilitate data interpretation, and improve decision-making processes, ultimately contributing to better outcomes in stroke prevention and management.

D. Heartbeat Sensor



Integrating a heartbeat sensor into stroke disease prediction systems can provide valuable insights into cardiovascular health, aiding in the early detection of stroke risk factors and abnormalities.

By leveraging heartbeat sensors in stroke disease prediction systems, healthcare providers can enhance their ability to detect, monitor, and manage cardiovascular risk factors, ultimately reducing the incidence and severity of stroke events and improving patient outcomes.

E. Temperature Sensor

Integrating temperature sensors into stroke disease prediction systems can provide valuable information about physiological changes associated with stroke risk factors, such as fever, inflammation.

By incorporating temperature sensors into stroke disease prediction systems and analyzing temperature data in conjunction with other physiological parameters, healthcare providers can enhance their ability to assess stroke risk, monitor disease progression, and tailor interventions to individual patient needs.

F. ECG Sensor

Integrating an ECG (Electrocardiogram) sensor into stroke disease prediction systems can provide valuable insights into cardiovascular health, aiding in the early detection of stroke risk factors and abnormalities.

By leveraging ECG sensors in stroke disease prediction systems, healthcare providers can enhance their ability to detect, monitor, and manage cardiovascular risk factors, ultimately reducing the incidence and severity of stroke events and improving patient outcomes.

VI. RESULT

This section describes the process of collecting and pre- processing multimodal bio-signals of ECGs and PPGs used for machine learning and deep learning-based stroke dis- ease prediction and in-depth analysis and verification. The bio-signals used in the experiments conducted in this study are multimodal data of ECG and PPG measured and collected in real-time. The bio-signals of ECG and PPG refer to values that can express the contraction and relaxation of the heart, as well as the movement of the electric current passing through the three intestines when the heart beats, which appears in the form of a wavy line. ECG and PPG capture changes in blood vessel volume according to the heartbeat measured in the heart's electrical pathway, heart rhythm, and peripheral regions. By analyzing the bio-signals of ECG and PPG, the occurrence of major cardiovascular diseases such as arrhythmias or atrial fibrillation and chronic diseases such as hypertension can be observed.

Therefore, in this study, we utilized the clinical results showing that abnormalities in the autonomic nervous system and sympathetic nervous system can occur due to the prognostic symptoms of stroke. We attempted to predict the prognostic symptoms of stroke disease and interpret the meanings based on the medical opinion and diagnostic results of abnormal symptoms, including cardiac arrest or arrhythmia in ECG and PPG. Further, using the raw data of the bio-signals of ECG and PPG, a deep learning model was used to verify the stroke prognostic and prediction experiments in the elderly.

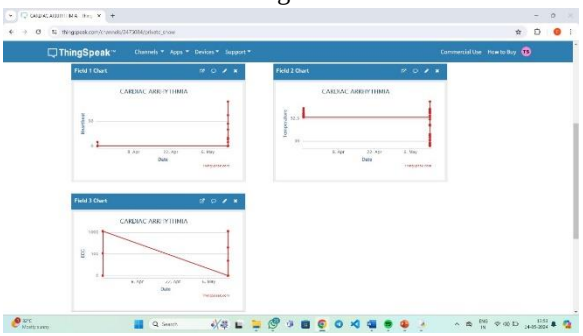
In this section, the accuracy of predicting stroke prognostic symptoms using the bio-signals of ECG and PPG was verified and the performance of the system was evaluated. Accuracy refers to the percentage of the total that correctly predicted elderly with stroke as stroke and normal elderly as normal.

Conversely, if a general patient without a given disease is misclassified as having that disease, it may lead to the waste of additional examination costs and treatment time. Therefore, in this paper, the prediction performance of stroke diseases in elderly is

comprehensively validated using all four performance evaluation indexes.

As a result, the experiment was conducted with a focus on finding and validating a model with high accuracy for predicting stroke prognosis while also having a low false positive rate.

An experiment was conducted using 29 attributes separated by a certain section from the ECG and PPG collected in real-time for various machine learning methodologies. In the first experiment, all 29 attributes of ECG and PPG, which separated the electrocardiogram data by section, were used to classify the normal elderly and the elderly with stroke based on machine learning.



In this section, we show that it is possible to distinguish between stroke and normal elderly based on long short-term memory (LSTM) using real-time ECG and PPG multi-bio signals, which is good for time series analysis in the deep learning field. We trained LSTM, Bidirectional LSTM, CNN-LSTM and using raw data of ECG and PPG to generate stroke prediction model. Bio-signals such as ECG and PPG are time series data that have sequential values according to time, and time information must be considered in the training process.

Therefore, in this paper, to solve this problem, we used a CNN-LSTM structure that combines a CNN for extracting features from ECG and PPG bio-signals and an LSTM model that shows good performance in predicting the next step in time series data. Important features were extracted from the time series data of the input ECG and PPG bio-signals, and these values were passed through the LSTM model using past and future information to accurately predict the prognostic symptoms of stroke disease. Finally, CNN-Bidirectional LSTM extracts features from ECG and PPG bio-signals by combining the CNN model in front of the LSTM model.

CONCLUSION

Healthcare monitoring and management system using IOT implemented. This system offers the doctors to take advantage of the massive amount of healthcare data and provide right intervention to the right patient at the right time. Hence personalized care could be given to the patient. This remote monitoring system allows the doctor to monitor the health status of the patient remotely. This is efficient system which alerts about the patient health condition to his or her family members. Since the response time of the proposed system is less, it is suitable or real time alerting.

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