A Wearable Device for Fall Detection and Heart Stroke Prediction using IoT and Machine Learning

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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 and wearable devices are mostly incorpaorated in cardiovascular community and clinical applications to achive medical breakthroughs. The wearable devices such as 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 the wearable device which 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 machine learning algorithm. Our proposed wearable device saves the lives of patient and reduces the death rate by taking immediate care.**

Keywords: Embedded System, Wearable device, IoT,Maching Learning, Heart rate

I. INTRODUCTION

The heart is the capital part of the cardiovascular system. It also comprise the lungs and muscular organ that used to pumb the blood into the body network. The cardiovascular system incorporate of blood vessels like arteries, veins, capillaries and these blood vessels form a network to transport blood in throught the body. Cardiovascular diseases (CVD) are a group of heart diseases caused due to irreugularities in usual blood flow from the heart. [Shadman Nashif]. Also, 80% of the deaths might occured 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. [1]

The major cause of injuries and injury-related deaths in elderly people is falling. Most of the elder population is unable to get up without any help when they fall, even if they are not injured. Also, lying on the floor for a long time leads to muscle damage, dehydration and

fear of falls. Fall detection approaches are of three types. They are vision-based, ambient-based and wearable-based. Although vision-based and ambient-based approaches provide better accuracy compared to wearable-based approaches, wearable-based approaches are advantageous in terms of cost, computational cost, setup and space restriction. [2]. Accelerometers, gyroscopes, heart rate sensors or a combination of these are typically used in wearable-based fall detection systems. A wearable device can be defined as a non-invasive sensor that is wearied to the body that compute a signal and gathered data which can then be stored or transmitted for further analysis and decision-making. [3]

To achieve high accuracy than that obtained when using a single accelerometer, a wearable device that combines a heart rate sensor and two accelerometers are proposed in this paper. The heart rate sensor is chosen as it achieved higher accuracy levels using a multidimensional fusion of physiological and kinematic parameters [2]. Also, a heart rate sensor is better in terms of size and cost compared with other physiological sensors, and it is generally used in smartwatches and hospitals. The sensors networks that are collecting, analyzing and passing data between multiple nodes are currently using Internet of Things (IoT) technology. Using IoT, the data collected from multiple sensors and pass the data and communicate over the Internet Protocols or public networks. The sensors collected data are analyzed are it is used to begin the essential action for planning and decision making using some machine learning algorithms.

The purpose of IoT is to make things capable to be connected anytime and at any place, with anybody and anything ideally using any path/network and any service. Ensuring the security for IoT devices is one of the main area to the researchers as the number of connected devices keep growing. IoT hardware development has many challenges whenever the new devices were introduced and that devices are made in small size and with limited battery life. Using communication protocols, the IoT sensor devices must be merged into the Internet and network protocols have to consider the less battery of sensors, mainly when sensors are placed in remote locations. [5].

Due to advanced healthcare monitoring system,the patient data is easily available in the cloud for designing predictive models for cardiovascular diseases. [Shadman Nashif].

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. [6].

Therefore, in this paper we proposed the patient fall detecton using acceleration sensors and heart stroke detection is predicted using the IoT and implementation of machine learning algotithm. This article covered in Literature review Section 2, section 3 proposed method, section 4 methodology and section 5 result.

II. LITERATURE SURVEY

The IoT Clinic-Internet based Patient Monitoring and Diagnosis System were presented by Niharika Kumar et.al in the year 2017 [1]. They presented the colorful factors for a healthcare system and the non identical tackle armature and the detectors being used to create the ecosystem and provide the treatment on time. The conventional healthcare system requires independent medical bias furnishing specific healthcare installations. These systems are normally installed at either healthcare centers or hospitals.Patient have to go these hospitals to healthcare services.

With the advent of smartphones, health monitoring gadgets, IoT and individual motorized collaborators used in modern healthcare system presented by Abdulhamit Subasi et.al ib the year 2018. The modern health care technologies brings the automated diurnal exertion covering for senior people [2].

The Complexity of Cyber Security Architecture for IoT Healthcare Industry: A Comparative Study by Aysha K et.al, In the year 2017. They discussed about the complexity issue of cybersecurity for IoT based healthcare system. The ideal theory of this study is for guarding healthcare against cyber attacks fastening on IoT networked healthcare bias. The IP core architecture is considered to have further advantages compared to other architecture. Anastasiia et.al proposed the Modelling of Healthcare IoT using the Queuing Theory by the year 2017. They have discussed the opportunities and prospects for the IoT operation in the domain of healthcare. A brief explanation of modules used in healthcare IoT structure have been presented. By using the Queueing Theory they analysed the factors an anthology, pall, healthcare provider, and communication channel. A smart IoT platform for personalized healthcare monitoring using semantic technologies presented by Ahmed Dridi et.al, by the year 2017. They addressed the siginificance of a new IoT-centric platform for substantiated healthcare monitoring. They have discussed about the problems of data interoperability, integration, visualization, and confidentiality.

The conclusive thing of attain best quality of healthcare practices relies on the ability of functionally integrate the data coming from assorted sources. Ensuring the security

of the data and use data analytics tool prie the information and visualization.

III. PROPOSED DESIGN

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[6]. After receiving the data to the cloud through a Esp 32, the machine learning algorithm will analyze the data to classify whether the patient condition is abnormal or normal. 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 continously recives data from the user and sends it to a smartphone via a thinkspeak cloud. All the operations and data examination take place in the cloud (ThingSpeak). When the algorithm senses an abnormality, the user gets a notification immediately [7].

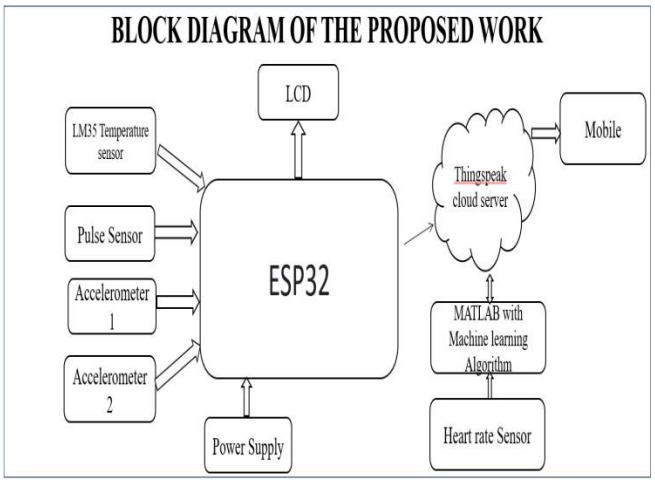

Figure1.Block Diagram

IV.IMPLEMENTATION

Heart rate sensor, temperature sensor, Humidity sensor and Pressure sensors are attached wearable band and output of the sensors are connected to the Rasperry Pi microcontroller. By using the IoT technology, The output of the sensor data is saved in the cloud .This received data are compared with the existing data set using un supervised machine learning algorithm. This algorithm has estimated the possibility of heart stroke Two acceleration sensors are connected in the wearable band to detect the falling down of the patient and immediate message send to caregivers through IoT technology [8]. After analyzing the heart stroke prediction parameters through machine learning algorithm, the risk data set send to the cloud and mobile app maintained by the hospital for immediate treatment.

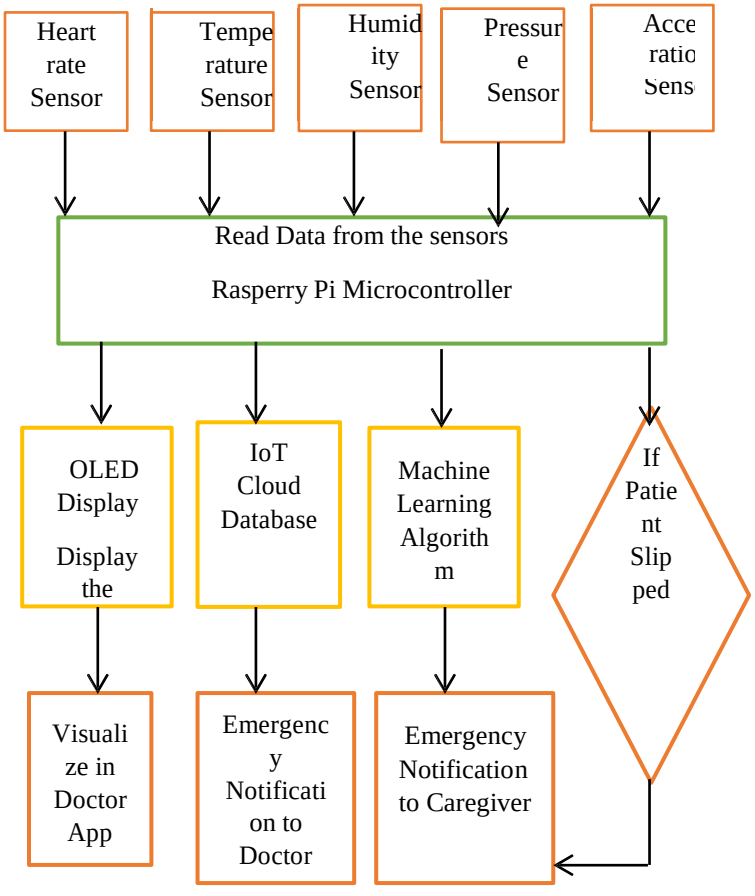

Figure 2. Flowchart

An Esp 32, a pulse rate sensor, accelerometers, and the temperature sensor are present in the initial prototype system. The Esp32 have integrated Wi-Fi and dual-mode Bluetooth with series of low-power microcontrollers. Arduino Zero is the closest Arduino board comparable to the Esp32,it is a 32-bit microcontroller designed for IoT purposes. The pulse sensor should be cloak around the subject index finger by extending it to the palm. During the daily activities of the user, it is quiet easy to measure pulse from the finger. we use the measured values like heart rate and body temperature interfaced with the smartphone, To receive and analyze data from the IoT device [9].

The software tool used in the research is Arduino IDE and ThingSpeak cloud server. It is the open-source software with limited code size, and it is easy to write and upload program to boards such as Arduino UNO and NODE MCU ESP8266. An application program was developed in the Arduino IDE and by using AT commands data is sent to the ESP8266 module. The real time data loaded on the cloud server database from sensor module and it is automatically updated during the specific time interval. We have carriedout some initial test on the ThingSpeak platform, for the formal verification for checking the operation of the prototype. In our proposed project, an efficient machine learning algorithm was developed and implement to detect the existence or to find the decision from the probability of having a heart stroke using a large sets of data [10]. The proposed an intelligent and user-friendly heart stroke prediction system, used to train large datasets and analyze the received data set with existing data set to predict the possibility of heart stroke detection. After the detection an alert message with containing the current data of the patient send to the Hospital/doctor's/caretaker's phone, they will respond immediately and provide appropriate medication.

III. RESULT

The heart storke detector by measuring with heart rate which is shown in figure (3). A finger dipped in to optical sensor for measuring heart rate and this value coneected to microcontroller and diaplyed into LCD.

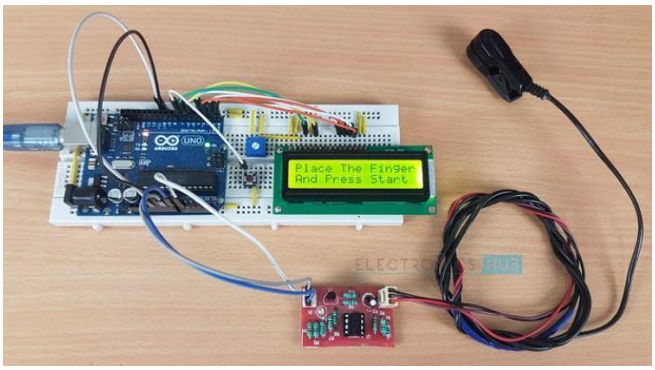

Figure 3 Heart Stroke detector

IV. CONCLUSION:

The patient fall detection and heart stroke prediction system has been proposed in this paper. By using various sensors, the system has measured heartpulse rate, body temperature, relative humidity and position of the patient. Any obnormalities were detected in the accleartion sensors ,the system will produce alert to caregivers through IoT technology.The other parameters like body temperature,relative humidity and heart pulse rate is quantitatively analyzed with the resk data sent and the probability of heart stroke is measured by using machine learning algorithm. This alert and verified data send to the hospital , doctors and caregivers through IoT Cloud channel. After the alert ,is is very musch helpful for quick recovery and statrd the treatment. Our prposed system are very effieicnt and high accuracy of detection is observed.

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