MediConnect - Remote Patient Health Monitoring

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***Abstract*—In this country, hundreds of thousands of old people are isolated from society and lonely as an outcome of urbanization and shifting family arrangements. They highlight the need for more mental health care, community outreach, and programs to identify and help those who are susceptible. The term ”lonely death” describes a person dying alone, frequently with no one around to see or be there in their last moments. This might occur as a result of social isolation, health problems, financial difficulties, or other factors. The emotional and social ramifications of these deaths highlight how important it is to avoid isolation and make sure that everyone has access to the care and assistance they require. Our project's objectives are to keep an eye on the patient's condition and identify any collapses, falls, or abrupt changes in heart rate. Additionally, it helps the user and notifies the authorities in an emergency or in case of discomfort by sending alerts.**

Keywords— Internet of Things (IoT), Cloud computing, Remote patient monitoring, Patient data analysis

I. Introduction

To maintain independent living, it is becoming more and more important to support mental and physical health, as well as the growing number of people affected by chronic diseases like diabetes, cardiovascular disease, obesity, and so forth. This is because many societies are seeing an increase in their age profiles. In general, older adults need more healthcare than younger adults do. Furthermore, as a result of the normal aging process, chronic disease is more common in older adults. The financial burden of healthcare is rising quickly in every country on the planet in conjunction with this demographic time bomb. A specified set of jobs can be effectively managed, maintained, and monitored via remote health monitoring systems over a network with lower costs and fewer errors. This network may consist of several linked devices on a local network or it may be an Internet-of-Things (IoT) system. They offer several chances to apply modifications and are scalable. To create a network, they make use of specific sensor-based devices like gyroscopes and accelerometers. The application, needs, and environment all influence the devices that are chosen for these systems. IoT places a strong emphasis on how all digital and physical objects, such as smart devices and sensors, are connected to one another. This enables automatic and effective data sharing and transmission over the Internet. Therefore, enhancing the use of IoT in healthcare by utilizing networked medical sensors—particularly wearable or implantable ones—is thought to be able to deliver intelligent, accurate, and reasonably priced individualized healthcare services. Our project's objectives are to keep a watchful eye on the patients' health, identify any collapses or falls, and determine whether the patient has heart disease. Additionally, it helps the user notify those responsible in case of an emergency or discomfort. We created a framework for the wearable, internet of things based health monitoring system in this study.

II. Literature Survey

The review of the research literature delves into a multitude of innovative remote health monitoring systems, all of which provide unique approaches that have the potential to completely transform the way

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healthcare is provided. These creative methods leverage the potential of state-of-the-art technology to drive notable improvements in healthcare outcomes.

Somayeh Iranpak, Asadollah Shahbahrami and Hassan Shakeri [1] proposed a system that uses wrist sensors to collect critical data is suggested to enable patients to have remote health monitoring at home or in hospitals. These sensors send data to cloud servers, including blood pressure, body temperature, and heart rate sensors. The system uses a microcontroller to communicate with a mobile gateway over Bluetooth or Wi-Fi while monitoring sensors and encrypting data. When a patient's health is classified by an LSTM deep neural network in the cloud, medical staff and their family receive timely alerts.

Nizar Al Bassam, Shaik Asif Hussain , Ammar Al Qaraghuli , Jibreal Khan , E.P. Sumesh , Vidhya Lavanya [2] suggested a gadget that is worn by a possible infected patient and senses the patient's location as well as their medical symptoms. It has a three-layer design consisting of a wearable IoT layer, a cloud layer, and a web frontend layer. CNN is used for cough detection. In order to monitor and handle critical circumstances, the medical authorities operate an API cloud processing system that receives the data gathered by the IoT device. Receiving warnings and notifications regarding the patient's critical health signs while under quarantine is primarily the responsibility of the registered user family member. Additionally, an Android application designed to provide frequent alerts regarding the patient's health problems while in quarantine is synchronized with the device.

Damini Verma , Kshitij RB Singh , Amit K. Yadav , Vanya Nayak , Jay Singh , Pratima R. Solanki , Ravindra Pratap Singh [3] The wearable biosensors in the proposed system are nano-integrated and internet-connected, enabling the real-time transmission of physiological data. These biosensors monitor metrics like blood pressure and heart rate and can be integrated into a variety of wearable devices. Cloud computing facilitates the processing and storage of data, and machine learning techniques allow for the rapid identification of health issues through data analysis.

Nagendra Singh, S.P. Sasirekha, Amol Dhakne, B.V. Sai Thrinath, D. Ramya and R. Thiagarajan [4] The paper suggests an Internet of Things (IoT)-based system that enables patients to self-identify and predict illnesses while assisting clinicians in remote disease discovery. Patient data is sent to a doctor or hospital monitoring centre via a lightweight wearable gadget that has a microcontroller, medical detectors, and Wi-Fi. Real-time data analysis and communication between patients and clinicians are made possible by deep learning models and the MQTT protocol.

Weiping Zhang, Mohit Kumar, Junfeng Yu and Jingzhi Yang [5] The suggested system uses the ZigBee protocol to provide wireless communication between sensors, allowing physicians to monitor patients' physical parameters in real-time. Patients with sensor nodes attached can walk about freely as wireless data transmission of body temperature, pulse, and ECG occurs. Routing nodes process and forward data to a coordinator node that is connected to a PC, allowing doctors who are on call to easily monitor patient physiology.

Jie Wang, Munassar A.A.H, Al-Awlaqi, MingSong Li, Micheal O'Grady, Xiang Gu, Jin Wang and Ning Cao, [6] To track individuals' health, this study presents the Wearable IoT cloud-based health monitoring system (WISE), which makes use of networked wearable sensors. Biomedical signals are gathered and sent straight to the cloud server, including body temperature, heart rate, and blood pressure. The W-BAN, W-Cloud, and WISE Users components make up the system, which allows for the real-time presentation of data on a webpage.

Salman Ahmad Siddiqui, Anwar Ahmad, Neda Fathima [7] The study suggests a novel illness prediction model that incorporates inputs such as body temperature, cough, family history, and patient symptoms. Accurate disease prognosis is achieved by the collaboration of trained machine learning models, such as Cough/Sound Classification, Image Classification for COVID X-rays, and Disease Prediction models. To maximize model performance, a variety of algorithms, including KNN, Random Forest, SVM, and Decision Tree, were used.

Abdul Rauf Baig, Kashif Zafar, and Afzaal Hussain [8] The suggested fog-centric framework uses mobility data, health history, and real-time vital monitoring to track and treat medical issues in smart gym settings. It classifies workouts, creates health risk alerts, and evaluates the physical impacts of exercise on athletes. With the use of fog computing, the system predicts health hazards in real-time, identifying athletes' physical status and predicting their gym attendance with over 97% accuracy.

III. Methodology

By using a range of wearable biosensors to continuously monitor the patient's health indicators, the proposed system seeks to lower the incidence of lonely deaths. Subsequently, this data is sent to a mobile gateway and the patient's smartphone application, which promptly notifies the user if any irregularities are found. Additionally, this data is uploaded to the cloud, where it can be processed further to produce a disease diagnosis. To make patient records easily accessible to healthcare providers, this data is also kept on cloud servers.

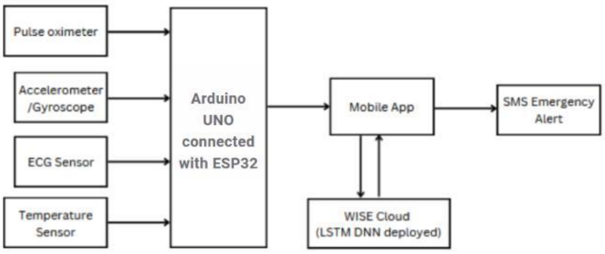

Fig. 1. Block Diagram of the proposed system.

A. Hardware Components

Various wearable bio-sensors that are utilized to gather and transmit patient health status data included in the hardware of the proposed system are:

1) ECG Sensor - AD8232: A commercial board called the AD8232 ECG sensor is used to determine the electrical activity of the human heart. An analogue reading is the result, and this action can be plotted similarly to an electrocardiogram. The ECG sensor functions similarly to an operational amplifier in order to assist in obtaining a clear signal from the intervals. A single supply can operate between 2 and 3.5 volts. This sensor comes in a 20-lead LFCSP package and is available in a 4 mm x 4 mm dimension. Although the performance is specified between 0°C and 70°C, it performs between -40°C and +85°C.

2) Pulse oximeter - MAX30102: The MAX30102 is a heart rate monitor and pulse oximetry module combined. Internal LEDs, optical components, photodetectors, low-noise circuitry, and ambient light rejection are all included. The internal LEDs of the MAX30102 are powered by a separate 3.3V power source in addition to a single 1.8V power supply. The standard I2C interface is used for communication, and the operating temperature range is -40°C to +85°C.

3) Temperature sensor - LM35: A temperature sensor called the LM35 produces an analogue signal proportional to the current temperature. It is simple to interpret the output voltage and get a temperature reading in Celsius. The temperature range that this 3-terminal sensor measures is -55 °C to 150 °C. The power consumption is 60 A, and the operating voltage ranges from 4 V to 30 V. The output type is analogue, with an accuracy of ±1°C.

4) Accelerometer/Gyroscope - MPU6050: A 3-axis accelerometer and a 3-axis gyroscope combine to form the 6- axis motion tracking MPU-6050 Triple-Axis Accelerometer Gyroscope Module. It can measure angular velocity around three axes (X, Y, and Z) in addition to acceleration. It requires 3.6 mA of running current and a 5V input power supply. The MPU-6050 features a VLOGIC pin that determines its interface voltage levels and supports I2C communications up to 400kHz.

5) Microcontroller - Arduino UNO R3: A Arduino Uno board based on the ATmega328 is called the Arduino Uno. It features 20 digital input/output pins, a 16 MHz resonator, a USB port, a power jack, an in-circuit system programming (ICSP) header, and a reset button. Of those pins, 6 can be used as PWM outputs and 6 as analog inputs. Operating voltage ranges from 7 V at the minimum to 12 V at the maximum. Its program memory is 31.5 Kbytes in size, and its RAM is 2048 bytes.

6) Pulse Bluetooth module - ESP32 : Operating on 3.3V by default, the ESP32 module is a flexible platform built for IoT and wireless communication. With onboard regulators, it can manage a 5V supply voltage. It enables variable data transmission rates and communication ranges based on setup and ambient parameters. It supports both Wi-Fi and Bluetooth. Designed to endure temperatures ranging from -40°C to 85°C (-40°F to 185°F), developers prefer the ESP32 because of its low power consumption, wide range of peripheral compatibility, and strong wireless communication and processing capabilities.

B. Implementation

Wearable Biosensors: The suggested system uses wearable sensors to measure various patient health indicators, including temperature, pulse oximeter, ECG, and accelerometer/gyroscope. Using a Bluetooth module, the Arduino microcontroller connects to the sensors, receives input from them, and sends the data to the patient's smartphone.

Mobile Gateway: The patient's smartphone app serves as the mobile gateway, receiving sensor data to monitor abrupt changes that can endanger the patient's life. The patient's nearest family and the patient's healthcare provider receive an SMS notification or alert if the patient's health parameters drop to the point where medical emergencies arise.

Machine Learning Algorithms: The sensor data gathered at the mobile gateway is transmitted to the cloud, where the Long Short-Term Memory (LSTM) deep neural network algorithm is used to analyse the patient's condition in greater detail. Both the patient and their healthcare professional have access to the patient data, which is also saved in the cloud along with the diagnosis.

Various wearable bio-sensors, including an accelerometer/gyroscope (MPU 60150), temperature sensor (LM35), pulse oximeter (MAX30102), accelerometer (AD8232), and Bluetooth transmitter module (ESP32) are included in the proposed system. The pulse oximeter monitors blood oxygen saturation level and heart rate, the accelerometer/gyroscope measures linear and angular acceleration along the three axes, and the ECG sensor records the electrical activity of the heart. The patient's temperature is recorded by the temperature sensor. The microcontroller gathers these sensor data, which are then sent to the patient's mobile app via the Bluetooth module for display.

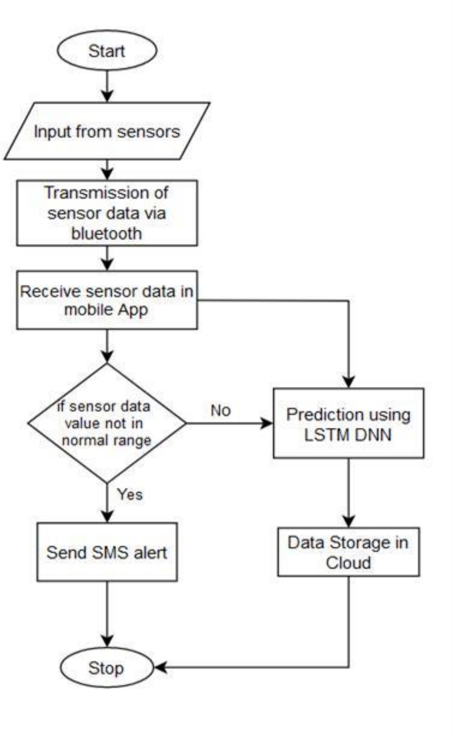

Fig. 2. Flow chart of the proposed system

Through the smartphone application, the patient can notify the closest relative and the healthcare practitioner by SMS or direct contact if they are experiencing any discomfort. Additionally, this data is sent to the cloud, where the LSTM DNN algorithm is used to determine whether the patient has any cardiac conditions. The heart of cloud computing is an embedded LSTM deep neural network system that is used to remotely categorize and track the health condition of patients. The LSTM deep neural network algorithm's primary job is to identify patients' normal and acute states. Based on the information obtained, the patient's deep neural network LSTM detects if the patient is in a severe state, and the appropriate alarms are sent right away to the patient, doctor, nurse, and patient's family.

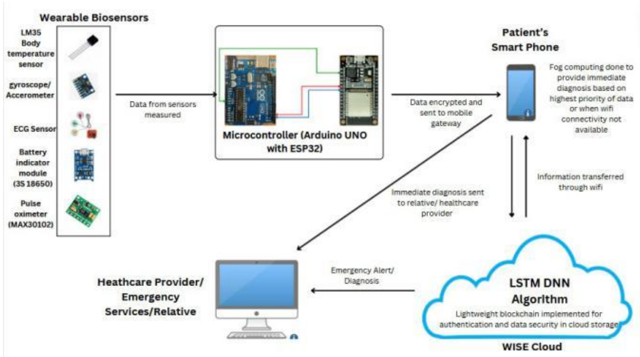

Fig. 3. Architecture diagram of the proposed system

IV. Result And Discussion

The accuracy of the proposed system for predicting heart disease was found to be 84%.

A. Comparison with Other Algorithms

Three additional widely-used algorithms—Random Forest, K-Nearest Neighbours (KNN), and Support Vector Classifier (SVC)—were compared to the proposed system's performance. Using the same dataset, these algorithms' accuracy scores are as follows:

Methods	Accuracy%
Random forest	83
KNN	75
SVC	81
Proposed Model	84

TABLE I
ALGORITHM MODEL ACCURACY

Our LSTM algorithm performed better and achieved more accuracy than both KNN and SVC, as shown in Table 4.1. Although Random Forest and our LSTM model demonstrated similar accuracy, our method has the benefit of using recurrent neural networks to use sequential data patterns.

According to these findings, our LSTM-based method maybe more effective than more conventional machine learning algorithms in predicting cardiac disease with accuracy and dependability.

V. CONCLUSION

The healthcare industry produces a large amount of patient data in the modern digital age. Chronic disorders like diabetes, cancer, heart disease, and chronic respiratory illnesses are among the world's top causes of death.

Finally, our study offers a comprehensive framework for remote health monitoring, specifically for those with underlying and chronic conditions, using cloud computing, IoT, and machine learning. We have created an efficient system for gathering, sending, and analysing patient data by utilizing wearable biosensors and LSTM deep neural networks. This has resulted in notable gains in recall, accuracy, and precision over previous approaches. In addition to facilitating early disease identification and treatment, this novel strategy offers more information about individuals' health and expedites access to emergency care when needed. In the end, our method may significantly lower the number of isolated fatalities among isolated people, improving their quality of life and improving medical results.

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