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Smart Health Care System

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Abstract

In the context of e-Health, we offer an Internet of Things (IoT)-based healthcare system implementation scheme that makes use of electrocardiogram (ECG) sensors and convolutional neural networks (CNNs) in this research. The program intends to improve cardiovascular disease (CVD) patients' access to medical care by facilitating better monitoring and prompt intervention. This implementation makes use of patient path estimator, patient table, and alert management schemes within the hospital to facilitate the localization and prompt intervention for the treatment of CVD patients, as real-time monitoring of patients from various locations remains a critical challenge for IoT-based health care systems.

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I. INTRODUCTION

One of the things that humans require is an appropriate method for monitoring their health. According to a World Health Organization (WHO) report, being in good health is having the ability to function both physically and mentally while being free from disease and disability. IoT-based technologies make it simple to monitor a number of deadly diseases. These days, routine health monitoring systems help every community lessen the workload of physicians and nurses. One of the best ways to prevent diseases and live a healthy, disease-free life is to monitor several health indicators. Nowadays, the Internet of Things (IoT) is a subject with extensive investigation and a solid technological foundation.

All objects are now connected thanks to the Internet of Things' most recent development, which is considered to be the next great technological revolution. IoT and sensor-based intensive care systems are being used more and more frequently. Our lives are easier, smarter, and more productive because to IoT. IoT can be used to track the unexpected events occurring in the patients' bodies. The dangerous condition known as cardiovascular disease (CVD) is the underlying cause of the majority of illnesses. In the event that any irregularities arise in any health parameter, action can be taken right away. For many years, a variety of techniques have been used to monitor health. Various types of sensors are used in health monitoring systems to measure various health characteristics and numerous health monitoring kits that can improve health have been developed in order to increase quality of life. Electronic circuits and computers can be used to automate health monitoring. Various kinds of sensors are connected to microcontrollers, Arduino, and other devices for automation. The primary concept of the article is the integration of ThingSpeak cloud, Ubidots, and microcontrollers to gather and process sensor data. The Internet of Things develops into cutting-edge medical technology. Once the temperature, ECG, and SPO2 sensors are connected, microcontrollers function as a miniature clinic.

The paper is divided into the following two sections.

Hardware Part (connect-ing temperature sensor, ECG sensor and SPO2 sensor).

Using Pre-trained Convolutional Neural Network (CNN) ECG Arrhythmia Detection

II. RELATED WORK

talked about a technique that connects a temperature sensor and a heart rate sensor (Easy pulse V1.1) to an Arduino board. This allows the sensor to send real-time data to the ThingSpeak and Ubidots IoT platforms while also displaying the measurement on an LCD display suggested a patient health monitoring system. The LM-35 sensor and the ECG sensor are used by the system to track a patient's body temperature, heart rate, and electrocardiography. These sensors were linked to an Arduino Uno microcontroller, which was configured to extract the patient's heart rate from the electrocardiograph signal that the ECG sensor had recorded. A doctor received the gathered data from the sensors that the microcontroller processed via wireless communication, which was created by connecting the Bluetooth HC-05 module to the Arduino.

III. PHYSICAL DEVICES

The hardware elements of the suggested system for measuring various health parameters are shown in this section.the sensors that monitor an individual's health state. The suggested system makes use of the biomedical sensors listed below.

A. Sensor of temperature

In our project, an LM35 temperature sensor is utilized. It is inserted into the user's finger to take their body temperature. The output range of the LM35 sensor is -40°C to 110°C.

B. The SpO2 gauge

The pulse oximeter MAX30102 is used to measure oxygen levels. It has additional uses, such as a pulse sensor. Its temperature range of operation is -40°C to +85°C.

C. An ECG machine

The primary term for ECG is electrocardiography. An ECG sensor displays the user's electrocardiography signal in real time. An ECG sensor is made using the AD8232 sensor. This sensor provides an analog output and measures up to ±300 mV.

IV. METHODOLOGY

This paper proposes a health tracking kit that is primarily divided into three components. They are as follows:

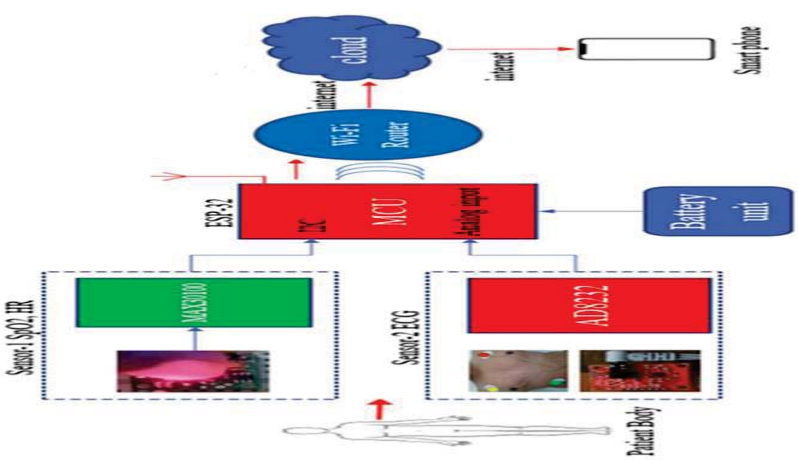
1) Data Acquisition from Sensors

2) Visualization of Data on the Thing to speak Cloud

3) CNN Data Analysis

Initially, a wide range of biomedical sensors are employed to gauge various health parameters, such as blood oxygen levels, body temperature, heart rate, movement, and sweat gland activity linked to emotional arousal. Users' data was gathered by these sensors. The microcontroller is linked to the sensors. It is in charge of the entire system. IoT is used to update and store the data on the Thing to speak platform for analysis and visualization.

Smart Health Care System, ECG monitoring system.



I. IoT Based ECG system

Due to the exponential increase in the human population and medical costs, public healthcare has received more and more attention. It is commonly known that a proficient health monitoring system has the ability to promptly identify anomalies in medical conditions and provide diagnoses based on the collected data. ECG monitoring is a crucial method for diagnosing cardiac conditions and is extensively researched and used. But almost all of the portable ECG monitoring devices on the market today require a mobile application to function; this application handles data collection and display. In this work, we suggest a novel Internet-of-Things-based approach for ECG monitoring.

(IoT) methods. Wearable monitoring nodes are used to collect ECG data, which are then wirelessly transferred to the Internet of Things cloud. The Internet of Things cloud uses both the HTTP and MQTT protocols to give users access to real-time and visually represented ECG data. The cross-platform problem has been significantly mitigated by the ease with which ECG data can be obtained by almost any smart terminal equipped with a web browser. Healthy volunteers are used in experiments to confirm the overall system's dependability. The suggested system can help with the primary diagnosis of some heart diseases since it is dependable in gathering and presenting real-time ECG data, according to experimental results.

II. Electrocardiogram (ECG)

An electrocardiogram (ECG) is a graphic depiction of the electrical activity of the heart that is produced by positioning different electrodes on the subject's body surface at particular points. A patient's ECG signal abnormalities may be a sign of heart conditions that require immediate medical attention. Therefore, it is essential to identify an abnormal ECG in order to improve the patient's condition. In this work, a method for categorizing ECG signals as normal or abnormal is developed. Bundle Branch Block, Cardiomyopathy, and Angina In our work, cardiac conditions such as heart failure, dysrhythmia, myocardial hypertrophy, myocardial infarction, myocarditis, and valvular heart disease have all been classified as abnormal ECG signals. First, statistical characteristics such as kurtosis, skewness, details of the Daubechies wavelet (db10) of order 5 standard deviation and approximation coefficients for a variety of aberrant and normal ECG signals acquired during the feature extraction phase. Second, the features that were extracted in the first stage were used to train the Support Vector Machine (SVM), which was used for classification. In the end, the SVM was tested using 36 signals from the PTB Diagnostic ECG Database and 36 signals from the MIT-BIH Normal Sinus Rhythm Database to determine the accuracy, sensitivity, and specificity of this method. The results showed that the accuracy, sensitivity, and specificity were, respectively, 98.61%, 97.37%, and 97.22%.

The ECG signal is analyzed using the PQR (Peak, QRS complex, and Recovery) complex analysis method to look for anomalies that might be related to heart disease. Three separate waves comprise the PQR complex:

P wave: The depolarization of the atria, or upper chambers of the heart, is represented by the P wave.

QRS configuration: The depolarization of the ventricles, or lower chambers of the heart, is represented by the QRS complex.

T wave: The T wave shows that the ventricles have repolarized of the ventricles.

Each wave in the PQR complex is measured for amplitude, duration, and morphology as part of PQR analysis.

A number of heart conditions can be indicated by abnormalities in the PQR complex, including:

* Cardiomyopathy

* Pericarditis (inflammation of the lining surrounding the heart)

* Arrhythmia (abnormal heart rhythm)

* Heart attack * Heart failure

* Coronary artery disease

* Myocarditis (inflammation of the heart muscle)

Patients without symptoms can have their risk of heart disease predicted using PQR analysis. Additionally, it can be used to track individuals with pre-existing heart disease and evaluate how they respond to therapy.

How PQR analysis works for research

PQR analysis is an effective tool for heart disease research.

It can be applied to:

* Find novel heart disease biomarkers

* Create new cardiac disease diagnostic instruments.

* Evaluate the effectiveness of novel heart disease treatments

PQR analysis, for instance, has been used to find novel biomarkers for atrial fibrillation, an arrhythmia that carries the risk of stroke. It has also been applied to the creation of fresh heart failure diagnostic instruments.

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An example of a research PQR analysis

According to this study, PQR analysis may be a useful method for estimating a patient's risk of heart disease if they have diabetes. It also implies that PQR analysis might be applied to the creation of fresh heart disease diagnostic instruments and therapeutic approaches.

A novel and promising technique for identifying and diagnosing heart disease is PQR analysis. It is an effective tool for heart disease research.

ECG Abnormal Patterns

ECG Abnormalities	mean I_{QT}	mean I_{QRS}	min V_T	min V_{ST}	max V_{ST}
ST depression				< -0.1	
ST elevation					> 0.1
Prolonged QRS interval		> 0.12			
Short QRS interval		< 0.1			
Prolonged QT interval	< 0.375				
T wave inversion			< 0		

Fig 1.ECG Abnormal Patterns.

The way in which ECG signals can be categorized into each kind of irregular cardiac rhythm is illustrated in Fig. 1.

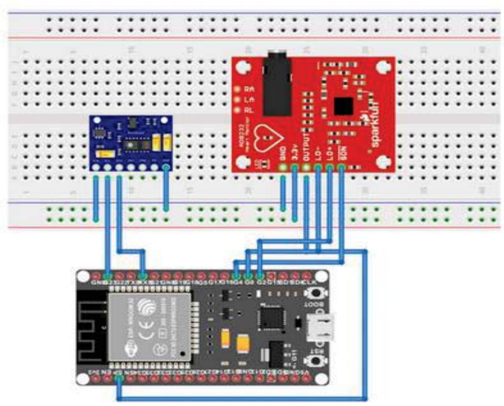
Angina and myocardial infarction are suggested by ST depression and elevation. VST voltage values in ST depression ECG signals are less than -0.1 mV. VST voltage values of ST elevation in ECG signals are greater than 0.1.

A prolonged or short QRS interval is indicative of cardiomyopathy. The average QRS interval for a prolonged QRS interval is more than 120 ms, whereas the average QRS interval for a short QRS interval is less than 100 ms.

Prolonged QT interval is average QT interval is less than 375ms. This value is 2 Sigma away from the average QT interval of healthy subjects.

Myocardial infarction is suggested by T wave inversion. The voltage of the T wave peak is used to calculate T wave inversion. Lead II's normal T wave has an upward direction and a positive voltage. An inverted T wave is suggested by a negative voltage. We determine the minimum voltages of T peaks in order to identify an ECG recording that contains at least one inverted T wave.

C. Sensors Module Connection Diagrams



III. RESULTS AND DISCUSSION

To test the functionality of the ECG sensor and make sure the electrodes were positioned correctly, the performance of the suggested ECG system was first examined using the Digital Storage Oscilloscope (DSO) and serial monitor of the Arduino IDE, as illustrated in fig. 5. The response from the ECG sensor was plotted by web while the subject was sitting comfortably. We manually calculated the R-R interval, QRS duration, PR interval, and QT interval from the obtained ECG waveform on the serial plotter of the Arduino IDE. Then, using the program we uploaded in the Node MCU microcontroller, we developed an algorithm based on these calculations to automate the process of finding these ECG parameters.

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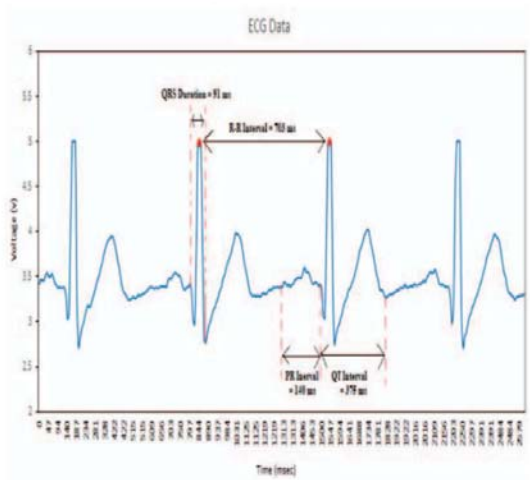

Fig. 8. Key features of the measured ECG signal.

After manually calculating the essential components of the ECG wave, we created several algorithms to enable the microcontroller to calculate these features. The algorithm used to calculate the R-R interval is based on initializing the microcontroller's built-in timer once the ECG signal crosses the upper threshold designated for the R peak. From there, it calculates the time interval between the two successive R peaks, which is equivalent to the R-R interval. Calculations are also made for the QRS duration, PR interval, and QT interval. The heart rate in beats per minute (bpm) = (60/R-R interval in seconds) and heart rate variability (HRV) = (difference between the two successive R-R intervals) are then determined using the computed R-R interval. Following the program's calculation of the heart rate in beats per minute, a straightforward algorithm is used to identify arrhythmia conditions like bradycardia and tachycardia based on the heart rate's normal threshold values, which are less than 60 bpm for bradycardia and greater than 100 bpm for tachycardia.

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Fig. 2. An example of the suggested IoT-based ECG system

The ECG data is finally transmitted to the Ubidots cloud after all of the algorithms have been successfully implemented and processed, where it is displayed in the Blynk web GUI dashboard and the mobile application. Thus, the results obtained on the GUI are compared with the 12-lead clinical ECG, and the error is computed using the KNN Algorithm for all the ECG wave parameters from the suggested IoT-based ECG system.

VI. CONCLUSION

The created prototype can virtually carry out medical tasks, taking the place of conventional techniques for routinely and continuously monitoring bodily parameters. Since it doesn't require the development of a separate app, it is portable, lightweight, inexpensive, and simple to implement in the real world. Moreover, a Velcro belt can be used to secure this to the patient's clothing or inside their body. Both patients and clinicians will find this suggested cloud-based mobile health monitoring system easy to use and straightforward for monitoring patients' health parameters from their homes or isolated wards. Because the system is entirely automated, patients can set it up and use it without difficulty, and clinicians can readily explain it to patients.It is designed to make remote monitoring, analysis, and decision-making simple and straightforward. The AD8232 and MAX30100 sensors, in particular, are the best options when examining the commonly used sensors for wearable devices that measure heart rate, SpO2, and ECG due to their accuracy and package form factor. Strong IoT connectivity is achieved by selecting an ESP32 module. This module uses less power and has low power consumption along with full TCP/IP stack protocol and Wi-Fi connectivity. Because of this, the module can be used in wearable applications with multiple sensors. The medical professional can view and analyze the sensor data in real-time on a smartphone or tablet thanks to the Blynk IoT cloud's processing and display of the data. This can aid in the doctor's diagnosis and take care of a critical patient in time.

VII. References

The Fourth International Conference on Computational Intelligence and Communication Technologies (CCICT) is being held in Ian F2021. The conference is being held at 978-1-6654- 2392-2/21/$31.00 ©2021 IEEE. The professor, Dr. Randeep Singh, is the contact person.

Ian F2021 is hosting the Fourth International Conference on Computational Intelligence and Communication Technologies (CCICT). The conference will take place at IEEE 978-1-6654-2392-2/21/$31.00 © 2021. The point of contact is Dr. Randeep Singh, the professor.

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