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A Novel Electrocardiogram-Based Approach for Detecting Cardiovascular Diseases

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Abstract— ***The accumulation of cholesterol over the past few decades has raised both the risk and prevalence of cardiovascular disease. Extreme internal pressure is the root cause of this disease. Without modern testing equipment, diagnosing heart diseases is difficult. A method for diagnosing heart issues has been created as a result of thorough research. Using a person's basic medical history, which includes genetic information, cardiovascular illness must be anticipated. Raspberry Pi and Arduino Uno are both integrated into this system. After being received, ECG signals are converted from analogue to digital by the Arduino board's included ADC (Analogue to Digital Converter). Processing is completed before these signals are sent to the Raspberry Pi. The cardiovascular system's condition will be displayed on the LCD. The Raspberry Pi computer transmits heart rate information by starting a Python code and connecting to the Blynk app via its built-in Wi-Fi. Remote access is possible to the system.***

Index Terms— ***Cardiovascular disease(CVD), Analog to Digital Converter(ADC),Internet of Things(IOT), Electrocardiogram(ECG)***

I. INTRODUCTION

Cardiovascular illness, also referred to as cardiovascular disease, is a fatal disorder that is becoming more and more dangerous quickly in today's culture. Numerous factors can cause heart disease. Development of lifestyle factors including tobacco use, dietary habits, regular exercise, obesity, and diabetes as well as physiological elements like high blood pressure or glycemia.Therefore, it's crucial to pay attention to important cardiac behaviors that are specific to each type of heart disease. Furthermore, a system that assists medical professionals in providing accurate and helpful diagnoses must be developed. ECG analysis is used to diagnose many cardiac conditions, and the Raspberry Pi uploads cardiovascular data. The system is accessible remotely[1].In order to describe the electrical processes of the cardiovascular system, William Einthoven created the ECG. In a medical setting, it represents an extremely precise and painless procedure. It entails applying an electrode to the body's surface while utilizing various lead arrangement approaches. As a result of atrioventricular and ventriculoventricular contractions, the heart's electrical state regularly depolarizes and repolarizes, as shown on the ECG. The amplitude, shape, and interval of the ECG reveal cardiac health[2].

This activity can be graphically recorded and shown by ECG equipment using electrodes placed on the skin. Ten electrical lines must be fastened to the body for an ECG, six over the middle of the body and one on each leg. An ECG wave, Waves that reflect an electrical event in the heart include atrioventricular and ventricular repolarization. The signal consists of a succession of complicated waveforms that repeat regularly with a frequency of about 1 Hz. In an ECG signal, the P-QRS-T waves stand in for one cardiac cycle[3].

The elements of a typical ECG are waves, periods, divisions, and one complex, as will be explained more below. A wave is an upward or downward divergence from the characteristics of an electrical event. An ECG will display P to U waves. The interval between two easily distinct ECG events is known as the period. The QRS interval, sometimes referred to as the

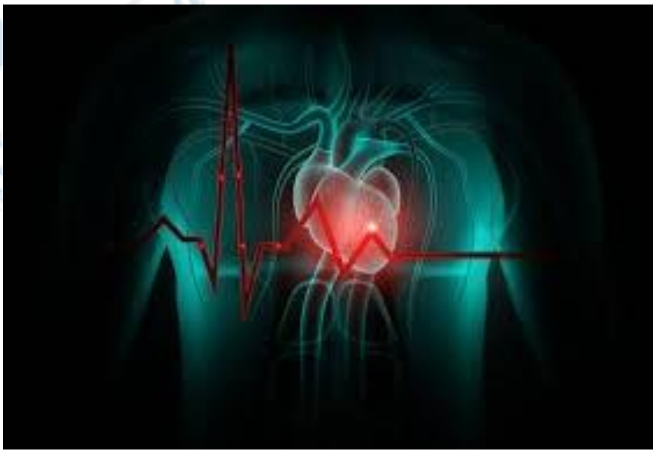

Fig. 1. Human Heart

QRS duration, along along with the PR, QT, and intervals of RR make up a typical ECG interval. An ECG segment is the area between two different ECG points, and segment must possess a baseline amplitude (they can not be both positive and negative). Segments found on ECGs include the PR, ST, and TP segments[4].

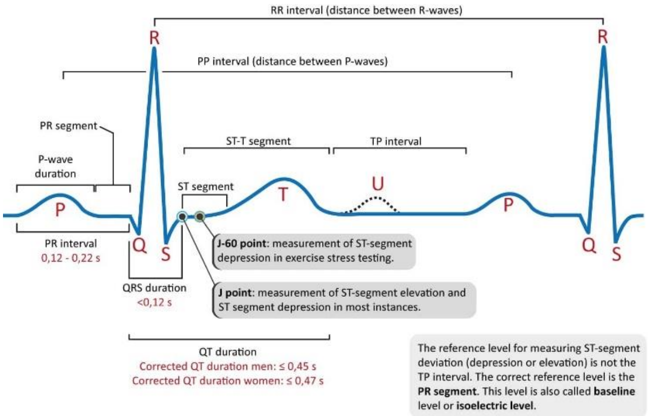

Fig. 2. Normal ECG Signal

The frequency of the ECG signal, together with the lengths of each wave, segment, and interval, are all displayed in FIG. 2 at a range of 0.5 to 150 Hz. The P-wave, the QRS complex, T-wave, and, according to this order, the process of repolarization of the heart's ventricles, all signify the depolarizing process of the cardiac ventricles[5]. When the heartbeat pulse is between 65 and 90 beats per minute, the P-wave period should have a duration shorter than 0.12 seconds, the PR time should be between 0.12 and 0.22 moments, the complicated sequence of QRS waves duration should be less than 0.12 moments, and the QT interval's period should typically be between 0.32 and 0.40 seconds[6].

The Internet of Things (IoT) makes it possible to remotely sense and control objects that are part of an existing network infrastructure. This allows for greater interaction of the real world with systems based on computers, increasing efficiency, precision, and income in addition to reducing the need for human intervention.[7]. The IoT also makes it possible to monitor biological signals outside of the home, which is another advantage.We can get information via the Internet from anywhere at any time. Users may obtain the information or findings gathered.

The method for building and creating a device for the diagnosis of cardiac disease utilising ECG signals is introduced in this work. A CPU, a microcontroller, an AD8232, a 5V power supply, an oscilloscope, a smartphone, an SD card, a WiFi module, and an LED (liquid crystal display) make up the system.

II. MATERIALS AND METHODOLOGY

A. Principle of ECG

It works on the theory that a little electric current is generated when a muscle relaxes, and that this current may be detected and measured using electrodes placed strategically on the body. A person is lay down in a reclining position for a resting ECG. Arms, legs, and the chest's area over the heart are all covered with electrodes.The electrodes are attached to the the subject's skin with a specific jelly[8]. The electrode in the electrocardiograph detects the current and sends it to an amplifier. The electrocardiograph then amplifies it, and a waveform is written down on paper as a result. A sensitive lever records changes in voltage on a moving piece of paper in an electrocardiograph.A heart monitor can be connected to a present oscilloscope, a tool that displays the present state on a screen[9].

B. Component Selection and Circuit Design

Monitoring the electrical impulses of the human heart is done using an electronic circuit board called the AD8232 ECG (electrocardiogram) sensor. Similar to an ECG, this movement provides a readout that may be analogously tracked. ECGs can be quite loud, despite the AD8232 device's ability to reduce noise. The operational amplifier function of the ECG sensor immediately removes a considerable signal from the gap. The AD8232 chip also analyses data from electrocardiograms for biopotential in along with these and other applications[10].This chip's primary job is to identify low biopotential pulse in noisy environments such those caused by mechanical device motions or external cable switching. To filter and magnify them, this is done.

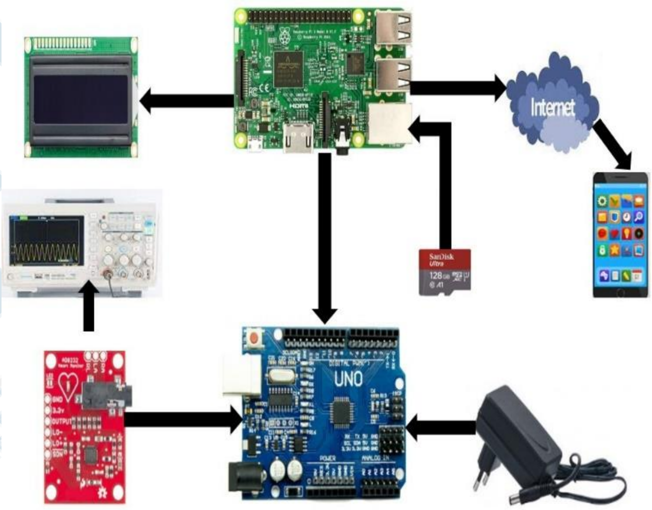

Fig. 3. Block Diagram

The ATmega328, an AVR family member, is the microcontroller board found on the Arduino Uno. A 16 MHz resonator is also incorporated, along with 6 A/I pins and 14 digital I/O pins. There are power, USB, and reset jacks[11]. It is simple because there are many libraries available to support programming applications. Only a few cardiac disease detection sensors, such as electrocardiogram (ECG) and heart rate sensors, can communicate with the Arduino Uno[12]. The system may take in analogue signals produced by these sensors, process the information, and then transfer the data to a device with extra features (such a PC or Raspberry Pi) to perform further the use of machine learning analysis of the algorithms.

Before transferring an analogue signal to the Raspberry Pi 4, the Arduino Uno converts it to a digital representation. The Arduino Uno needs to alter the signal before transferring it because the Raspberry Pi is deficient in an analog-to-digital

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converter (ADC)[13]. The Raspberry Pi then analyses patient inputs and detects ailments using machine learning and programming in Python. The name of the ailment and its result are both obvious on a lead. The results of the test will show an appropriate heart rate and output if a patient is in good health. You may create specialised apps for controlling and tracking your IoT devices using the IoT platform Blynk.It provides a straightforward smartphone application that communicates in real time with your IoT projects[14]. Blynk supports a wide range of devices and communication protocols, making it simple to interface with them and create projects with them. The stored in the cloud Blynk platform[15] makes interactions between mobile apps and IoT devices reliable and secure. Additionally, it comes with a selection of built-in widgets so you can create your own special user interfaces.Using data for training, which are samples of data, machine learning algorithms create models in order to make predictions or judgements. This is carried out without any training. Using the provided data set, machine learning was used to train and assess the model. A set of inputs and outcomes can be mathematically described using supervised learning techniques. To forecast cardiac illnesses, they used a range of techniques, including support vector machines (SVM), decision trees with k-nearest neighbours, random forests models, and linear classification algorithms[16].

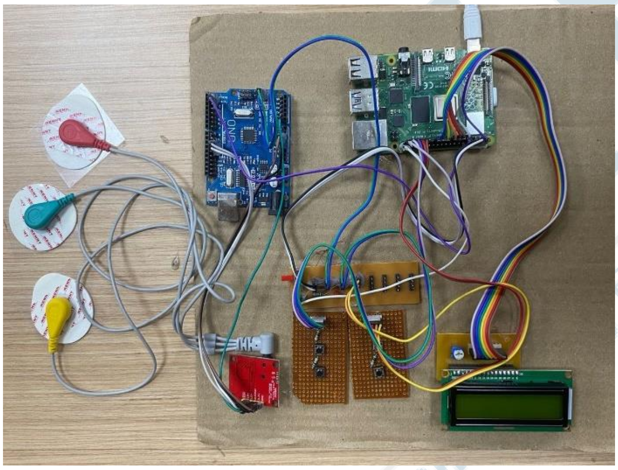

Fig. 4. Schematic Circuit

1) *Proposed Circuit:*

- Cardiovascular conditions will be recognised by a liquid crystal display, and their given names will be shown on the display. The patient can then be given a suitable treatment plan.
- The medical team will be notified if any irregularities are found in the patient's heart rate, which the equipment will also monitor.
- Utilising a machine learning algorithm. A sizable data collection of heart diseases and therapies will be used to train the machine learning system.
- The system will then accurately identify heart problems and make therapy recommendations.
- Manual button-based dataset entering. creating an easy-to-use interface for accessing algorithm findings by medical experts.
- Type the titles of your cardiac ailments into the Blynk app. Results should be produced using the algorithm.
- This research was carried out using an Arduino Uno microcontroller and a Raspberry Pi computer. Please provide an assessment and a plan of action.
- Contact the patient's doctor or other medical professional for additional help.

2) *System Circuit:*

- The Arduino receives the analogue signals from the electrocardiogram (ECG) sensor and converts them into digital signals before processing and sending them to the Raspberry Pi.
- Making use of the Arduino board's ADC. Voltage is measured by the Arduino, which then transforms it into a digital signal. The Raspberry Pi receives this signal and processes it before sending the data to the user.
- The system's interfaces are the Raspberry Pi 4 and Arduino Uno.
- After that, the Raspberry Pi decodes the signals and shows them on the monitor. Additionally, it retains the information to enable future signal analysis.
- The required and saved dataset number is entered using the push button. The LCD display will display the project's status.
- The LCD module shows the findings of the analysis. The information can also be kept for later analysis.
- You can use the data set to update the Raspberry Pi. There are more heart problems in this data set.
- The four CPUs on the Raspberry Pi examine button input and compare it to the data collection. Different heart disorders are identified and categorised in this way.
- An LCD display module displays this data.
- A Raspberry Pi computer will upload cardiac problems to the Blynk app using its built-in Wi-Fi. The device is portable as a result.
- In order to do this task, the Raspberry Pi loads a Python program.

Fig. 4 depicts the circuit's testing setup. A quiet environment is used to test the circuit. The participant received basic instructions, such as maintaining calm and relaxation while capturing the waveforms.

III. RESULTS

The study covers creating a system for monitoring and identifying heart problems.An LCD screen shows the diagnoses, while an oscilloscope shows the EKG waveform. The Blynk app received these pictures via the IOT.

A. The result of a typical waveform.

Adults sleep at a rate of between sixty and one hundred beats per minute. Figure 5 shows an example of an ECG waveform. Figures 6 and 7 show the LCD display of the normal ECG state and the Blynk app result, respectively.

B. Implication of an abnormal waveform

An exclusive category of heart block is referred to as "atrioventricular block" (AV block). Electrical transmission is halted or delayed in an AV block. The typical heartbeat is between 45 and fifty beats per minute. Figures 8 and 9 depict the cardiac AV Block waveform and LCD, respectively, of an aberrant (AV Block) ECG state. Figure 10 then shows the BLYNK app's output.

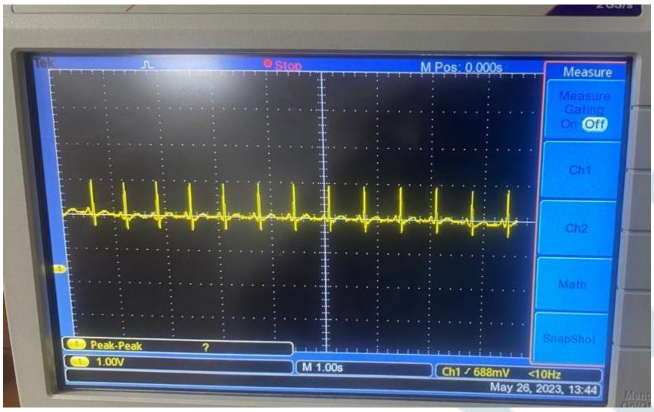

Fig. 5. Waveform of a typical ECG on an oscilloscope

Fig. 6. Detection of a regular ECG on an LCD

Fig. 7. Blynk app outputs of normal ECG

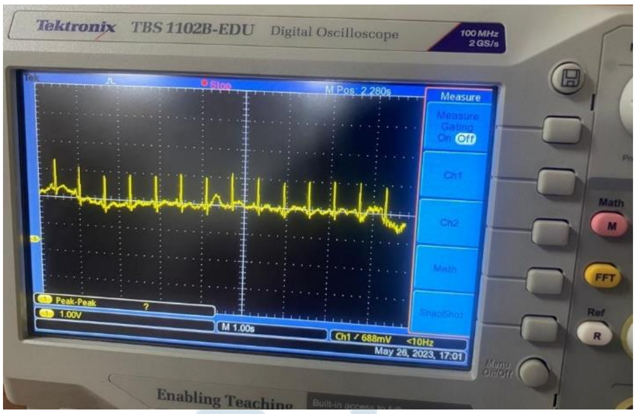

Fig. 8. Abnormal ECG waveform on Oscilloscope

Fig. 9. Abnormal ECG Detection on LCD Display

Fig. 10. Blynk app outputs of AV block

IV. FUTURE WORK.

By including elements that track your blood pressure and sugar levels, the proposed system could be improved. Determining the severity of the ailment in addition to the progress would be beneficial. It is also feasible to increase the efficacy and accuracy of detection.

V. CONCLUSION

With the suggested solution, the Internet of Things and health care are modestly combined. A doctor can make prompt choices because they can see the patient's live streaming data from anywhere at any time. This might be able to save patients' lives because of the speedy diagnosis. Due to the constant data streaming, this device might be referred to as a continuous ECG monitor. The only restriction on this technique is rapid Internet connectivity. The proposed method employs an Arduino Uno and Raspberry Pi to identify early heart illness and show it on an LCD panel. On their smartphones or tablets, users can use Blynk's user-friendly interface to check their cardiac health. A patient's status can be quickly determined by doctors thanks to information that is securely provided to cloud services through the internet.

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