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IoT based Remote Sound Stethoscope and Electrocardiogram (ECG) System for Post Covid-19 Heart Issues

Abdul Basit[1], Komal Saxena[2], Surabh Singh Rajawat[3], Ajay Rana[4]

[1]Amity Institute of Information Technology, Amity University Noida Amity Rd, Sector 125, Noida, Uttar Pradesh
[2]Amity Institute of Information Technology, Amity University Noida Amity Rd, Sector 125, Noida, Uttar Pradesh,
[3]Amity Institute of Information Technology, Amity University Noida Amity Rd, Sector 125, Noida, Uttar Pradesh
[4]Amity Institute of Information Technology, Amity University Noida Amity Rd, Sector 125, Noida, Uttar Pradesh

Email: [1]abdul.basit1619@gmail.com, [2]ksaxena1@amity.edu, [3]r26.saurabh@gmail.com, [4]ajay_rana@amity.edu

Abstract: Electrocardiogram (ECG) gadgets measure the electrical activity of the heart muscle to decide heart conditions. ECG signal quality is a vital factor in detecting the abnormalities of the heart. The proposed model introduces a wireless Stethoscope and electrocardiogram system that can be used to record the sound of the chest organs and monitor the heart activity of the patient. The proposed system consists of two main components Sound Stethoscope and Electrocardiogram. Arduino UNO board is responsible for controlling and data processing and all the sensors are connected to Arduino UNO. Through the proposed system, we can monitor the heart activity including the Electrocardiogram (ECG), and record and hear the sound of the chest organs that is lungs, and heart. With the use of different sensors, it is possible to calculate the values precisely. The six analog pins of the Arduino UNO board can be used to connect the analog sensors. The measured values are then used for detecting any critical circumstance. On account of a critical circumstance, an alarm can be given as a message to the concerned physician for immediate assistance. Likewise, it is conceivable to monitor and hear heart and lungs activity remotely from anywhere using the internet. Information from sensors is transferred to the database repeatedly with no interference if the internet is accessible. In the proposed system a Wi-Fi module is used for interfacing Arduino UNO to the internet.

Keywords: Electrocardiogram (ECG), Sound, Stethoscope, Arduino UNO, Internet of Things (IoT), ECG Module, Mobile Application, Database.

1. INTRODUCTION

Today, the coronary disorder is one of the leading causes of death around the world [1] and a spreading number of researches show several covid-19 residues have experienced a few types of heart damages. To avoid cardiovascular diseases from turning out to be serious, early analysis is of most extreme significance. One of the analytic methods is Electrocardiogram

(ECG). ECG gadgets record electrical signs from cardiovascular muscle to foresee the variation from the norm present in the heart [1].

Generally, the ECG is recognized through enormous and fixed hardware in expert clinical foundations. The type of gadget commonly utilizes twelve cathodes to gather ECG information because of their good performance in a short time. Notwithstanding, the hardware is inconceivable to be compact, which implies that patients' activities are seriously restricted during the time of information assortment. Also, as these gadgets are typically costly for home use, patients need to go to the medical clinic regularly, which will raise the concern of medical clinics [2]. Hence, a portable and efficient system for durable ECG signal detection is needed.

The proposed system will allow the physicians to remotely monitor and listen to the real-time heart activity of the patient from across the globe. The physician will be able to send the data for an expert opinion if there is any complication in the patient's heart activity. The other physicians will have the advantage to analyze the patient's heart activity using a mobile application without visiting the patient and thus, saving time. The patient's data will be stored in the database and can be later used for better diagnosis based on the patient's previous records.

2. LITERATURE REVIEW

The current innovation describes a distant ECG monitoring framework and, all the more especially, a framework for conveying ECG patient indicators to screens at favorable areas anyplace inside an office furnished with an expert receiving wire TV link system [3]. The system is proposed with an ECG distant checking framework that is devoted to non-specialized clients in need of long haul wellbeing checking in private conditions and also, incorporated in a more extensive Internet-of-Things (IoT) framework [4]. The report centers around the three parts of the distant ECG observing framework: patient (the end client), the specialist workstation, and the far off worker, looking into and assessing the fast approaching difficulties on the wearable frameworks, packet misplaced in far off the transmission, convenient ECG checking framework, understanding ECG information assortment framework, and ECG signals transmission including continuous preparing ST section, R wave, RR stretch, and QRS wave, and so forth [5]. The traditional automated stethoscope incorporates a receiver; an accelerometer to distinguish stethoscope development [6] and a strategy for identifying trademark phonocardiographic heart sounds utilizing a novel, recording, advanced stethoscope [7].

System Architecture

The Proposed System consists of various components including the Arduino Uno Microcontroller, ECG Module, Wi-Fi Module, Sound Stethoscope Module, Database, and Mobile Application. Figure 1 represents the block diagram of the proposed system. Arduino Uno performs the processing and transmission of data between sensors and Wi-Fi modules. Arduino Uno Microcontroller has an in-built 10-bit ADC (Analog to Digital Converter) which means it can take analog inputs and convert them into digital outputs in the range between 0-1023 (2^{10}).

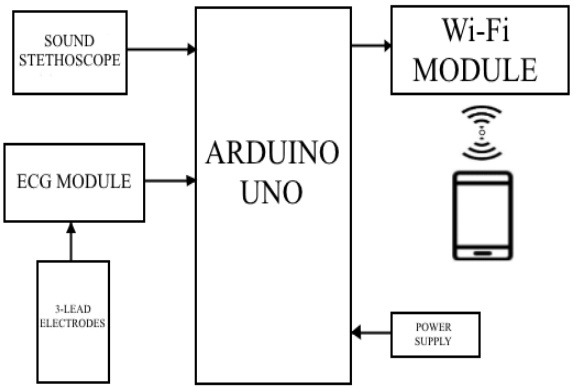

Figure 1. Block Diagram of the Proposed System

3. METHODOLOGY

4.1 Arduino Uno

The Arduino Uno is an 8-bit microcontroller board dependent on the ATmega328 [8]. It is a free and open-source platform [9]. It is responsible for all the processing in the proposed system. All the different Modules are connected with the Arduino Uno board. Arduino Uno has an implanted USART connection trait that permits USART transmission and gathering through advanced pins. A Wi-Fi Module concludes transmission between Arduino UNO and Mobile Application. Arduino Uno can also communicate with a laptop through a USB cable.

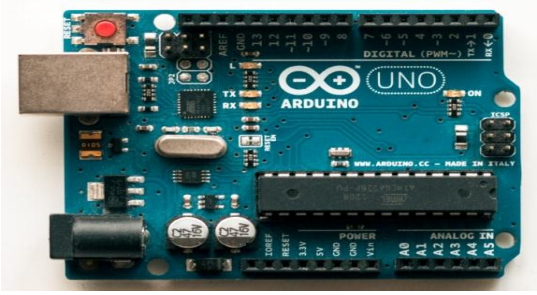

Figure 2. Arduino Uno Microcontroller based ATmega328

4.2 ECG Module

The ECG Module is an economical, high precision instrumentation amp, unified signal accustom block for ECG. It determines the electrical activity of a thumping heart through cathodes taped to the skin; it creates the regular analog values as indicated by the information given by the electrodes, the last estimation results can be shown as an electrocardiogram. It is intended to pull out, intensify, and channel less energy bio-potential signal within the sight of loud conditions, for example, those made by development or distant electrodeposition. The pair of sensors are put on the LA, RA, and LL of the patient (Figure 3).

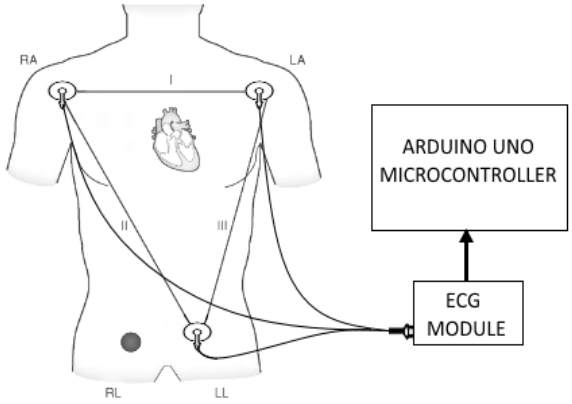

Figure 3. The positioning of ECG Electrodes

4.3 Electrocardiogram (ECG)

An Electrocardiogram (ECG) is a paper or digital recording of the electrical activity in the heart. The ECG is utilized to decide pulse, heart tempo, and other data concerning the heart's condition. ECGs are utilized to help analyze heart arrhythmias, coronary episodes, pacemaker situations, and cardiovascular breakdown.

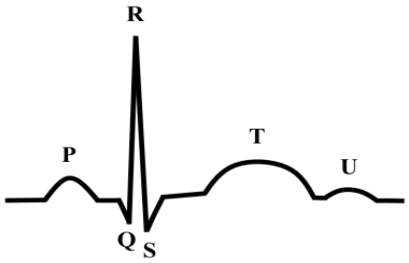

Figure 4. Schematic representation of a standard ECG feature

ECG can be broke down by examining segments of the waveform. These waveform parts demonstrate heart electrical movement. The principal upward of the ECG following is the P wave. It demonstrates atrial deflation. The QRS complex [11] starts with Q, a little descending avoidance, trailed by a bigger upwards redirection, a pinnacle (R); and afterward a downwards S wave. This QRS complex shows ventricular depolarization and withdrawal. At last, the T wave, which is regularly a more modest upwards waveform, speaking to ventricular re-polarization.

An electrocardiogram can be a valuable method to see if your hypertension has made any harm to the heart or veins. Along these lines, you might be approached to have an ECG when you are first determined to have hypertension.

4.4 Wi-Fi Module

The Wi-Fi Module is an independent SOC with an incorporated TCP/IP convention stack that can give any microcontroller approach to your WiFi grid. The Wi-Fi module can do either facilitating an application or offloading all Wi-Fi grid activities from another application processor. The Wi-Fi Module comes pre-customized with an AT regulation set firmware, which means, you can connect this to your Arduino UNO Board and get about as much Wi-Fi capacity as a Wi-Fi Shield offers [10].

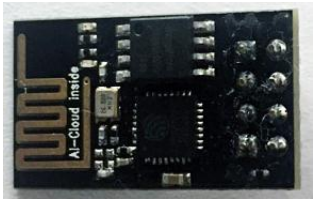

Figure 5. Wi-Fi Module

4.5 Sound Stethoscope Module

The sound Stethoscope module comprises an attachable chest piece with a diaphragm for detecting the sound of higher frequencies like the heartbeat. It also has a condenser microphone attached to the chest piece. The condenser microphone records the sound of the heartbeat and sends it to the Arduino Uno Microcontroller. The sound of the heartbeat needs to be optimized for remote listen so an operational amplifier is used.

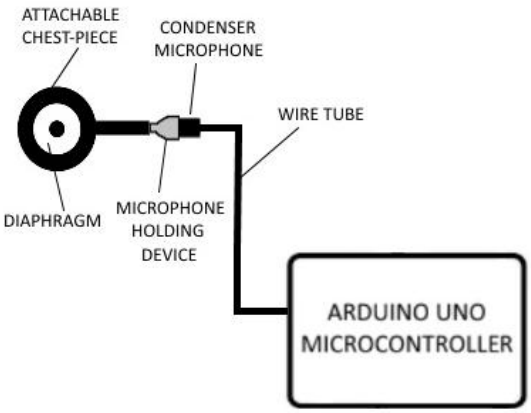

Figure 6. Sound Stethoscope for the remote heartbeat and Chest Sound hearing

4.6 Power Supply

The proposed system uses two 9V disposable Lithium batteries for making it portable. It can also be powered by a charging adapter of 5.1 Volt and 2.5 amps when using at a fixed location.

4.7 Database

The Database is responsible for collecting all the information from the Wi-Fi Module and providing access to the Mobile Application. The Mobile Application can access the database and use the data for analyzing [12] and plotting the electrocardiogram (ECG) of the patient. All the data of the patient is stored in the database concerning time and date. A physician can analyze the data of the patient according to date and time.

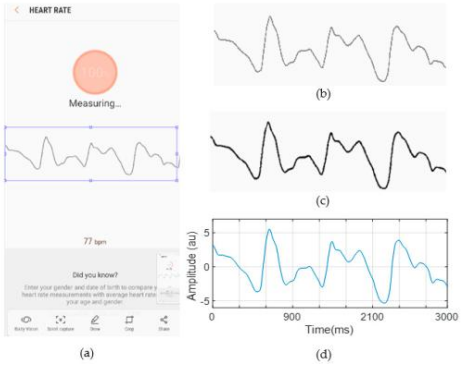

Figure 7. Heart Rate Representation

4.8 Mobile Application

The Mobile application gets the digitized signals, handles the preparing and extrapolation of ECG information for shifting levels of estimation and understanding, and shows the entirety of the information to the client utilizing a custom Graphical Unit Interface (GUI). It provides a friendly environment and interaction between the user and the database.

Figure 8. User-Friendly GUI
Of Mobile Application

Working of the Proposed System

The proposed system is divided into four main components. The First Component is the ECG Module. ECG Module is responsible for collecting the electrical activity of the heart. The 3-lead electrodes record the electrical activity of the heart as analog output. These analog outputs are then filtered by the ECG Module for unwanted nuisance due to the far placement of the electrodes. The Filtered analog output is then sent to the Arduino UNO Microcontroller. The Analog to Digital Converter (ADC) mounted in the Arduino UNO Microcontroller converts the analog output from the ECG Module to Digital Signals. These Digital signals are then transferred to the Wi-Fi Module from the Arduino Uno Microcontroller. Figure 9 illustrates the interconnection between different components of the proposed system.

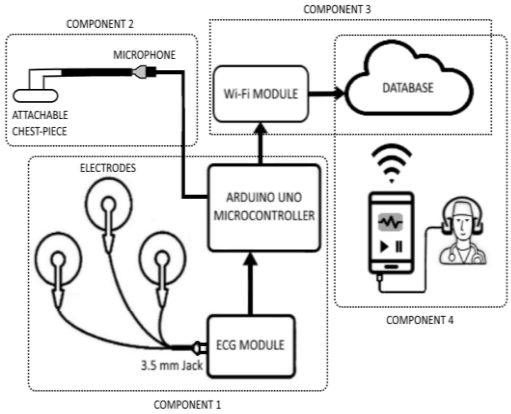

Figure 9. Components of the Proposed System

The second component is the Sound Stethoscope Module. It consists of an attachable chest piece that is attached to the skin on the chest. The Sound Stethoscope Module records the sound of the Heart and lungs through a diaphragm and a condenser microphone attached to it. The recorded sound of the heart is sent to Arduino Uno Microcontroller that is later transferred to Wi-Fi Module.

The third component is the vital part of the proposed system. This component is responsible for taking the digital output of the ECG Module and Sound Stethoscope Module from the

Arduino Uno Microcontroller and sends it to the database. All the data is stored in the database. The Data can later be charted as an Electrocardiogram (ECG) and audio of the sound of the heart respectively on the mobile application. All the information stored in the database can be used for analysis and better diagnosis of the patient. The information in the database is transferrable and a physician can send the information of the patient to have an expert opinion. The data can also be used for research purposes and make the diagnosis of cardiovascular diseases more advanced and accurate.

The fourth and last component of the proposed system provides a user-friendly environment for the user. The Graphical User Interface (GUI) of the mobile application is easy and the patient can itself record the data and send it to the physician for analysis.

The proposed system will be very helpful in providing remote information of the data of heart to the physician. As we know we have a shortage of heart-related physicians and due to an increase in cardiovascular diseases (CVDs), it was necessary to develop a system that the patient can themselves use to record the heart activity if they find any abnormality in heart conditions. The data can later be sent to a physician for analysis. If the physician finds out any abnormalities in the heart conditions an early diagnosis can be performed. This function of the proposed system can save a lot of time for the physician and the patients can get a diagnosis based on the data provided by the proposed system.

4. CONCLUSION & FUTURE SCOPE

This paper proposes an electronic and economical ECG observing framework which is convenient and helpful for utilization in any circumstances. The framework additionally executes a network utilizing the Wi-Fi module through Arduino which can be utilized to send the information to any cell phone, where a particular application measures the information and concentrates the fundamental boundaries. The outcomes are shown in an easy-to-use graphical interface that can be effortlessly perceived by the patient and through it very well may be shipped off the specialist in any area. Through this framework, ideal observing of the heart condition should be possible and the variation from the norm can be identified ahead of schedule of cardiovascular illnesses; likewise, the framework is battery worked making it versatile for use in any distant spots and under any conditions. In the future, the gadget can be made wearable through electronic equipment execution, so to make the subject continually checked 24 hours per day without having any obstruction or uneasiness in his day by day activities.

5. REFERENCES

[1] Gifari, Muhammad Wildan, Hasballah Zakaria, and Richard Mengko. "Design of ECG Homecare: 12-lead ECG acquisition using single channel ECG device developed on AD8232 analog front end." 2015 International Conference on Electrical Engineering and Informatics (ICEEI). IEEE, 2015.
[2] Yang, Zhe, et al. "An IoT-cloud based wearable ECG monitoring system for smart healthcare." Journal of medical systems 40.12 (2016): 286.
[3] Lewis, David E. "Remote ECG monitoring system." U.S. Patent No. 3,986,498. 19 Oct. 1976.

[4] Spanò, Elisa, Stefano Di Pascoli, and Giuseppe Iannaccone. "Low-power wearable ECG monitoring system for multiple-patient remote monitoring." IEEE Sensors Journal 16.13 (2016): 5452-5462.
[5] Guo, Shu-Li, et al. "The future of remote ECG monitoring systems." Journal of geriatric cardiology: JGC 13.6 (2016): 528.
[6] Tran, Bao. "Digital stethoscope and monitoring instrument." U.S. Patent Application No. 11/480,206.
[7] Johnson, Keith H., and David A. Underwood. "Recording, digital stethoscope for identifying PCG signatures." U.S. Patent No. 5,025,809. 25 Jun. 1991.
[8] Harini, R., B. Rama Murthy, and K. Tanveer Alam. "Development of ECG monitoring system using Android app." International Conference on Emerging Trends in Engineering, Science and Management. 2017.
[9] Uno, Arduino. "Arduino Uno." online), https://store. arduino. cc/usa/arduino-uno-rev3, diakses 4 (2019).
[10] Kotiyal, Bandanawaz, and Muzamil Muzamil. "Home automation using arduino WiFi module ESP8266." (2016).
[11] Sörnmo, Leif, and Pablo Laguna. "Electrocardiogram (ECG) signal processing." Wiley encyclopedia of biomedical engineering (2006).
[12] Basit, Abdul, Komal Saxena, and Ajay Rana. "A Wearable Device used for Smart Doorbell in Home Automation System." 2020 IEEE International Women in Engineering (WIE) Conference on Electrical and Computer Engineering (WIECON-ECE). IEEE, 2020.