WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Low Cost ECG Monitoring System for the Patient Using Smartphone

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ABSTRACT—

This project uses some sensors and Arduino to design and implement the Smart ECG Monitoring System. ECG monitoring is now becoming part of everyday life. Through ECG characteristics such as patient's heartbeats, heart conditions, and heart disease can be analyzed. The proposed system sensed the patient's ECG through 3 lead electrode system via AD which amplifies minor and small bio-signals to the Arduino which processes them. This sensor was used to measure the heart's electrical activity called ECG. In this project, Arduino and Bluetooth module are used to collect and transfer the heart activity and send it to the mobile application. The current portable ECG technologies are costly so that anyone can't use that on their home for an emergency if they want and this new technology is less expensive.

Keywords- Electrocardiogram, ECG signal, FIR Filters, High- pass Filter, Low-pass Filter, Arduino-uno, temperature sensor

I. INTRODUCTION

The electrical activity In many cases, the patient requires continuous monitoring and it needs a long time to stay in hospitals which is expensive now a days. Traditional monitoring system enables monitoring of vital parameters requiring the sensors to be connected to bedside machines and the patient is essentially confined to bed. However, busy in today's world and the increase in sudden death events motivate a monitoring system that monitors patients remotely located on a continuous basis.

Some patients do not have any symptoms of atrial fibrillation arrhythmia, but the doctor may be able to detect arrhythmia during a routine ECG examination. It the ECG waveform. Therefore, continuous monitoring of patients' heartbeats in daily life is crucial to arrhythmia detection. The quicker the diagnosis, the quicker the lives of the patient can be saved The design and development of this research work focus on the system architecture of detecting arrhythmia (atrial fibrillation) and alarm processing. To construct an effective model for predicting arrhythmia, Long Short-Term Memory This model does not require explicit preprocessing, but it can find hidden structures of various ECG entities and learn their dependencies automatically by deep machine learning.

The ECG is collected and monitored in real-time within the system. Because of the sophisticated features and open source nature, the Android smart-phone is chosen as a portable monitoring device. The reliability and time delay of this research has been tested in a real environment..

The ECG Remote Monitoring System and Human Body Temperature Signals, a remote healthcare system for monitoring electro-cardio graphic and temperature data has been described. The system consists of three modules namely (i) a hardware module, (ii) Bluetooth module, and (iii) display module. For data acquisition, the hardware module is used. As well for data transmission, the Bluetooth module is used. Finally, the display module displays the data. Using Wi-Fi, the acquired clinical data is sent to a database server. The system performance has been tested on various patients and the proposed change has been found to be very helpful to the physicians...

II. LITERATURE REVIEW

Cardiovascular disease (CSD) has become the leading cause of death worldwide in recent years. This CSD is the most challenging problem for detection or identification in early stages of patients. at very low cost for the patients who can receive his/her ECG signal and detect the probability of cardiovascular diseases instantly. This ECG signal is transmitted via Bluetooth/Wi-Fi/Zigbee module to smart device with support software simulation where feature extraction and detection algorithm is setup for cardiovascular disease.

Electrocardiogram (ECG) has been the golden standard for the detection of cardiovascular disease for many years. Any electrical impulse disruption that causes the heart to the contract may lead to arrhythmia. Arrhythmia patients have no indications of having an arrhythmia, but a doctor may recognize arrhythmias in a routine test. Therefore, continuous wearable personal monitoring system plays a big role, and it's become popular day by day..

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III. SYSTEM IMPLEMENTATION AND DATA FILTERING

this study, we make an effort to create an Arduino-based embedded ECG system, specifically for the diagnosis of heart-related issues utilising a hardware toolkit for rural Bangladeshi medical facilities. For this suggested system, we must utilise a hardware toolkit that can measure electrocardiogram (ECG) daily health conditions. This digital signal is transferred to a receiving device for signal processing, and we must use an EKG shield to convert it into a form of binary data that can be used. We just gather the ECG data and apply various ECG data filtering algorithms on it (like: Low-pass filter, High-pass filter, FIR filter). The heart expert will next utilise this raw data and the signal displaying curve to recommend medication..

System Model: This project fulfill the aim to significantly reduce the risk of infection in healthcare workers. It is also expected to reduce the increasing demand for PPE (personnel protection equipment) kits and other needs. The health can be monitored and disease diagnosed by any doctor at any distance. An IoT based health monitoring system was developed. The system monitors body temperature, pulse rate and saline level, which are also displayed on a LCD.

These ECG sensor values are then sent to a medical server and to patient relatives using wireless communication. These data are received in an authorized personals smart phone with IoT platform.

With the values received the doctor then diagnose the disease by checking the severity and the state of health of the patient is known.

1. Hardware specification
2. Interfacing between Arduino with Microcontroller and WiFi Module of the computer
3. Reading serial data from the sensor port
4. Storing those data into a Real time data file
5. Monitoring ECG and Temperature sensor using IoT

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. The HC-05 Bluetooth Module can be used in a Master or Slave configuration, making it a great solution for wireless communication.

This serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband.

Embedded systems are controllers with on chip control. They consist of microcontrollers, input and output devices, memories etc., on chip and they can be used for a specific application.

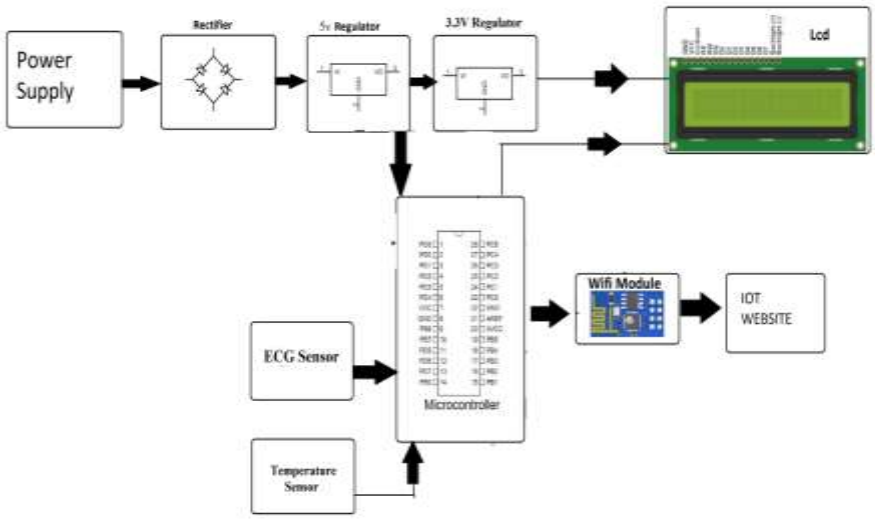

Figure 1: Real-time ECG Monitoring system

Hardware specification: The Atmel core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in a single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

1. Arduino Compatible Board (Ex; atmel 311)
2. Shield EKG-ECG (Ex. AD8232 Sensor)
3. Bluetooth Module (Ex. HC-05)

Shield EKG-ECG sensor has 6 connecting pins. The supply voltage of this sensor is 3.3V. 3 ECG electrode pads are needed for the sensor to take measurements in the human body. These pads are connected to the sensor via the sterao jack. In addition, it contains one led so that the led will blink at the time of heart beat. Since the amplitude levels of biomedical signals are at uV levels, amplification is required. Therefore, another advantage of this sensor is that it contains the amplifier and filter circuit.

In the output, it sends the ECG signal to the ARDUINO platform as analogue form NRF24L01 modules produced by NORDIC company are used for wireless communication. 2Mbit communication speed on air and simplex communication are preferred. SPI communication protocol is provided between this module and ARDUINO for data transmission

A small computer designed in a single chip is called a single chip microcomputer. A single chip microcomputer typically includes a microprocessor RAM, ROM, timer, interrupt and peripheral controller in a single chip. This single chip microcomputer is also called as microcontroller; These Microcontrollers are used for variety of applications where it replaces the computer. The usage of this microcomputer for a specific application, in which the microcontrollers as a part of application, is called embedded system

Arduino Complier with KEIL C Software to ECG: The C programming language is a general-purpose, programming language that provides code efficiency, elements of structured programming, and a rich set of operators. C is not a big language and is not designed for any one particular area of application. Its generality combined with its absence of restrictions, makes C a convenient and effective programming solution for a wide variety of software tasks. Many applications can be solved more easily and efficiently with C than with other more specialized languages.

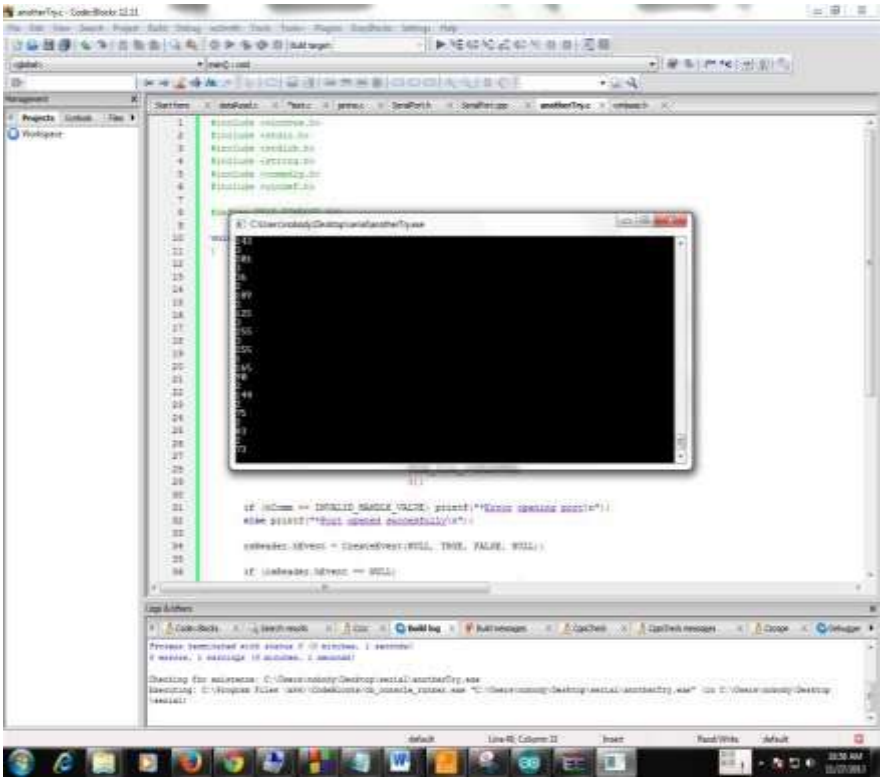

Figure 2: Keil C Software for real-time ECG visualization

Reading and Storing Data from sensor Port: This allows very fast start-up combined with low power consumption. In Extended Standby mode, both the main oscillator and the asynchronous timer continue to run. Atmel offers the QTouch® library for embedding capacitive touch buttons, sliders and wheels functionality into AVR microcontrollers.

1. Storing those data into a Real time data file:

Stored data may contain Baseline wander, Power line interference and muscle noise. To eliminate those noise we apply different filters including High-pass filter, FIR filter, Low-pass filter and QRS detection algorithms. Using of those filters certainly make the ECG data more practical and functional.

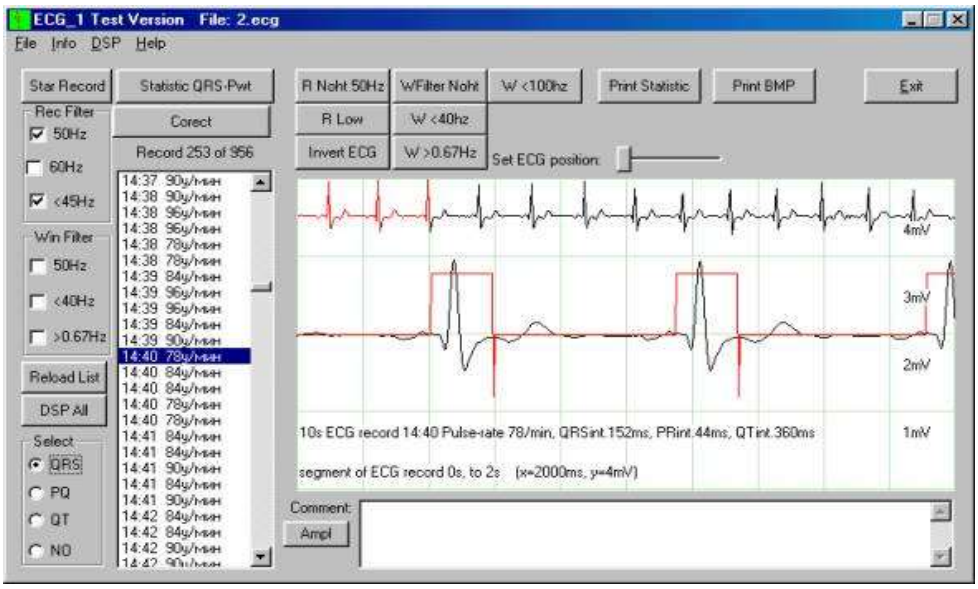

Figure 3: Reading and storing ECG data using C programming

Figure 4: Temperature sensor

5v Regulator: We are using linear regulated power supply having 5V output which will be useful for driving the other components in the circuit like microcontroller.

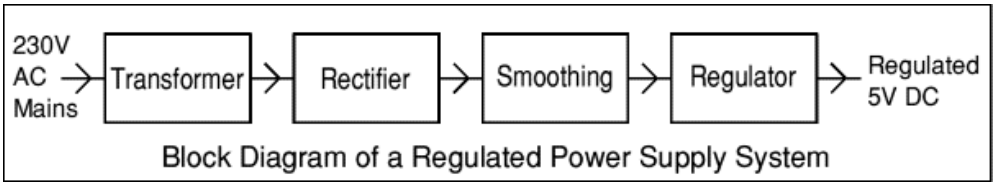

Figure 5: 5v Regulator

A module should not be inserted or removed from a live circuit. The ground terminal of the power supply must be isolated properly so that no voltage is induced in it. The module should be isolated from the other circuits, so that stray voltages are not induced, which could cause a flickering display.

Transformer: Transformers convert AC electricity from one voltage to another with little loss of power. Transformers work only with AC and this is one of the reasons why mains electricity is AC. Step-up transformers increase voltage, step-down transformers reduce voltage. Most power supplies use a step-down transformer to reduce the dangerously high mains voltage (230V in UK) to a safer low voltage

$$\text{turns ratio} = \frac{V_p}{V_s} = \frac{N_p}{N_s} \quad \text{and} \quad \text{power out} = \text{power in}$$

$$V_s \times I_s = V_p \times I_p$$

Vs= secondary(output)voltage

Ns= number of turns on secondary coil

I s = secondary (output) current

Vp= primary(input)voltage

Np=number of turns on primary coil

I p = primary (input) current

The transmitter section includes an IR sensor, which transmits continuous IR rays to be received by an IR receiver module. An IR output terminal of the receiver varies depending upon its receiving of IR rays. Since this variation cannot be analyzed as such, therefore this output can be fed to a comparator circuit. Here an operational amplifier (op-amp) of LM 339 is used as comparator circuit.

ELECTROMECHANICAL REGULATORS:

In electromechanical regulators, voltage regulation is easily accomplished by coiling the sensing wire to make an electromagnet. The magnetic field produced by the current attracts a moving ferrous core held back under spring tension or gravitational pull. As voltage increases, so does the current, strengthening the magnetic field produced by the coil and pulling the core towards the field.

IV. RESULT ANALYSIS AND DISCUSSION

The main goal of this project is to gather information from the human body to be used by the Arduino EKG-ECG shield to measure the ECG wave. We have tested this technology on several individuals in order to assess the ECG data of the human body at various ages. Based on the study, we have obtained the results listed below..

ECG data has been shown to exhibit noise and baseline drift. We discovered a minimal resemblance to the genuine ECG graph. Nevertheless, we saw substantial differences after applying those filters to the same ECG data, as shown in figure 9. Knowing the patients' heart health status has become more dependable thanks to the produced outcome's strong resemblance to genuine ECG data.

Figure 6: ECG graph and temperature monitoring

If we can find the number of errors, it can be a significant way to extract and store the heart rate data of human body. We tried to filter those ECG data using different filters for removing the noise form the ECG data. Further research can contribute to the improvement of this process and make it more accurate.

V. CONCLUSION

The project developed and implemented an Arduino based ECG monitoring system. The system aspects are developing a low cost portable ECG monitoring system to analyze the heart conditions of the patient. This project proposes an effective heart attack detection system that helps to reduce deaths caused by heart attacks as the main cause of deaths from heart attacks is due to delay in proper treatment.

The small and portable ECG measuring device is successfully implemented. In this way, it is possible to monitor ECG signals while doing daily activities of unhealthy people. In addition, due to its small size, it works independently from other platforms (smartphone, PC, web).

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