

DESIGN AND IMPLEMENTATION OF LOW COST ECG MONITORING SYSTEM USING SMART DEVICES (MOBILE OR LAPTOP)

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Abstract - Now a days Heart disease (Cardiovascular diseases) has become a very big problem for human health. This Cardiovascular disease causes the death of human. The most challenging job is detection or identification of Cardiovascular disease in early stages of patients. This research work approaches to develop an ECG monitoring system at very low cost for the patients who can identify and detect the probability of heart diseases instantly. This ECG signal is transmitted via Bluetooth module or Zigbee to smart device with support of software simulation where extraction and detection algorithm is setup for cardiovascular disease. This network can be connected with the doctors and hospitals to get the fastest treatment. This proposed idea is to contribute to bring under control heart diseases and also act as an expected results in health care service to patients in remote area.

Key Words: ECG Sensors, Smart phone, Laptop, Arduino, Bluetooth, Zigbee, Cardiac Patient.

1. INTRODUCTION

Electrocardiogram (ECG) is the recording of the electrical activity of heart. ECG signal is a bipolar low-frequency weak signal and the normal range of the signal is 0.05-100Hz. Its amplitude ranges from 10 μ V to 5mV, whose typical value is 1mV. ECG signal can help to diagnose several heart related diseases. Cardiovascular diseases (CVDs) are a group of disorders of the heart and blood vessels. CVD remains the leading cause of death around the world. Our aim is to develop a low cost ECG monitoring system, which is real-time, affordable, portable and user-friendly. In this research paper a prototype ECG monitoring system is developed which is low cost, portable, battery powered, and it includes wireless facility for safety concern and reducing noise interference.

1.1 Need of Such System:

- Our existing ECG Monitoring system has very complex structure with huge wired connectivity. This proposed system provides wireless monitoring of the heart disease.
- Patient has to come hospital from long distance residence to check the ECG for identification of CVD. In this paper proposed system is able to monitor the ECG via smart devices any time from home and can send it to doctor.

1.2 Way to Cut Down Cost of ECG monitoring devices

One way to cut down the cost of ECG monitoring devices is to implement these around smart devices like Android mobiles and laptop running under Android operating system and equipped with wireless Bluetooth and Zigbee technology. The following benefits may result from the massive adoption of this technology, besides lowering ECG monitoring cost. Patients may have their ECG recorded at home, avoiding travelling to distant hospitals and moving through heavy traffic urban areas. This might be helpful for elderly patients, chronic cardiac patients, and patients living in the countryside where doctors are not available.

In addition to replacing expensive and bulky traditional ECG machines, mobile phone-based ECG monitoring devices offer the paramount feature of instant warning about the heart condition of the patient. This characteristic is quite appealing, for life threatening arrhythmias and ECG alterations appear before a sudden heart attack occurs. Moreover, the chance to survive such an event is higher when patients are treated promptly.

This paper presents the design and evaluation of an ECG monitoring system deploying an Android mobile phone and laptop using wireless technology (Bluetooth and Zigbee).

In the system, we have developed a software for Laptop and an android application to visualize the ECG signal. This system consists three electrodes, by which ECG can be taken from either limb leads (Lead I, II and III), and augmented limb leads (aVR, aVL, and aVF). The equipment used in this system consumes low power for this it can function for a long time.

2. SYSTEM ARCHITECTURE AND METHODOLOGY

A. System Overview

The designed ECG monitoring system comprises three distinct subsystems:

- The first one is dedicated to condition the analogy ECG signal.
- Preparing it for conversion to the digital world.
- The third subsystem is the cell phone and the PC itself.

As depicted in fig. 1 The first one is dedicated to process the analog ECG signal, preparing it for conversion to the digital world. This is necessary, for today's mobile phones do not include a means to directly interface to analog signals from the external world. This can be achieved by using AD8232 single lead heart rate monitor. The second subsystem consists of a microcontroller and a Bluetooth module and a Zigbee Module. This unit samples the ECG, serializes the samples and transmits them via the Bluetooth module to the Android cell phone and via Zigbee to the PC with JAVA application. So that ECG graphs can be identified on both smart devices. The third subsystem is the cell phone and the PC itself. An application has been program written, the ECG samples and suitably charts the ECG signal on the screen for analysis.

B. ECG Sampling and Transmission via Bluetooth and Zigbee

An 8-bit Microcontroller ATmega-8 samples the ECG signal at 150 Hz, using an embedded 10-bit ADC. The control program sends the incoming raw samples to an embedded USART serial port. The program reduces every 10-bit sample into a correspondent 8-bit sample, before transmission, simply by discarding the two less significant bits. The USART serializes the samples at 9600 bits per seconds, using the following settings: 8-bit data length, no parity, and one stop bit. Upon receiving the bits streaming from the USART, the Bluetooth module (Linvor JY-MCU) sends them into the air, which can be received by a nearby Bluetooth-equipped smart phone. Bluetooth is used for short distance data transmission. For PC application Zigbee can be used to transmit data wirelessly. Zigbee can transmit data upto 100 meters. The XBee module uses Zigbee protocol for communication also they can communicate with other devices using simplest serial communication protocol and hence they are used in microcontroller base boards(Arduino). We use only two Xbee modules to transmit and receive the data but controlled using the Arduino board. Since These modules communicate using serial communication protocol with the interfacing devices they can be connected to a microcontroller using a minimum of four pins, Power supply, and Ground, UART Data Out, and UART Data In pins. The Xbee modules have several digital and analog I/O pins apart from these pins and the pin out of an Xbee module. The control program running on the microcontroller just implements the commands supplied by the datasheet for the Bluetooth module (EGBT046S AT Command Set) and Xbee module to establish communication with the mobile phone and PC itself. Fig. 3 shows . ECG Graph monitored on PC Application via Zigbee

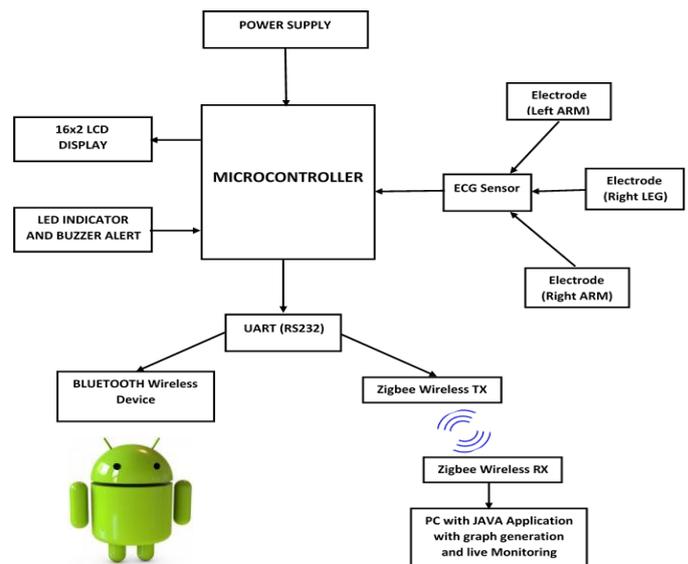


Fig 1: ECG monitoring system based on Smart Devices

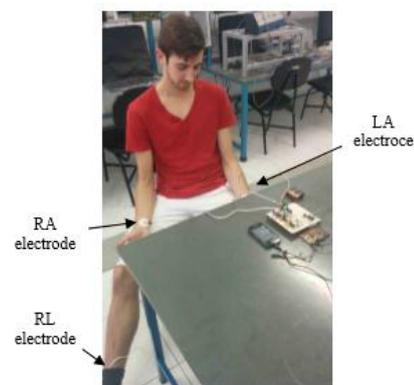


Fig. 2. Mobile phone-based ECG monitoring prototype connected to a user.

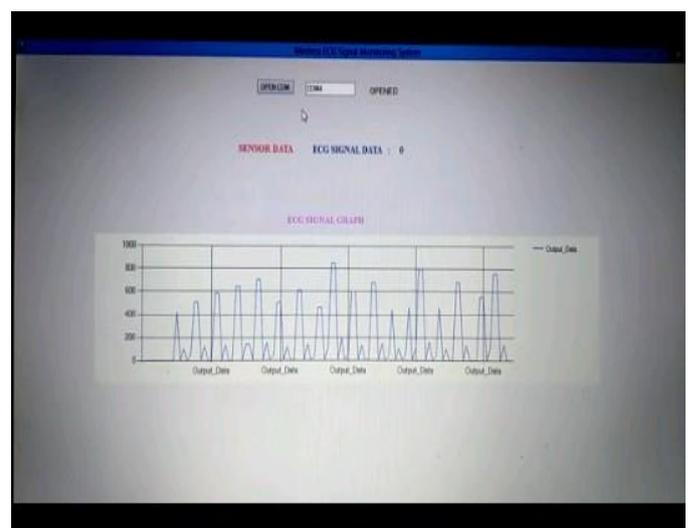


Fig. 3. ECG Graph monitored on PC Application via Zigbee

C. Android Mobile and PC:

A commercially available Android Mobile phone with Bluetooth served as the target mobile phone during implementation of this project. We have developed android application using Android Studio which can be installed on mobile and The PC application provides a graphical user interface (GUI) allowing you to configure and interact with ECG Samples over a USB connection.

3. CONCLUSIONS

As we know current ECG Monitoring Systems are bulky having with complex wired structure, in this research paper we have proposed a low cost ECG Monitoring System using smart devices (Smart phone /laptop). As discussed earlier, this system brings many advantages to both the patients and doctors. Patients can monitor their ECG signal graph at home without wasting time in travelling. With the help of such system patients can have instant recording of their ECGs and this can be very important to save the life of Cardiac patient before the Cardiac disease reaches it's last stage.

This paper presents a prototype for ECG waveforms monitoring using smart device(Mobile/Laptop) which performed quite well with both normal and abnormal ECG waveforms. This prototype of the proposed system provides the Monitored ECGs on Patients Smart device for further improvement in project following Features can be added in future:

1. ECG monitor system based on android smart phone. ECG signal is transmitted to an android phone and then be forwarded to a remote server. Using a PC, doctors can view the ECG after logging in the server. In this system, Android phone is sending ECG signal all the time when the system is running, which could cause a lot of power and network consumption. There is a scope in future to enhance the power consumption and network consumption quality.
2. ECG waveforms needs to be send by MMS or email but if image resolution is not high doctors will not be able to see it on correct time. This disadvantage should be overcome in future scope.

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