ECG MONITORING AND ANALYSIS SYSTEM FOR RURAL/REMOTE AREAS

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Abstract

Ubiquitous vital signs sensing using wireless medical sensors are promising alternatives to conventional, in-hospital healthcare systems. The advent of modern age has shown a drastic shift in the way humans have worked leading into sedentary lifestyles. Change in dietary pattern where fresh food is replaced by processed and fast food along with the increase of stress has led to rise of cardio-vascular disease which is glaringly evident in developing countries. Especially, Asians are more prone to cardio-vascular diseases genetically. The ECG device is a diagnostic medical instrument which determines the electrical activity of the heart. The conventional ECG devices are powered by mains electricity, thus are not energy efficient. Transformers used make the device bulky and expensive. Optimum isolation amplifiers have to be incorporated in these devices for patient safety, adding to the cost and complex circuit. In this work, a wireless ECG sensor for rural/remote areas is proposed.

Keywords: Electrodes, Arduino UNO, AD8232 Heart monitor module, RF module, LabVIEW.

I INTRODUCTION

The Electrocardiogram (ECG) [1] is a measurement of the electrical activity of the heart over time, captured and externally recorded as measured by skin electrodes. The signals indicate the overall rhythm of the heart and weaknesses in different parts of the heart muscle. This technique is the best way to measure and diagnose abnormal rhythms of the heart [1], and is commonly used in hospitals all over the world. It is also used in sports and military environments for advanced diagnostics of healthy individuals. In recent years, the research community has been active in pursuit of technologies for a “Wireless ECG” where patients are no longer required to be attached to a large stationary device while their ECG signals are monitored. A major motivator behind this trend is the reduced healthcare costs of remote monitoring, where patients can reside in their homes rather than occupy a hospital bed. Many systems have been proposed to accomplish this feat, with varying goals and approaches [2].

Wireless ECG monitoring can be done using 3, 4, 5 or 10 sensors, providing increasingly detailed information to cardiologists. The data is captured and monitored by wearable circuitry, and is then wirelessly transmitted to a nearby listening device. The nearby listener can be as simple as a basic logging or analysis device, or as complex as a large hospital information system that actively collects wireless data in real-time from multiple patients. Wireless ECG systems may be loosely grouped into two categories: those with wired sensors and those with wireless sensors. The first group of systems[2] use physical wires to

connect all sensors to a central PDA-sized device, which then transmits the data wirelessly to a monitoring station. These systems free the patient from being tethered to bulky equipment.

One of the main goals of our project is toprovide maximum convenience to the user orpatient during ECG measurements, especiallyfor prolonged use.Wireless technology is ability to generate interactive healthcare utilizing modern technology and telecommunication. In telemetry system is useful for absent of directly contact between the patient and doctor- physician. The wireless device employ for the efficient remote monitoring system, using for real time, continuous and accurately information of patient heart condition. Here we will design wireless ECG sensor and display its output on computer screen wirelessly for rural/remote areas.

The main objective of the project is to provide a real time wireless monitoring system by analyse the measured ECG signal into normal or abnormal by the obtained data and ECG waveform.

II METHODOLOGY

Electrocardiography (ECG), most commonly performed cardiology test, is the procedure of recording the electrical activity of the heart over a period of time using electrodes placed on the skin. These electrodes sense the small electrical changes on the skin that arise from the heart muscle's electrophysiological pattern of depolarizing and re polarizing during each heart beat. For this purpose, a device known as ECG machine is used to measure the electrical activity the heart, transform it into an electrical signal and display it on a monitor in real-time.

1. ECG analog signal acquisition

The Analog signal portion has been simple, in order minimized space board. The raw signal-noisy ECG signal is acquire through disposable electrodes, attached to cables through a couple of standard clips. That signal applied to the filter circuit and then to wireless module for transmission.

1. Wireless Transmission/Reception

Wireless module based on CC2500 2.4GHz used for transmission and receiving the signal. ECG front end circuit connected with wireless module as remote base station. Receiver module is interface with PC at Base station.

Analog signal, ECG form measurement data from the sensor (electrodes) are transmitted wirelessly using low cost module radio equipment. At the receiver side same type of radio module for receiving the wireless signal which was transmitted by the transmitter module at ECG taken from the body using transducer (electrodes).Then forwarded to com port of PC for further processing of ECG signal. And the signals are displayed using LabVIEW.

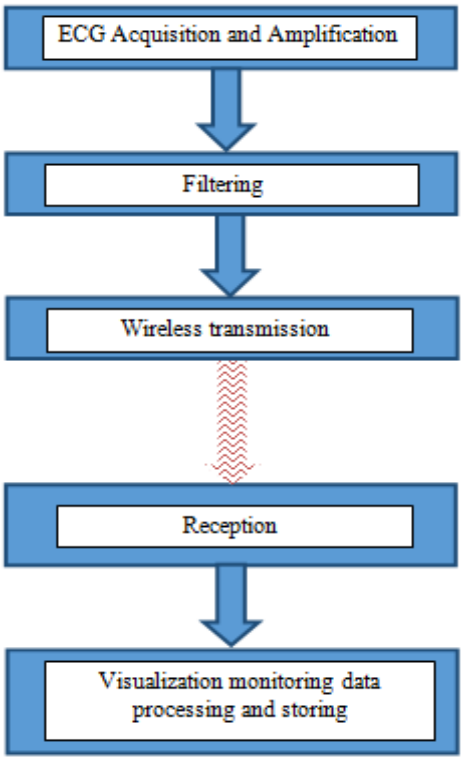

Figure: Wireless ECG Workflow

2. BLOCK DIAGRAM

Electrocardiogram:

An ECG is used to measure the electrical activity of the heart treated as a vector quantity.It measures the rate and regularity of heartbeats, the position of the various chambers, the existence of any damage to the heart and the effects of drugs and devices used to regulate the heart.The potential created by the heart wall contraction spreads electrical currents from the heart throughout the body.

The spreading electrical currents create different potentials at different points on the body.Leads are placed on the body in several pre-determined locations to provide information

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about heart conditions.The cardiac signal, typically 5 mV peak to peak, is an AC signal with a bandwidth of 0.05 Hz to 100 Hz. The ECG signal is characterized by six peaks and valleys labeled with successive letters of the alphabet P, Q, R, S, T, and U.

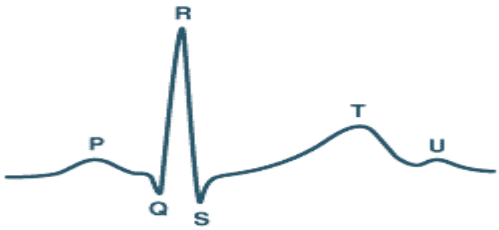


Figure: Typical ECG waveform

The Activity of the Heart

The main purpose of the heart is to pump blood throughout the body. The heart is divided into four chambers; the right atrium, right ventricle, left atrium and left ventricle. The right side of the heart delivers deoxygenated (carbonated) blood from the body to the lungs, and the left side of the heart delivers oxygenated blood from the lungs to the body. Deoxygenated blood enters the Right Atrium of the heart. The atria contract and push the blood into the Right Ventricle. The ventricles then contract and push the blood out of the heart, and thus to the lungs. The oxygenated blood from the lungs is returned to the Left Atrium. The Atria again contract and push the blood through into the Left Ventricle. The Ventricles again contract and push the blood to all parts of the body.

The signals from the body is taken by the electrodes (Ag-AgCl electrodes), the signals are very weak hence it is given to the amplifier. The front-end for the signal acquisition system is an instrumentation amplifier. It has a very high common mode rejection ratio (CMRR) and high input impedance which is required for capturing EKG signals. Along with the signal noise also gets amplified, this noise is removed by band pass filter. Since the acquired signals are weak it is given to the buffer amplifier. The signals are digitized using Analog to Digital Converter (ADC).

AD8232 (Heart Rate Monitor Front End IC) description

The AD8232 is an integrated signal conditioning block for ECG and other biopotential measurement applications. It is designed to extract, amplify, and filter small biopotential signals in the presence of noisy conditions, such as those created by motion or remote electrode placement. This design allows for an ultralow power analog-to-digital converter (ADC) or an embedded microcontroller to acquire the output signal easily.

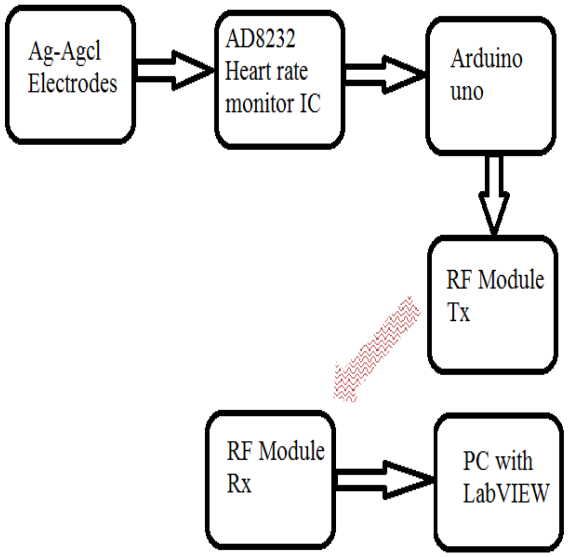
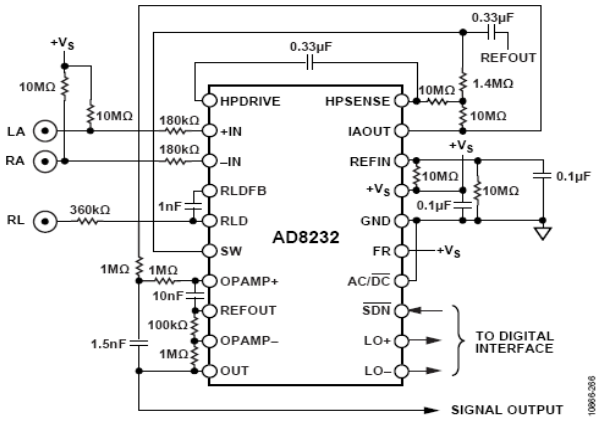


Figure: Block Diagram

To improve common-mode rejection of the line frequencies in the system and other undesired interferences, the AD8232 includes an amplifier for driven lead applications, such as right leg drive (RLD). The AD8232 includes a fast restore function that reduces the duration of otherwise long settling tails of the high-pass filters. After an abrupt signal change that rails the amplifier (such as a leads off condition), the AD8232 automatically adjusts to a higher filter cutoff. This feature allows the AD8232 to recover quickly, and therefore, to take valid



Circuit for ECG Waveform Monitoring

measurements soon after connecting the electrodes to the subject.The AD8232 is to obtain an ECG waveform with minimal

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distortion, the AD8232 is configured with a 0.5 Hz two-pole high-pass filter followed by a two-pole, 40 Hz, low-pass filter. A third electrode is driven for optimum common-mode rejection.

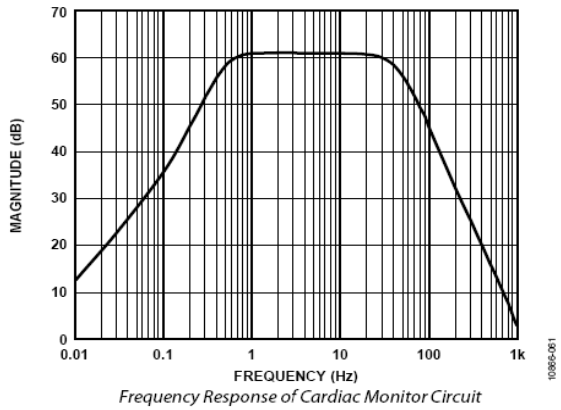


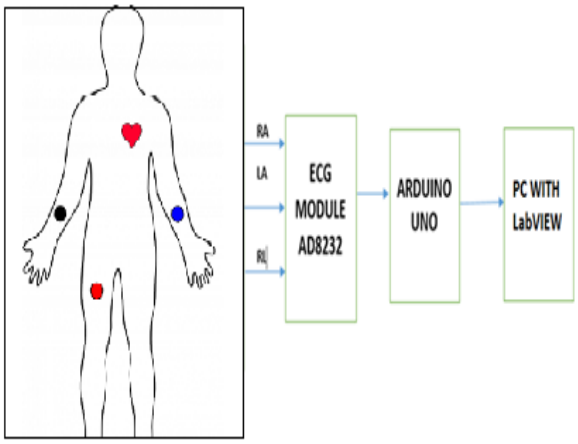
Figure 3: Circuit and frequency response of ECG monitoring circuit.

Then Microcontroller will format the data for in the form suitable for transmission. A Microcontroller consists of a powerful CPU tightly coupled with memory RAM, ROM or EPROM), various I / O features such as Serial ports, Parallel Ports, Timer/Counters, Interrupt Controller, Data Acquisition interfaces-Analog to Digital Converter (ADC), Digital to Analog Converter (DAC), everything integrated onto a single Silicon Chip. Then it is wirelessly transmitted to PC using RF. Receiver RF can be interfaced with a micro controller or a PC using serial port.

The result is viewed in LABVIEW (Laboratory Virtual Instrument Engineering Workbench). LABVIEW is a graphical language method by which codes are generated and saved .There is no text based code, but a diagrammatic view of how the data flows through a program. LABVIEW contains a comprehensive set of tools for acquiring analyzing, displaying, and storing data.

III IMPLEMENTATION

The ECG module is getting three inputs from the human body using 3-lead electrodes. The ECG module (AD8232) has Instrumentation Amplifier and High pass filter for the working purpose. After, processing the inputs, It produces the single output. This output is givento the Arduino Uno Microcontroller with the help of the Analog pins.



Above Figure, represents the block diagram of the proposed system.

It consists of the Electrodes which are placed on the Left Arm, Right Arm and Right leg of the patient's body.

The input is taken from the human body and then it is transmitted to ECG module (AD8232).

The ECG module processes the data and it produces the continuous analog values according to the input given by the electrodes to the Arduino microcontroller.

The RF module is connected to the Arduino microcontroller for wireless transmission purpose.

Arduino Software

The Arduino provides the Arduino Integrated Development Environment (IDE), which is a platform Independent Application written in Java. It originated from the IDE for the languages Processing and Wiring. It includes a code editor with features such as text cutting and pasting, searching and replacing text, syntax highlighting automatic indenting, brace matching and provides simple one-click mechanisms to compile and upload programs to an arduino board. It also has a message area, a text console, a toolbar with buttons for common functions and a hierarchy of operation menus. The ECG wave is displayed on the Serial Monitor.

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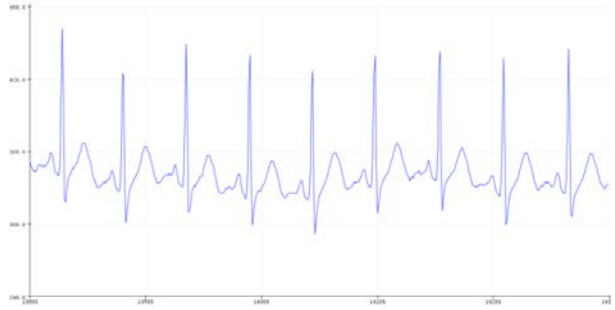
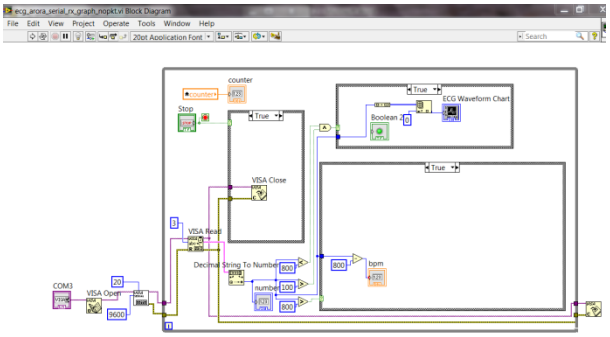
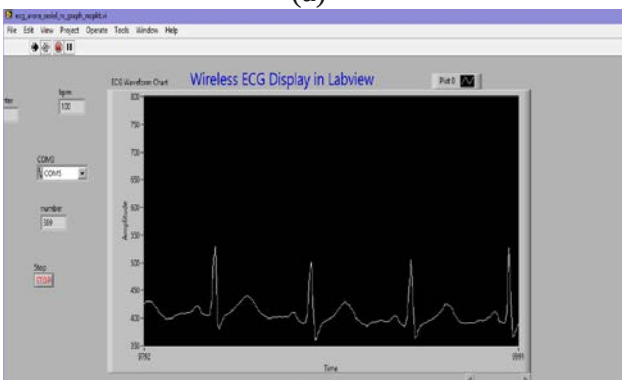


Figure 4: Arduino output (ECG signal)

IV OBTAINED RESULT



(a)



(b)

Figure 5: LabVIEW output: a. Block diagram b. Front panel

IV CONCLUSION

In this paper we provide maximum convenience to the user or patient during ECG measurements, especially for prolonged use. Wireless technology is ability to generate interactive healthcare utilizing modern technology and telecommunication. In telemetry system is useful for absent of directly contact between the patient and doctor-physician. The wireless device employ for the efficient remote monitoring system, using for real time, continuous and accurately information of patient heart condition. In this project we will design wireless ECG sensor and display its output on computer screen wirelessly for rural/remote areas.

V FUTURE SCOPE

Instead of body worn ECG electrodes we can use capacitive electrodes which can be fitted in clothing instead of sticking to body using gel.

Wi-Fi can be used as it can be directly connected to phone and hence to internet directly with dedicated android app.

Ultra low power system can be built with low power wireless protocol to save power and longer battery life. Solar powered ECG electrodes can be used in future.Very small electrode with all electronics can be built in future no need to carry extra electronics.

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