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Real-Time Miniaturized ECG System With Bluetooth Transmission

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Abstract— There is the need to consider miniaturized ECG devices for proper and effective way of recording and analyzing ECG signals from the human body.The world's ageing population and prevalence of chronic cardiovascular diseases have led to high demand of simply,portable,cost effective and accurate ECG devices.A small portable ECG amplifier system is presented using microcontroller to analyze the ECG signals and Bluetooth to interface these signals to the PC.The aim of this project is to design and fabricate a portable ECG amplifier system which utilizes microcontroller and bluetooth to analyze abnormal ECG signals.This device detects some abnormalities of the heart such as bradycardia and tachycardia.The device has three leads and these leads are attached to the users or patients to get the ECG signals.LED and Buzzer are incomperated in the system to detect the state of the QRS complex at every ECG cycle.The experimental results show that it is possible to get these signals on the PC using microcontroller and the Bluetooth which is cost effective,user friendly,and easy to carry around.

Index Terms— ECG,Bradycardia,Tachycardia,Bluetooth,Microcontroller,Buzzzer,QRS,LED.

1. INTRODUCTION

Hospital devices and equipments have gone through a lot of transformation as a result of increasing of diseases.Initial healthcare systems were just intended for hospital applications.The healthcare is changing due to raising healthcare cost,busier lifestyles,increasing aging population,strengthening healthcare consciousness and growing economy.This calls for radical changes in how care will be provided,targeting preventive care,effective provision of continuous treatment,personalized and connected health[1].. Chronic diseases are becoming the world's leading causes of death and disability, and will account for almost three-fourths of all deaths by 2020. Each year, number of deaths caused by cardiovascular diseases and hypertension is estimated to be 16.7 million and 7.1 million, respectively. Population of diabetic adults is expected to reach 300 million by 2025[2].

Cardiac disease is one of the most dangerous threats to human health. Moreover, due to the problem of aging of population is getting worse and worse, the number of cardiac deaths is sustained increasing. In nowadays medical conditions, there are a variety of means of diagnosing heart disease, such as Auscultation, Echocardiography, Color Doppler Ultrasound,ECG/EKG, Magnetic Resonance Imaging (MRI), Left Ventriculography(LVG), Computerized tomography.

(CT), Coronary angiography. Among these measures, ECG diagnosis has the advantages of convenience, precision and low-cost, and therefore ECG diagnosis has been widely used nowadays.Whereas, some arrhythmias (fast, slow, or irregular heartbeat), which have the abnormal symptoms, may occur only once in a while, or may occur only under certain conditions, such as strain. These kinds of arrhythmias are very difficult to capture by ECG tracing which is only checked in hospital or only runs for a few minutes at the normal condition. As it can not check the heart disease conveniently and betimes, a pocket ECG monitor device which can monitor arrhythmias at once and give different alarms would be very helpful[3].

Over the last two decades portable physiologic signal acquisition systems have been developed that are light, small, and capable of recordingmultiple signals for up to 48 hours. These systems are used in electrocardiography (ECG) studies to detect infrequent cardiacarrhythmias or transitory cardiac function abnormalities often related to the tensions of daily life[4].

Wireless medical telemetry is not totally new.A number of wireless medical monitors are currently on the market, including ECG, pulse oximeters, blood pressure monitors and fetal heart rate monitor [1 - 3]. These devices are wirelessly linked to allow the remote measurement and reporting of vital signal to the healthcare personal.However, the commercially available wireless/telemetry monitors are usually expensive, big in size and only confined in hospital uses and some private patients. The systems are designed only to replace the wired monitor system with wireless link using Bluetooth. Few of these systems are designed to be wearable and none are low-cost and certainly not very widely used[5]. This system considers the portability,efficiency and cost effectiveness of the ECG using microcontorllers and bluetooth.

2 RECORDER DESCRIPTION

2.1 Electrodes (Sensors)

The electrodes are small plastic tabs that attach to the skin much like an adhesive bandage. Each electrode is made up of a very thin metal layer (usually stainless steel or silver wire) and a thin layer of gel which is an electrolyte. The electrolyte assists with the transfer of the electrical current from the heart to the ECG machine.

Electrodes are placed in specific areas of the patient and are attached to the lead wires via mini-alligator (or similar) clips.

2.2 Lead Wires

Lead wires could be:

The wire that connects an electrode to the electrocardiograph machine,

A combination of electrodes that form imaginary lines in the body along which the electrical signals are measured.Each lead is attached to a different electrode and each lead will provide different view of the heart (front to back, side to side, etc.).This proposed project consists of three leads.

2.3 Low Heart Rate Alarm

It has three stages: (a). A.c coupled amplifier stage (b).QRS filter stage and (c).Level detector stage. The QRS is very important in this circuit because the most important part of the ECG is the QRS complex.Simply because if the QRS of the ECG of a patient is known,then the heart rate of the patient can be calculated.

3. Hardware Frame

3.1. ECG Signal Processing Uint

The ECG signal is acquired and processed by an instrumentation amplifier and a second order low pass filter.These sections are built with ICs,074 and 324 respectively.There is a level detector circuit which indicates the the condition of the heart incase there is any abnormality.This circuit is built with operational amplifier with IC number LM358..

3.2. Power Supply

This system utilizes a rechargeable lithium battery giving an output voltage of 12V.Additional 5V power is required by the microcontroller and the bluetooth.The microcontroller and the bluetooth both need 3.3V.

3.3. Microcontroller and Processing Unit

A single-chip microcontroller,ATmega8 is used. Single-chip microcontrollers combined many features into a single IC package. Single-chip microcontrollers integrate memory (both RAM and ROM) on-package and so do not need to expose the data anddress bus through the IC package's pins. These pins are then available for I/O lines. These changes reduce the area required on a printed circuit board and simply the design of a single-board microcontroller.

3.4. Bluetooth Module

This Bluetooth chip is designed to replace cables that are usually found in patient monitors by taking the information normally carried by the cable, and transmitting it at a special frequency to a receiver Bluetooth chip in the PC or the phone, which will then give the information received to the computer, or the phone.BC417 Bluetooth is used as a wireless transmission interface.This is simply,cost effective,compactible and reliable.

4. DISPLAY AND ANALYSIS METHODS

4.1. General Block Diagram

The general block diagram consists of Bio-amplifiers, ECG filters, LED's, Bluetooth, Microcontroller,Heart Rate Dectector,and Android platform.This is shown in figure 1.

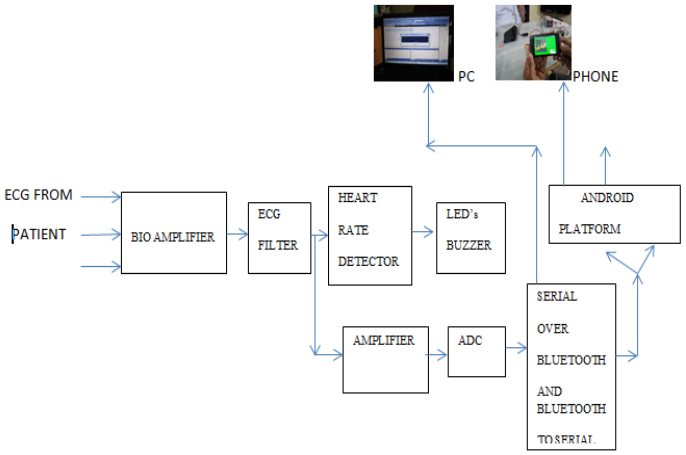

Fig. 2. Block diagram of the Heart Rate System.

4.2. How The System Works

The ECG signals are acquired using three lead electrodes.These leads are placed on the appropriate locations of the patient.The ECG signals detected from the patient are amplified by the instrumentation amplifier and filtered by a second order low pass filter. The filtered ECG signals which are in the range of 2 to 5V are then compared with a reference voltage to detect a ECG event. These biosignals ranging from 2V to 5V is fed to the microcontroller board.When the signals are fed to the collector, it they go to a potentiometer to select the amplitude.When this potentiometer is varied, the amplitude of the signal will antenuate or will be fed in directly.This then goes to the ADC of the microntroller which convert the signals from analog to digital then to the bluetooth module which communicates with the PC or Smart phone using bluetooth interface and the android platform.There is a program running in the microcontroller that constantly reads the ADC channel then converts it into bit packets how the bluetooth module requests then assemble these packets and send them over a serial port to the bluetooth module which also send the same packet to the PC or Smart phone The program is initialized on the PC by setting the amplitude and the time.This is done by setting the range of the y co-ordinate from 0 to 4 as the amplitude and the X co-ordinate(time) as 540ms. This initialization is basically through bluetooth connection port After initializing the port,the port opens and the PC receives the data The amplitude and the time are fixed.The data transmission for this project is fixed at two second.This means that every 2sec, data is been transmitted and plotted on the PC or the Smart phone. Serial over bluetooth is used for transmitting the data to the smart phone.

5. RESULTS AND DISCUSSIONS

Laboratory testing is first done with this device to see how the ECG signals are being generated. Components are assemble and fixed on bread board.This is shown in figure2.This is followed by an experimental testing using different subjects and their ECG signals being interfaced on digital storage oscilloscope.Figure 3 shows this.Subsequent testing are done on these subjects interfacing their ECG signals on PC and a Smart phone.Figure 4 and 5 indicate these ECG waves.It is noticed that the samart phone gives more clearer bio-signals compared to the PC.The microcontroller ATMEGA8-8PU gives very good signal transmission and by the help of the Bluetooth these signals are transmitted to the PC and the Smart phone.This is shown in Fig.4 and 5 respectively.

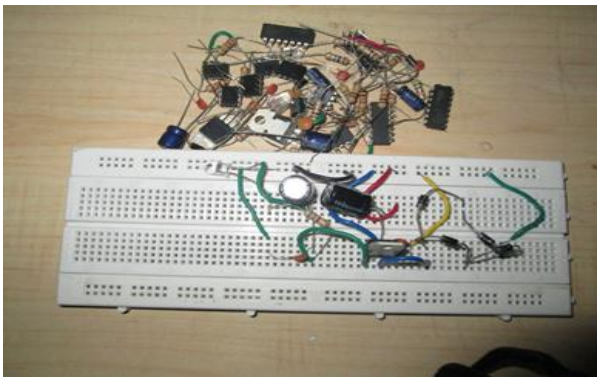

Fig.2.Components assembling

Fig. 3.ECG signal on digital storage oscilloscope

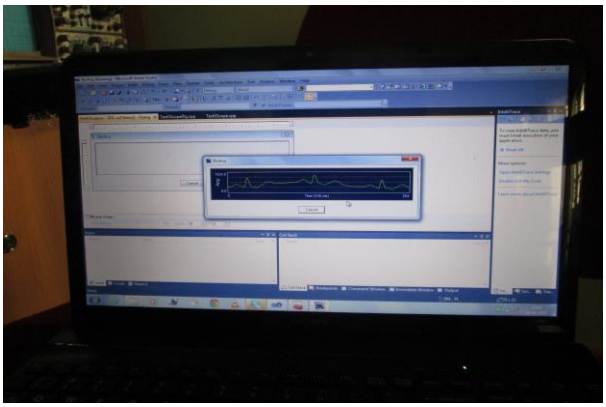

Fig.4.ECG signals on PC

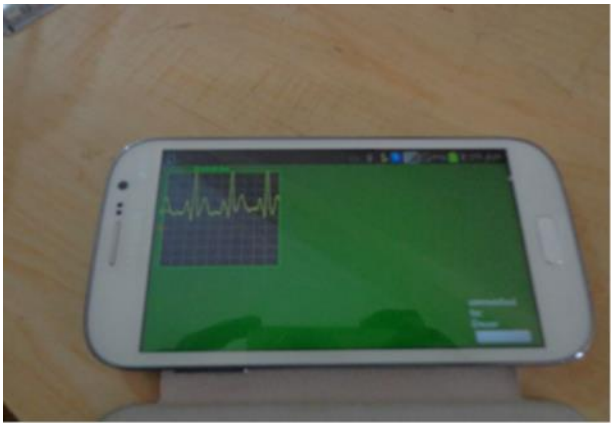

Fig: 5 .ECG signals displayed on Smart Phone

6. CONCLUSION

With the development of PC and Smart Phone as heart rate monitors is a big step forward in ensuring good,effective and efficient heart abnormalities monitoring in patients who are especially far away from the doctor and the healthcare centers.With proper and appropraite softwares such as Labview and telemetery, patients ECG as well as his or her heart abnormalities can be analyzed and transmitted everywhere.This will help prevent and reduce the rate of heart diseases.

7.FUTURE SCOPE

With the bluetooth transmission,it is limeted to short distance, thus the signal transmission distance can be enhanced in this project by using wireless transmission in the future.This proposed system has been limited to few heart conditions but with modification of the software program,this device can be used to analyze a lot of heart diseases and abnormalities.

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