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RASPBERRY PI BASED ECG DATA ACQUISITION SYSTEM

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ABSTRACT

Now days, ECG machines used by the doctors are expensive. Aim of this paper is to develop low cost real time ECG data acquisition system. ECG signal analysis involves detection of P wave,ST segment, PR segment, T wave, QRS complex. So ECG sensors are placed on body surface and sensor output is connected to AD8232 ECG acquisition module. Further ECG module is connected to ADC.Further it is connected to raspberry pi.A code is generated using Python-II language and ECG signal is displayed on screen.

Keywords: Electrocardiogram (ECG), Heart Rate, Python-II,Raspberry pi etc.

I.INTRODUCTION

Electro-cardiogram i.e. ECG is a periodical, rhythmically repeating signal caused due to the functioning of the heart. ECG test is safe and painless test which takes few minutes. But such machines are not available in rural areas due to its high costs. These machines need to be handled with care. The aim behind the work is to develop low cost, less complex and real time ECG monitoring system.The ECG waveforms have phase and amplitude relationship. But change in amplitude and phase in ECG waveform find outan abnormality in the functioning of heart. Normal heart rate of human beingis about 72 BPM.

Figure.1 shows ECG signal having different waves. The P wave of the ECG waveform iscauseddue to the contraction (depolarization)of the atrium and QRS complexis caused due to contraction (depolarization) of the ventricles.But T wave is formed due to the ventricular relaxation.A detection of QRS complex is important to find out R-R interval. Further it will calculate heart rate in Beas Per Minute (BPM).The time duration for one PQRST wave is about 0.8s.

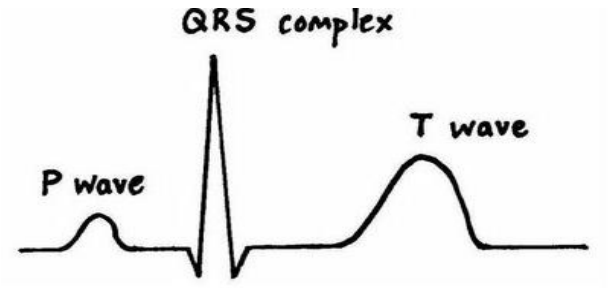

Fig.1 Electrocardiogram (ECG) Signal

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II. RELATED WORK

A literature review offersprevious results on ECG signal which was done by authors using different ways. It benefits new researchers to carry out and implement their ideas and research work.

JuGao*et.al* proposed a model which identifies type of abnormalities. It has been identified using heart rate abnormalities and ECG analysis. Authors carried out work on tachycardia and bradycardia which isthe heart beat abnormalities. MATLAB is used for development and implementation of algorithm. It happens due to the flow of oxygen and blood to vital body organs too fast in tachycardia and too slow in bradycardia.[3]

Liang-Hung Wang et.al proposed a method of telemedicine. It includes wireless monitoring of ECG for personal health monitoring. A proposed design contains ECG acquision node, the protocol for standard IEEE 802.15.4 Zig-Bee system and the radio frequency (RF) transmitter circuits. Telemedicine information system with interactive and intelligent features has become increasingly important to provide the high quality healthcare monitoring.[4]

RashimaMahajan*et.al* developedsystem for comparing normal heart rhythm from irregular ones. For that system, method of Power spectral analysis using (FFT) is used by the authors. It findsvariations in ECG with respect to frequency. The ECG data files from MIT Arrhythmiadatabase were loaded to MATLAB and matlab code is developed to calculate heart rate.QRS complexes are important while calculating heart rate. [6]

Dr. Ganesh V Bhat and AnandraddiNaduvinamani have been designed a low cost model of ECG monitoring system using Raspberry Pi. Authors developed front end ECG analog circuit using ECG electrodes coated with silver-silver chloride (electrolyte), AD620 instrumentation amplifier and filter circuit. Then amplified output converted into digital form using MCP3008 analog to digital converter (ADC).SPI protocol is used for communication between Raspberry Pi and ADC. They explained pin connections between Raspberry Pi board and ADC. Results are displayed on monitor. The system operated in real time mode.[1]

MendrelaBiswas*et.al* proposed a system which sent patient data wirelessly using RF transmitter module. GUI is created to display patient data on monitor. ADC0809 is used to convert analog data from different sensors into digital form. When a critical condition occurs, the visual indications will be sent onto the screen But developed system observe data only in hospital premises due to Local Area Network (LAN).[7]

III. DEVELOPED SYSTEM

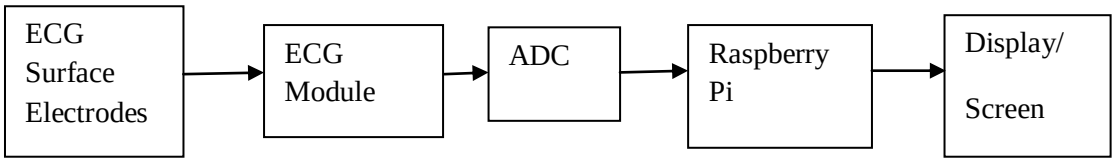

Fig.2Block diagram of ECG data acquisition system

Figure.2 shows block diagram of ECG data acquisition system. Raspberry Pi is selected as main controller of the system. First, Raspberry Pi is installed using SD card successfully. ECG adhesive electrodes are places on body parts to collect bio medical signals i.e ECG signal. These signals are very weak .So it needs to be amplified. So ECG data acquisition module such as AD8232 is selected. It amplifies and filters the ECG signals. Further module is connected to Analog to Digital converter (ADC). But Raspberry Pi interfacing with ADC requires installation of Adafruit library. Output signals are plotted on display unit which is connected to R-pi via HDMI

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cable. GUI is created using Raspberry Pi for displaying results. Python-II language is used for coding in raspberry Pi.

IV. HARDWARE REQUIREMENTS

4.1. Electrodes

Electrodes used in developed system are adhesive. These are placed on body parts to get ECG signals. Generally electrodes are coated with Ag-AgCl. These 3 electrodes form a single lead System. It creates potential difference in between them. It will generate ECG plot .

4.2. Analog to Digital Converter

ADS1x15 is analog to digital converter compatible with raspberry pi .It has 16 bits of resolution. It operates at range of 2.0V to 5.5V. It digitizes output of ECG acquisition module (AD8232).I2C Bus communication is used for data transfer.ADS1115 has sample rate about 860 sps.

4.3. ECG Data Acquisition Module

It is fully integrated signal conditioning ECG front end circuit. It is used to amplify and filter ECG signals obtained from ECG electrodes. AD8232-ECG acquisition module has output pin to which ADC is connected. Single supply operation is within 2.0 V to 3.5 V. Output pin of Ad8232 is further connected to ADC.

4.4. Raspberry- Pi Controller

It is Broadcom BCM2837 Arm7 Quad Core 32 bit processor.It is running at 900MHz. It has total 40 GPIO pins Micro SD port is usedto load operating system and to store data. It has Linux platform. Raspberry Pi is main part of developed system which reduces hardware complexity and enhances system portability. Display unit is connected to the controller using HDMI cable.

V. RESULTS

5.1. Matlab Simulation

For the study purpose, Physionet ECG online database having 1 minute time intervalis taken. ECG .txt file is simulated in matlab. Code for Butterworth low pass filter is designed to remove noise at low frequency components. It shows different waves i.e.P wave, QRS complex, and T wave.Figure.3 contains two plots of ECG signal having time and voltage relationship. First plot shows original ECG text file loaded in matlab and second plot shows filtering of ECG using Butterworth filter.

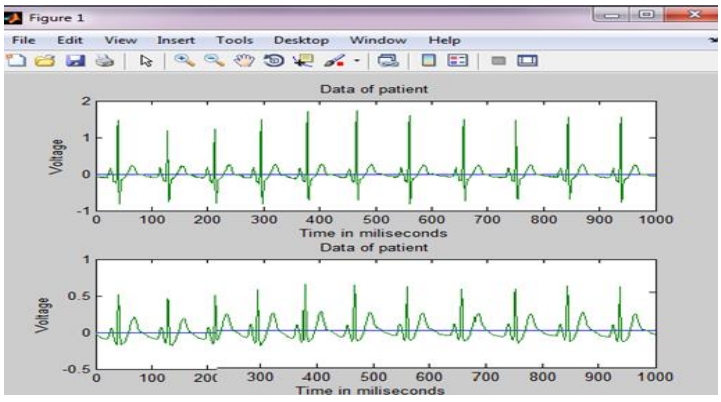

Fig.3 ECG signal plot in matlab

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5.2 Simulation using Raspberry Pi and Python-II language

Raspberry pi controller has Linux platform to run all the commands.For developed system, code is generated using python-II language. Figure.4 shows GUI creation using Python-II which is similar to the matlab. For testing purpose online ECG data in .csv format loaded in developed system. Generated code in python first read data and plot with help of GUI as shown in figure.5.Real time data obtained in digital values is plotted as shown in figure.6

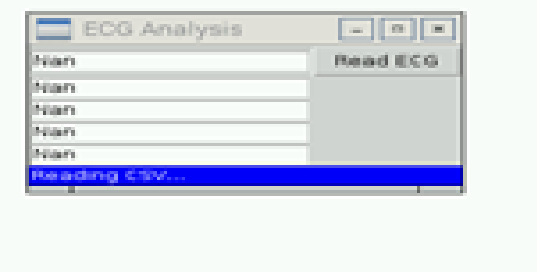

Fig.4 GUI Created using python-II

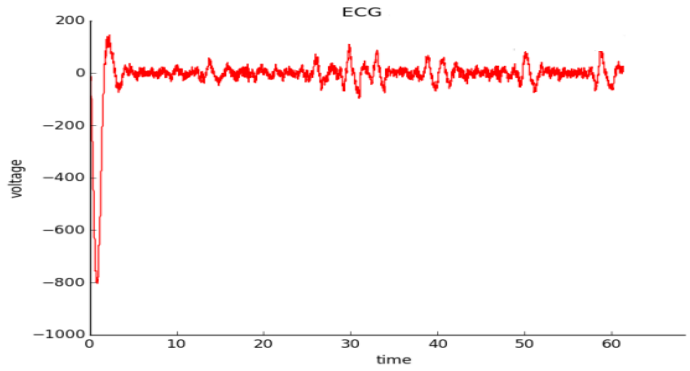

Fig.5 ECG signal plotted using online database

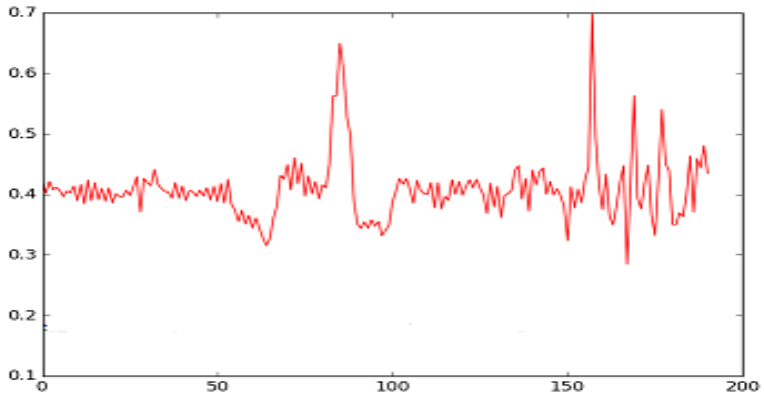

Fig.6Real time ECG plot using developed system

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VI. CONCLUSION

A current paper develops portable, low cost ECG data acquisition system. Overall circuitary is less complex and movable. Results are presented using matlab and Raspberry Pi. It shows that real time data collection is not possible in matlab which is done using developed system. It is helpful for comparative study of ECG signal processing in matlab and raspberry Pi.

VII. FUTURE WORK

A proposed work is helpful for analysis of ECG signal. Different features from obtained plot will be extracted. It will find out an abnormality in ECG signal if any. It will determine heart rate and abnormalities related to heart rate like tachycardia, bradycardia. A proposed system will extend the concept of telemedicine. It will be beneficial for the study of wireless transmission of data of patients in case of emergency.

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