Real Time ECG Signal Monitoring in LabVIEW platform Using Arduino Interfacing for the Patient

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Abstract— Electrocardiogram (ECG) is the common interpretation technique for the measurement of heart activity. Now a days ECG signal are widely used for the diagnosing clinical application because many people are suffered from the heart disease. This paper leads to developing a real time ECG signal monitoring in LabVIEW software using Arduino hardware for the patient and also provide efficient and economical system for the measurement of heart activity. Here, ECG signal is acquired by the AD8232 sensor and Arduino UNO act as the analogue to digital converter (ADC). LabVIEW is used for the monitoring and stored the data of ECG signal.

Keywords: ECG, LabVIEW, Arduino, Electrodes, ECG Signal Processing

I. INTRODUCTION

An electrocardiogram is a test that checks how your heart is functioning by measuring the electrical activity of the heart. With each heartbeat, an electrical impulse (or wave) travels through your heart. This wave causes the muscle to squeeze and pump blood from the heart. When the heart beat is normal the ECG signal looks like as shown in the Fig.1.

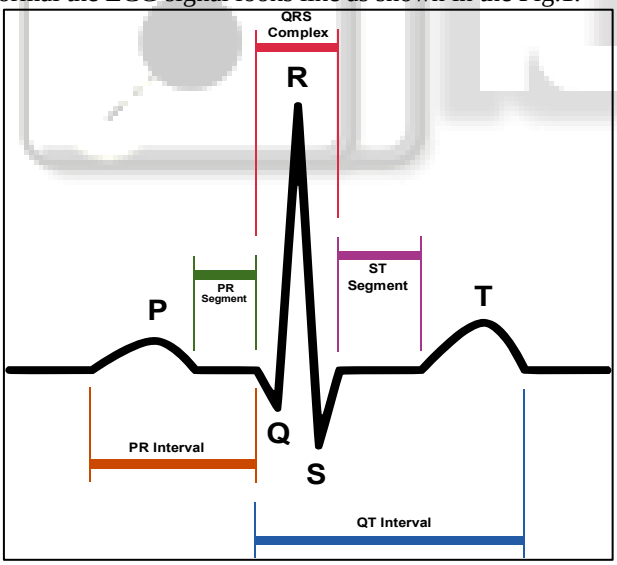


Fig. 1: Normal ECG wave [1]

When the heartbeat is too fast, too slow, or beats in an irregular rhythm, it is known as a cardiac arrhythmia or abnormal heart rhythm, which is among the most common of the heart disorders [2]. Abnormality of the heart caused arrhythmia. The proposed system of detecting ECG signal is non invasive method. Now a days many methods are used for ECG signal detecting. For signal detecting we used an Einthoven's triangle method for the detecting ECG signal from the patient which has three lead as shown in Fig.2. First lead is attached with the left arm, second lead is attached with the right arm and the third lead attached with the left leg [3][4].

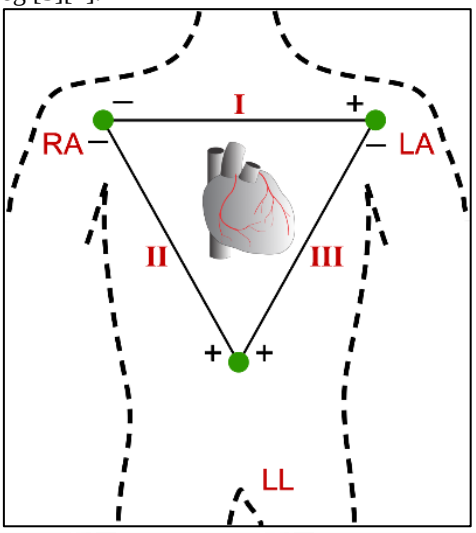


Fig. 2: Einthoven's triangle [5]

ECG is used for the diagnose following cardiac abnormalities such as Tachycardia, Bradycardia, AV block, Ventricular fibrillation and atrial fibrillation [6]. This research offers the different contribution like portable ECG monitoring system under the Arduino Uno and AD8232 sensor. The ECG data was stored and analyze through the laptop/PC.

II. SYSTEM ARCHITECTURE

In this research for signal processing we require ECG sensor AD8232, Arduino UNO, USB to TTL serial adapter, 3 lead electrode cable, Surface electrode, LabVIEW software, Arduino IDE software and a power source. The functionality and working of every part are described below.

A. ECG sensor AD8232

The AD8232 is an integrated signal processing block for measurement of heart activity. AD8232 is designed to extract, amplify and filter bio potential signal in the noisy condition. The design allows low power (2 to 3.3 v) embedded controller to easily capture the output signal. Filtering of the data measured by the high and low pass filter. Also, AD8232 has built in amplifier for the right leg drive circuit. A high pass filter can reduce the original long tail phenomenon [7]. The AD8232 will automatically adjust high pass filter cutoff state so when we connected electrode at that time measurement value show as soon as possible. Also, there is an LED indicator light that will pulsate to the rhythm of a heartbeat.

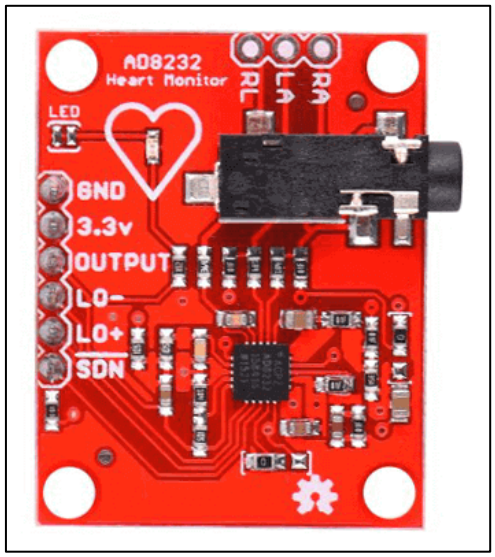


Fig. 3: ECG Sensor AD8232

B. Arduino Uno Board [7]

The Arduino uno is an ATmega328 based microcontroller board. It has 6 analog input, 16 MHz ceramic resonator, 14 digital input/output pins, power jack, USB connection, reset button and ICSP header. Arduino UNO is directly connected with the laptop/PC with the USB cable. Also, it works with the 5v power supply. It does not use the FTDI USB to serial driver chip which makes Arduino different from other available board. AT mega 16U2 used for the directly communicate with the computer or laptop. In this research we use Arduino board because it has low cost, low power consumption and inbuilt ADC.

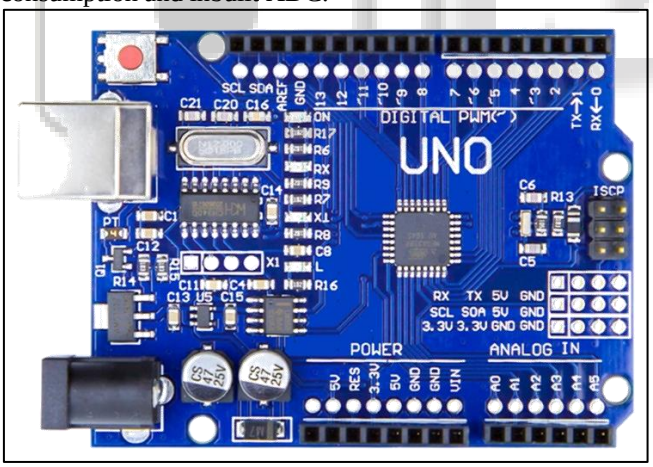


Fig. 4: Arduino Uno Board

C. USB to TTL serial adapter

This converter based on CP2102 bridge and powered from the USB (universal serial bus) port. This module can be used to upload Arduino sketches over receive and transmit process. This converter is used for the standard full duplex USB port into a full duplex TTL (Transistor to transistor logic) port and vice versa [8]. This adapter support data auto sensing and adjusting. There is no need to setting baud rate. We used this device for providing receive input (Rx) and transmit output (Tx) to the Arduino board.

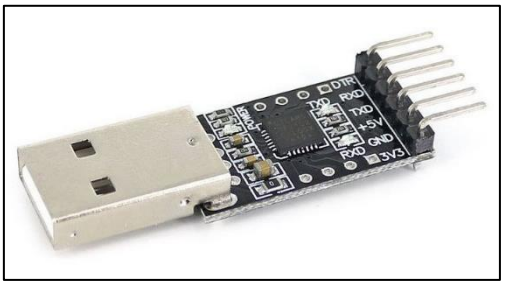


Fig. 5: USB to TTL serial adapter

D. 3 lead ECG electrode cable

This cable is used for the signal received from the human body and transmit signal to the ECG sensor module. In this cable there is three different lead which are red, yellow and green. Position of three lead as below:

- Red: Right arm, just below the right clavicle
- Yellow: Left arm, just below the left clavicle
- Green: Left leg, on the lower chest, just above and left of the umbilicus [9] [10]

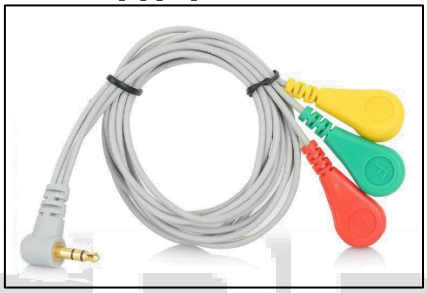


Fig. 6: Three lead ECG cable

E. Surface electrode

The use of the electrodes is to measure physical parameter of the patient body and convert into an electrical output. Here, we used round surface electrode which is shown in figure. It has an adhesive on the back, which helps the electrode to stick firmly to the patient's skin. On the surface electrolyte gel is used because e it provides proper contact between skin and electrode.

Fig. 7: Surface Electrode

F. LabVIEW software

LabVIEW (Laboratory Virtual Instrument Engineering Workbench) is a system-design platform and development environment for a visual programming language from National Instruments. It is a software package developed to build programs with the symbols. LabVIEW is programmed to act as an interface, helping different hardware to communicate with each other. Also, LabVIEW is used for signal processing, data acquisition, signal transmission, signal analysis, instrument control, and industrial automation on a different operating system.

G. Arduino IDE software

The Arduino integrated development environment (IDE) is a cross-platform application (for Windows, macOS, and Linux) that is written in the programming language Java. It is also open source software for writing easily code and upload code on the any Arduino board. Also, it supports C and C++ language using special code structuring.

III. METHODOLOGY

To extract the ECG signal we used here AD8232 and Arduino UNO for signal acquisition and converting. For interfacing with the LabVIEW, we used TTL to USB serial adapter. The Arduino used to take values from the body with the helps of ECG sensor. In a LabVIEW flat structure used for further signal processing [4]. An error handling function is also used to handle different error when the error occurs in the program. Basic block diagram of the ECG signal acquisition is shown in the below block diagram. We get the result of ECG waves in LabVIEW front panel in the form of graphical representation.

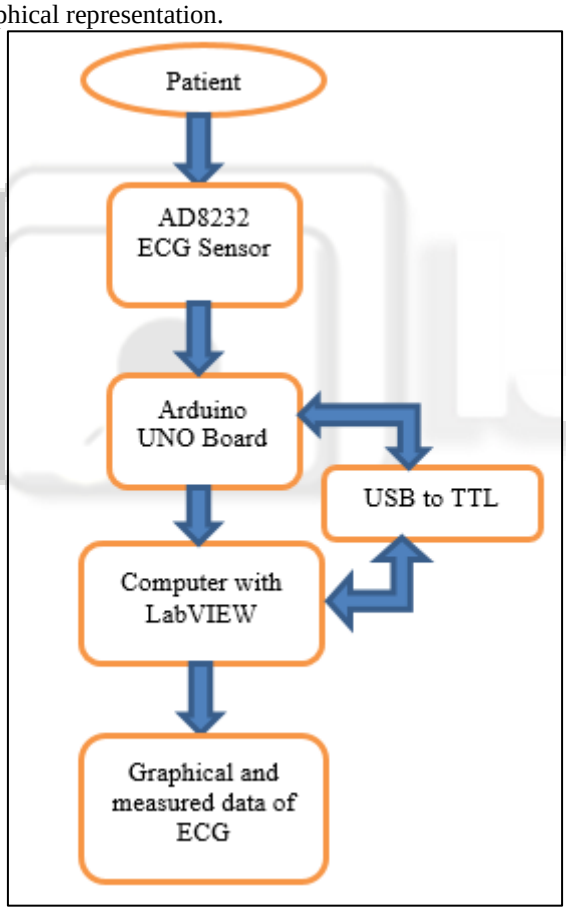


Fig. 8: Block diagram of the ECG monitoring system

IV. EXPERIMENTAL SETUP AND RESULTS

A. Experimental setup

In this ECG monitoring system, code is developed in the Arduino IDE software and then upload in the Arduino board. To collect biopotential from the patient round surface electrode attached with the skin and it is connected to the ECG sensor via ECG cables as shown in below figure.

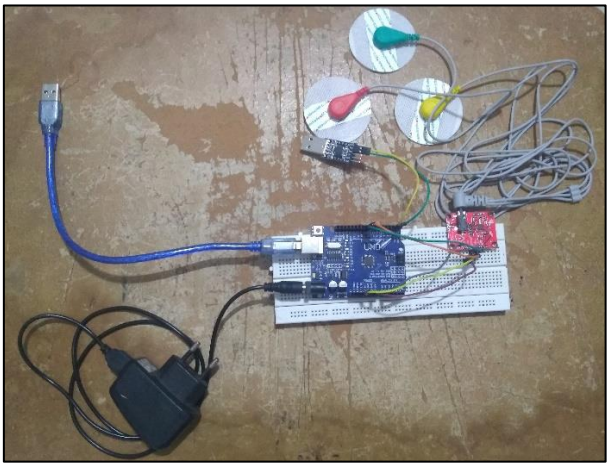


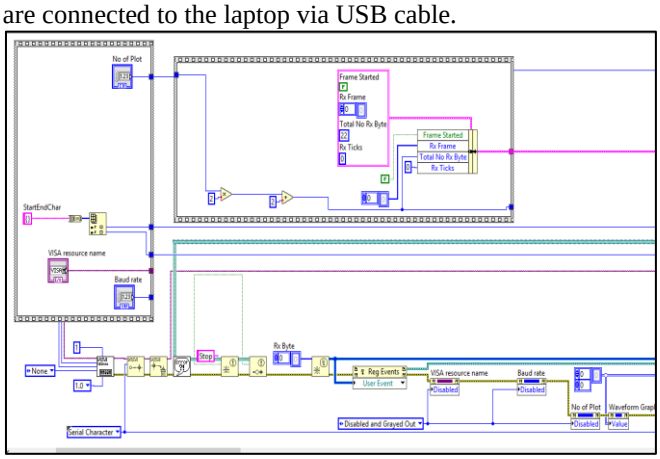
Fig. 9: ECG monitoring system setup

The procedure of electrical signal obtained from the body skin is shown in below figure.

Fig. 10: Electrode placement on patient

B. LabVIEW block diagram

Here, is the block diagram and front panel of the LabVIEW software which is used for the monitoring ECG of the patient. The digital output of the ECG is transfer through the TTL to USB connector and Arduino uno board output which are connected to the laptop via USB cable.



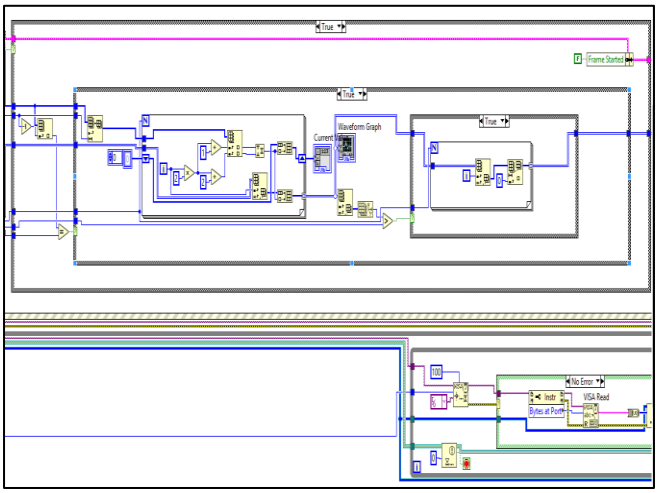


Fig.11: LabVIEW Software block diagram

C. Monitoring of ECG

This system is able to produce the result shown in fig.13, which shows the result of ECG signals. Also, the result can be monitored in both digital and analog term. For the digital output we use serial monitor from the Arduino IDE software and on another side for analog output we use the LabVIEW waveform graph which is shown in figure 12 & 13. LabVIEW give real time data with accuracy. The data collected from the software can be tabulated and it is useful for further diagnosis and thus data stored in PC via LabVIEW stored data system.

The proposed system is functioning well once all the hardware connected properly. The whole system is very reliable, portable and cost effective.

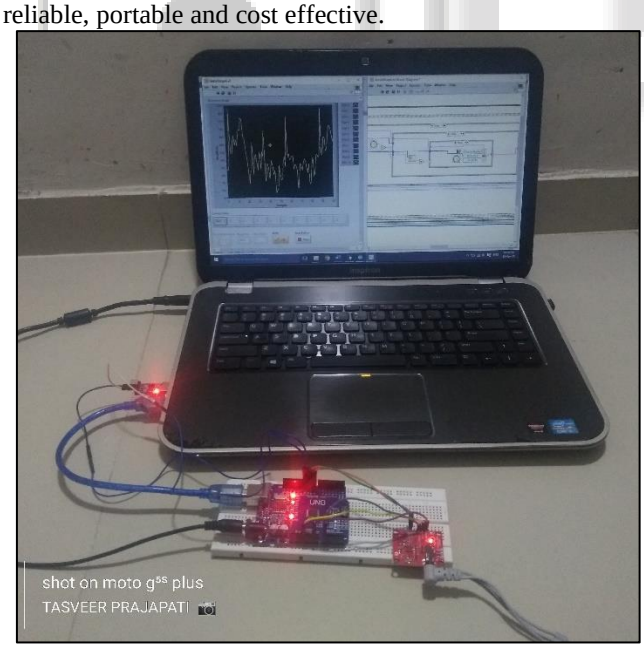


Fig. 12: Experimental setups

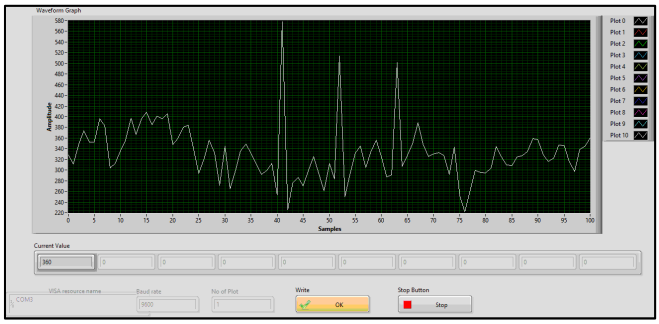


Fig. 13: ECG signal monitoring

V. CONCLUSION AND FUTURE WORK

In this paper, the low-cost real-time ECG monitoring system was proposed and implemented. This system consumes less power compared to traditional technology. The hardware we used are commercially available and the software programming are described here. The proposed system could be modified and add more functions like Respiration rate, Temperature pulse rate, etc.…

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