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ANALYSIS OF HEART RATE AND ECG SIGNAL THROUGH ARDUINO AND PROCESSING SOFTWARE

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Abstract

Heart rate plays an important role in health parameter that is directly related to the soundness of the cardiovascular system. This paper describes the monitoring and analysis of ECG signal and pulse rate of the patient using Arduino. The input is taken from the patient through ECG module and heart rate sensor. Then ther are processed through arduino and the output is displayed using the processing software. The code used in the processing software will intimate us about the ECG signal of the patient is normal or not.

Keywords:- Arduino, Heart rate sensor, Electrocardiogram, Instrumentation amplifier, Processing software, Electrodes.

Introduction

The heart rate is the rate at which the heart beats per minute. Early ECG monitoring system consists of set of electrodes that are attached to the different parts of the body. For adult, the average heart rate is around 72 beats per minute. And the heart rate for babies and elders are around 120 and 90 bpm respectively[3]. The heart rate gradually increases during physical exercise and decreases while taking rest. Normal heart rate shows the fitness of the person. When the heart rate is lower than the normal heart rate is known as bradycardia and higher than the normal heart rate is known as tachycardia. Based on the heart rate, the analog waveform is obtained when it is attached to the finger. Then the analog output is interfaced with microcontroller ADC and the calculated reading gives the the heart rate per minute. It is simple to use and accurate result is obtained. It works on the principle of light modulation by blood flow through finger at each pulse. Electrocardiography is the process of recording the electrical activity of the heart over a period of time using electrodes placed on the surface of the body. The electrodes detect the tiny electrical changes on the skin that arise from the the heart muscle's electrophysiologic pattern of depolarizing and repolarising and repolarizing during each heartbeat. It is a very commonly performed cardiology test. Because this action is electrical in nature and the body is conductive with its fluid content, this electrochemical action can be measured at the surface of the body.[2]

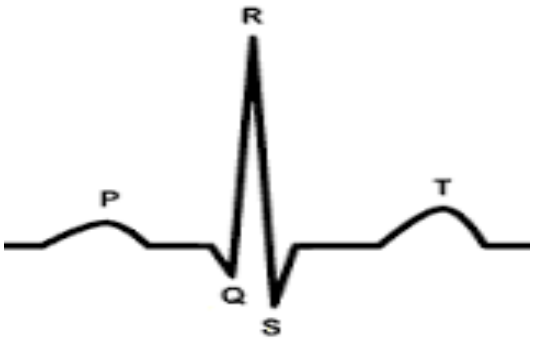

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Fig 1. PQRST waveform

Proposed system

Cardiac arrest is a critical problem that may ultimately leads to death. This paper mainly focuses on monitoring and analysis of heart rate and ECG signal of the heart patient.

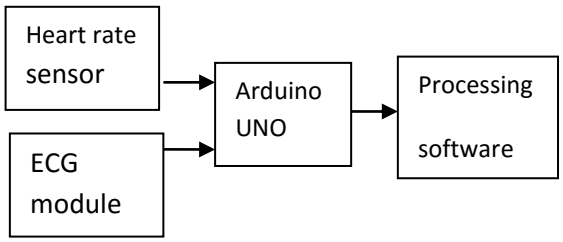

Fig 2. Block diagram

The implementation of this design is the need for a small, portable ECG monitoring system. It can be measured either by the ECG waveform or by sensing the pulse rate – the rhythmic expansion and contraction of the heart focuses the blood to the artery and veins. This fluctuation of blood can be examined through an optical sensing mechanism. The pulse rate sensor consists of an infrared light emitting diode and a photodiode. The IR LED transmit an infrared light into the fingertip, and a portion of light is reflected back from the blood inside the finger arteries. The ECG waveforms can be monitored using suitable electrodes are placed over arms and chest region. The electrical potentials which are generated from the heart are applied to the instrumentation amplifier via electrodes. The inputs from the heart patient are given to the heart rate sensor and the ECG module that is interfaced to the arduino and processed using arduino. Finally, the ECG signal is converted into digital by AD624 and which are plotted heart rate and the ECG signal whether it is normal or not.

Arduino

Arduino Uno is an open source hardware and it is based on the ATmega328. using processing software. The amplitude of the PQRST wave is compared with the output signal and can detect the patient The arduino boad is a small microcontroller board, which is a small circit that contains a whole computer on a small chip. It has 14 digital input & output pins, 6 analog input, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header and a reset button. The microcontroller is powered via USB cable from the computer and also adapter is used for power supply.

Electrodes

The electrodes are used to collect the electrical potentials from the heart. Here the Einthoven's triangle lead 1 system is adopted. Here the electrodes used are pre-gelled disposable electrodes. These type of electrodes are used for prolonged applications. Here the electrodes used are uni-polar electrodes.

Heart rate sensor

The analog output is interfaced to microcontroller with ADC pin directly to measure the heart beats per minute (BPM). It works on the principle of light modulation by blood flow through fingertip for every pulse. Based on the pulse rate, the analog signal is obtained

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from the heart rate sensor. Then the analog input is interfaced with microcontroller ADC and it converts analog to digital form. It is Simple to use and can give accurate results.

Specification

Parameter	Value
Operating Voltage	+5v DC regulated
Operating Current	100 mA
Output Data Level	5V TTL level
Heart Beat detector	Analog Out
Light source	660nm Super Red LED
Detector	Photo Diode

Fig 3.Heart rate sensor

Pin Diagram

Pin	Name	Details
1	+5V	Power supply Positive input
2	A.OUT	Analog voltage out (0-5Vrange)
3	GND	Power supply Ground

Instrumentation amplifier

The AD624 is a high precision, low noise, instrumentation amplifier designed primilarly for use with low level transducers, including load cells, strain gauges and pressure transducers. An outstanding combination of low noise, high gain accuracy, low gain temperature coefficient and linearity makes the AD624 ideal for use in high resolution data acquisition systems. The AD624 offers outstanding noise performance. Input noise is typically less than 4nV/Hz at 1kHz. The AD624 provides totally independent input and output offset nulling terminals for high precision applications.

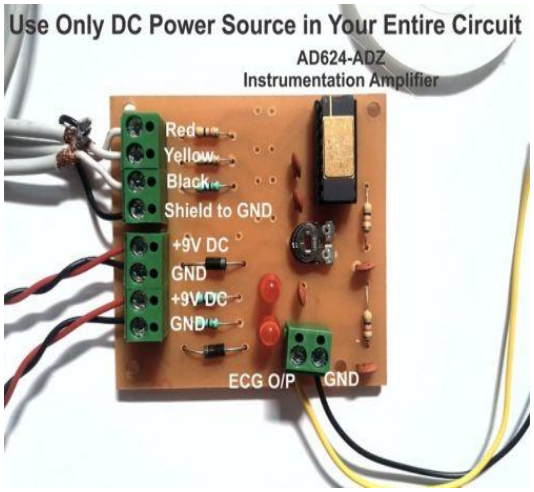

Fig 4. Instrumentation amplifier

The AD624 is a functionally complete instrumentation amplifier. Pin programmable gains of 1, 100, 200, 500 and 1000 are provide on the chip. The AD624 doesn't require any external components and it is internally compensated. The gain bandwidth product for AD624 is 25MHz.

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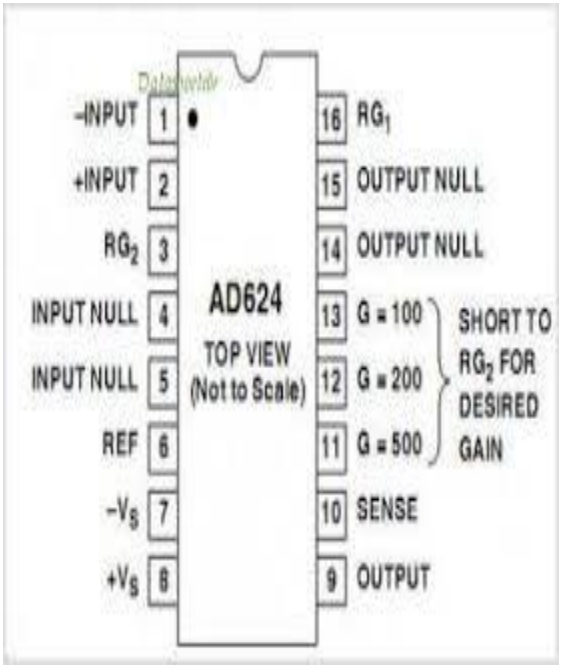

Fig 5. pin diagram of AD624

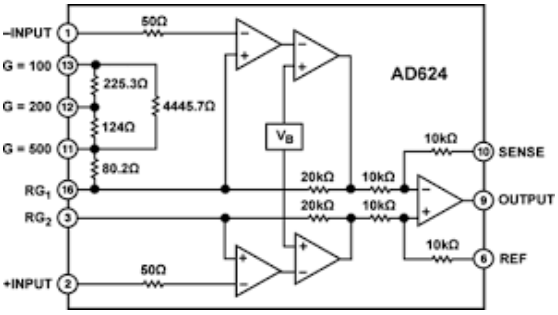

Fig 6. Circuit diagram of AD624

Programming software

Processing is an open source computer programming language and integrated development environment (IDE) built for the electronic arts, new media art, and visual design communities with the purpose of teaching the fundamentals of computer programming in a visual context, and to serve as the foundation for electronic sketchbooks. One of the aims of Processing is to allow non-programmers to start computer programming aided by visual feedback. The Processing language builds on the Java language, but uses a simplified syntax and a graphics user interface.

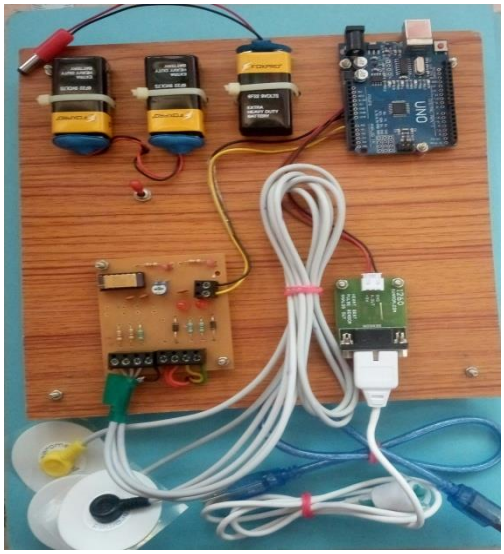

Fig 7.Real time monitoring of ECG signal and pulse rate

Results and discussion

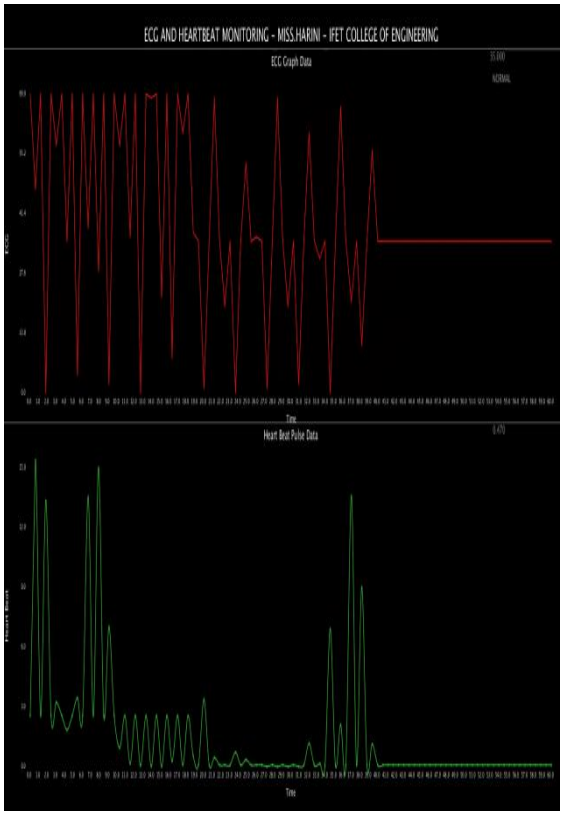

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Fig 8. ECG signal and pulse rate is displayed on the processing sketch

If the average amplitude of the P wave is above 90, it is noted as bradycardia. If the average amplitude of the Q wave is above 80, then it is noted as tachycardia. When the average amplitude of the R wave is above 70, it is noted as coronary arrchymia. When the ECG signal is not generated, it is noted as dead. This graph shows the variation of both normal and abnormal signal by changing the colour of the ECG signal.

Conclusion

Thus the monitoring and analysis of heart rate and ECG signal can be done through arduino and processing software and the abnormality can be easily detected using the ECG waveform.

Future scope

-Buzzer for ECG signal when any defect is present in the ECG waveform.

- Abnormality is detected in which chamber among the four chambers of the heart. And also there is a lot of place for enhancement.

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