# Heart Beat Sensor- EE381 EC Project


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## Aim

Monitoring body temperature, heart rate and blood pressure are the basic things that we do in order to keep us healthy.Conventionally we have two methods to measure the heart rate:

1. Manual Way: Heart beat can be checked manually by checking one's pulses at two locations- wrist (the radial pulse) and the neck (carotid pulse). The procedure is to place the two fingers (index and middle finger) on the wrist (or neck below the windpipe) and count the number of pulses for 30 seconds and then multiplying that number by 2 to get the heart beat rate. However pressure should be applied minimum and also fingers should be moved up and down till the pulse is felt.
2. Using a sensor: Heart Beat can be measured based on optical power variation as light is scattered or absorbed during its path through the blood as the heart beat changes.

Our idea was to create a device that will help in measuring heart rate i.e. speed of the heartbeat making use of a Arduino and some basic circuit elements instead of employing a sensor.

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## Equipment Used

- Arduino Nano microcontroller
- USB cable
- LM324 op-amps, AD620 instrumentation amplifier
- IR Pair (IR emitting LED and phototransistor)
- Resistors, capacitors, potentiometers
- Breadboard, connecting wires

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## Software used

- Arduino IDE
- Matlab

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## How it works

Our circuit consists of a light emitting diode and a detector like a light detecting resistor or a photodiode. The heartbeat pulses cause a variation in the flow of blood to different regions of the body. When a tissue is illuminated with the light source, i.e. light emitted by the led, it either reflects (a finger tissue) or transmits the light (earlobe). Some of the light is absorbed by the blood and the transmitted or the reflected light is received by the light detector. The amount of light absorbed depends on the blood volume in that tissue. The detector output is in form of electrical signal and is proportional to the heart beat rate.

This signal is actually a DC signal relating to the tissues and the blood volume and the AC component synchronous with the heart beat and caused by pulsatile changes in arterial blood volume is superimposed on the DC signal. Thus the major requirement is to isolate that AC component as it is of prime importance.

To achieve the task of getting the AC signal, the output from the detector is first filtered using a 2 stage high pass-low pass circuit. The signal then obtained as output of the system is fed into the Arduino Nano directly. The same is imported into MATLAB and using its digital signal processing toolkit, we get the desired results.

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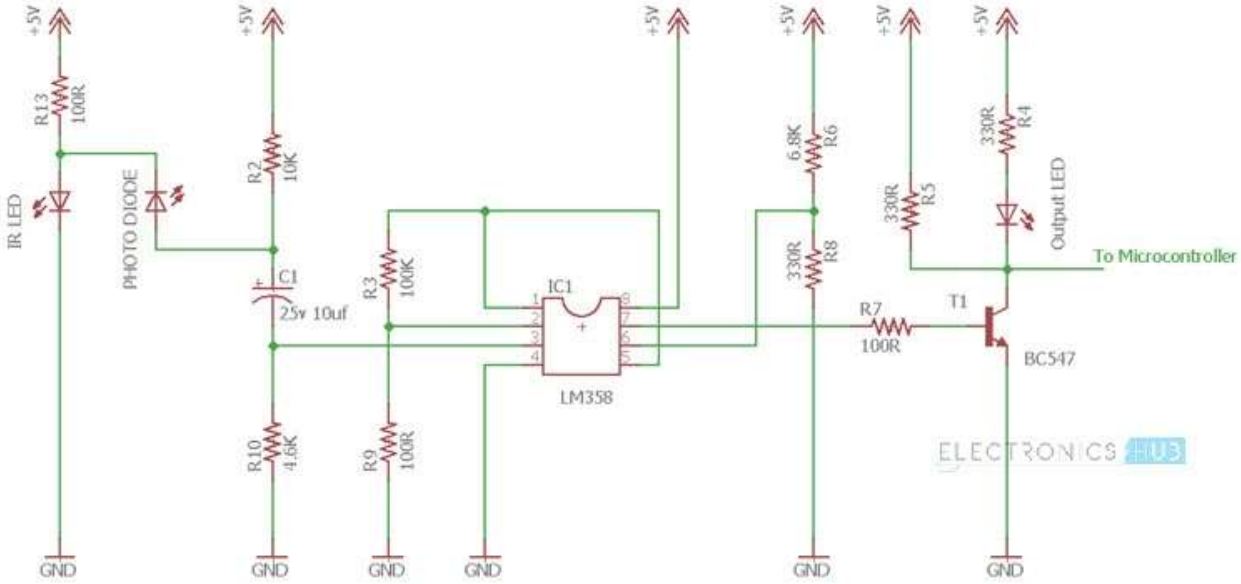
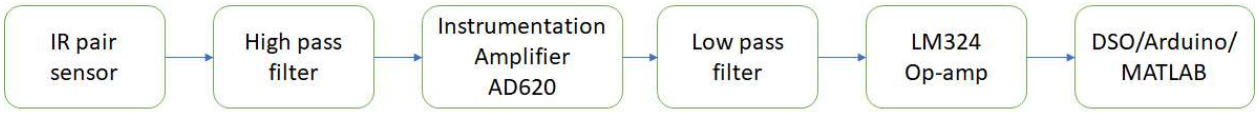
## Circuit Diagram

Following is the circuit diagram of a sensor made using the basic circuit elements



The output signal thus then obtained is fed into the Arduino microcontroller which is then further processed using MATLAB signal processing tools.

## Block Diagram

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## Output Waveform

## Utilities required

We use two major software utilities

### Arduino IDE

- To access the analog data from the amplifier output
- To convert the data into a usable format for signal processing using MATLAB

### MATLAB

- To process the signal obtained in order to measure the number of peaks of the heartbeat in a specified time interval
- To output the result (some fraction of the pulse rate)

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## Issues and Challenges

One of the main issues is the operation. Typically we expect the device to be used in any circumstance with the user be given the flexibility to use it as he/she pleases. The device is very sensitive to noise variations as you need to be in a complete standstill so that your heart beat can be measured.

Also, different people have different amplitude variations in blood pulses and/or different thickness of fingers and hence it becomes difficult to set a threshold signal strength so as to differentiate between signal and noise, which is required for peak detection and simultaneously the heart rate.

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## Possible improvements

1. Incorporating a normalisation technique so that individual differences in amplitude of heartbeat  can be accounted for. This can be achieved using signal processing techniques.
2. Implementing better filters such as the Sallen Key low pass filter for noise reduction.

# References


1. https://www.electronicshub.org/heartbeat-sensor-using-arduino-heart-rate-monitor/
2. https://www.elprocus.com/heartbeat-sensor-working-application/
3. https://blog.ytotech.com/2015/11/01/findpeaks-in-python/


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