# Design of Heart Rate Monitor through Fingertip

Ashish Kumar[#1], Deepak Rasaily[*2], Pooja Sharma[#3]

[1] *Diploma Studentin Dept. of Electronics & Communication Engineering, CCCT Polytechnic*
[2] *Sr. Lecturer in Dept. of Electronics & Communication Engineering, CCCT Polytechnic*
[3] *Diploma Studentin Dept. of Electronics & Communication Engineering, CCCT Polytechnic*
*Chisopani, P.O. Nandugaon, South Sikkim, India*

*Abstract—The project is totally based on microcontroller.It uses PIC16F874/77 microcontroller which is based on microchip's Mid-Rangecore.It uses an IR sensor (The sensor consists of an IR light emitting diode transmitter and an IR photo detector acting as the receiver) which will detect the volume of blood per second passes through the finger. Using this project we can easily find the heartbeat of a person per second without a doctor. The microcontroller check the status of IR sensor and based upon it will send a signal tothe LCD display. This circuit is being tested in protous and in breadboard and is properly working. This project is basically made for use in hospitals and can be used for simple experiments in colleges and schools. It is a cost effecting project, easy to use, reliable and simple.*

**Keywords—***Microcontroller,Sensor, Biomedical monitoring*

## INTRODUCTION

**PIC** is a family of modified Harvard architecture microcontrollers made by Microchip Technology, derived from the PIC1650 originally developed by General Instrument's Microelectronics Division. The name **PIC** initially referred to Peripheral Interface Controller.The PIC16F877 family of microcontrollers is based upon Microchip's Mid-Range core with an 8 level deep hardware stack and 35 instructions. These MCUs provide up to 5 MIPS, 3.5 Kbytes program memory, 128 bytes RAM and EEPROM of 64 bytes.

## MY PROJECT

This project demonstrates a technique to measure the heart rate by sensing the change in blood volume in a finger artery while the heart is pumping the blood. [1],[2] It consists of an infrared LED that transmits an IR signal through the

Fingertip of the subject, a part of which is reflected by the blood cells.The reflected signal is detected

By a photo diode sensor. [7],[10] The changing blood volume with heartbeat results in a train of pulses at the output of the photo diode, the magnitude of which is too small to be detected directly by a microcontroller. [2] Therefore, a Three-stage high gain, active low pass filter is designed using three Operational Amplifiers (Op-Amps) to filter and amplify the signal to appropriate voltage level so that the pulses can be counted by a microcontroller[5],[9].The heart rate is displayed on a 3 digit seven segment display. The microcontroller used in this project is PIC16F877.

## BLOCK DIAGRAM AND DISCRIPTION
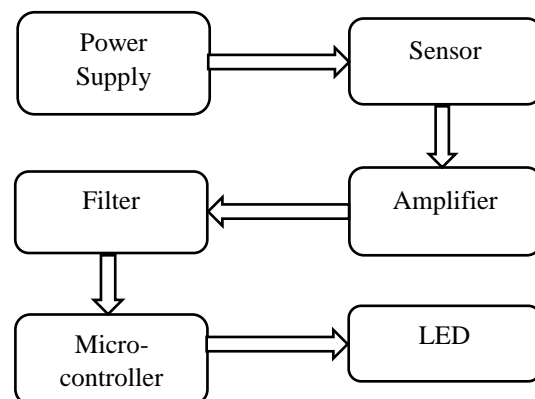


### IR Sensor:-
The sensor consists of an IR light emitting diode transmitter and an IR photo detector acting as the receiver. The IR light passes through the tissues. Variations in the volume of blood within the finger modulate the amount of light incident on the IR detector.

### Amplifier and Filter Design:-
Filtering process is required to remove the undesirable noises. The weak nature of the IR signal and the noise affecting on it, requires the implementation of a range of filters and differential amplifiers. [1]The signal conditioning circuit consists of two identical active low pass filters with a cut-off frequency of about 2.5 Hz.

*LCD:-*
**LCD** (**liquid crystal display**) is the technology used for displays in notebook and other smaller computers. Like light-emitting diode (LED) and gas-plasma technologies, **LCDs** allow displays to be much thinner than cathode ray tube (CRT) technology. It is used to display heart rate measurement in numeric.

*MICROCONTROLLER:-*
A pic microcontroller (PIC16F87X) is used to collect and process data. The PIC16F87X has High performance RISC CPU. It has up to 8K x 14 words of FLASH Program Memory, up to 368 x 8 bytes of Data Memory (RAM) up to 256 x 8 bytes of EEPROM data memory. Its power consumption is low. Thus it is ideal to be used as an embedded system. The pulse signal of heart extract from finger is fed to the port. The counter of microcontroller is used to measure the pulse rate per minute. Microcontroller also initiates the corresponding command for LCD Display.

## CIRCUIT DIAGRAM
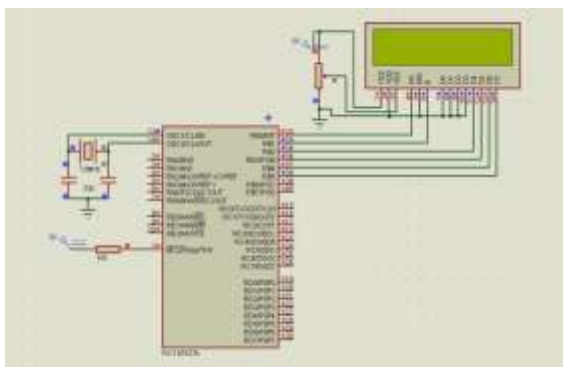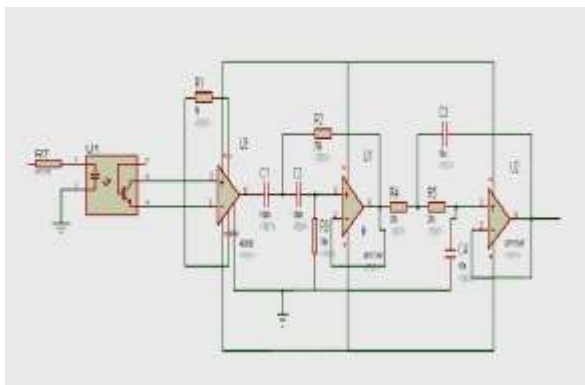




## CIRCUIT DESCRIPTION AND DIAGRAM

LTH1550-01 is simply an IR diode – photo transistor pair in single package. The front side of the IR diode and photo transistor are exposed and the remaining parts are well isolated. When the fingertip is placed over the sensor the volumetric pulsing of the blood volume inside the fingertip due to heart beat varies the intensity of the reflected beam and this variation in intensity is according to the heart beat.

When more light falls on the photo transistor it conducts more, its collector current increases and so its collector voltage decreases. When less light falls on the photo transistor it conducts less, its collector current decreases and so its collector voltage decreases. This variation in the collector voltage will be proportional to the heart rate. Any way this voltage variation is so feeble and additional signal conditioning stages are necessary to convert it into a microcontroller recognizable form.

The next part of the circuit consists of a two active low pass filters using op-amp LM324. The LM324 is a quad op-amp that can be operated from a single rail supply. Resistor and capacitor sets the gain and cut off frequency of the first filter. With the given component values, gain will be 11 and cut off frequency will be 2.5Hz. The gain and cut off frequency are determined using the following equations.

Voltage gain $Av = 1 + (R17 / R23)$
Cut off frequency $Fc = 1/ (2\pi *R17*C5)$

The second low pass filter also have same gain and cut off frequency. The two low pass filters form a very critical part of the circuit as any noise or false signals passing to the microcontroller stage will produce disastrous results. The output of the filter stage will be a voltage level fluctuating between 0 and 0.35 volts and this fluctuation is converted into a 0 to 5V swing using the comparator based on the third op-amp (IC1c). The reference voltage of the comparator is set to 0.3V. Whenever the output voltage of the filter stage goes above 0.3V, the output of the comparator goes to zero and whenever the output voltage of the filter stage goes below 0.3V, the output of the comparator goes to positive saturation. The result will be a neat pulse fluctuating between 0 and 5V at a rate equal to the heart rate. This pulse is fed to the microcontroller for counting.

## RESULT AND SIMULATION

This project is being tested in proteous and breadboard and is properly working. The circuit will sense the volume of blood flow through the veins per second. The microcontroller will count the blood pulse per second and display it in the LCD display.

## CONCLUSION

We have developed the system in such a way that it can be implemented for monitoring heart beat in

real time. This system is helpful for Monitoring of Heart beat for athletes and person who are doing exercise regularly .This system can be used in home, or during travelling, or in hospitals also. It can be used during emergency time and it also save our time.

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**Authors:**

**[1]**



**Ashish Kumar**is presently associated with the Department of Electronics and Communication Engineering at Centre for Computer and Communication Technology (CCCT- Govt. Polytechnic) Chisopani, South Sikkim, India as a student since 2013 to till date.

**[2]**



**Deepak Rasaily** is presently associated with the Department of Electronics and Communication Engineering at Centre for Computer and Communication Technology (CCCT- Govt. Polytechnic) Chisopani, South Sikkim, India as a Senior Lecturer since 2003 to till date. He is ME-Scholar at National Institute of Technical Training and Research, Chandigarh, India. He worked as project Scientist in the Department of Science and Technology, Govt. of Sikkim prior to lecturer in CCCT. His area of interest is PLC and robotics, Microprocessor and Microcontroller and Digital Signal Processing.

**[3]**



**Pooja Sharma** is presently associated with the Department of Electronics and Communication Engineering at Centre for Computer and Communication Technology (CCCT- Govt. Polytechnic) Chisopani, South Sikkim, India as a student since 2013 to till date.