PROJECT REPORT
ON
HEART BEAT DETECTION AND MEASUREMENT SYSTEM

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FACULTY OF TECHNOLOGY
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CERTIFICATE

This is to certify that the project on HEART BEAT DETECTION AND MEASUREMENT SYSTEM and term work carried out in the subject of Term Project is bonafide work of Vidhi V. Vadher (Roll no.: EC 92) and Mitali N. Vagadiya (Roll no.: EC 93) of B. Tech. semester V in the branch of Electronics & Communication Engineering, during the academic year 2019-20.

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Thank You.

ABSTRACT

In this digital world, along with the development of technology, the environment is also being ruined day by day and it also affects human health and causes different heart diseases. Now a days, rate of heart attacks are increasing drastically which is a serious problem and we should take it into account. In a regular busy schedule, people couldn't look after their health, so it would be much more helpful to have a handy module which can detect heart pulses. ECG is one of the electronic devices for measuring heart pulses but it's not affordable to all people. So here a small and reliable module for heart beat detection is introduced which counts number of heart pulses per minute and displays the counts on the seven-segment display.

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Introduction

In this 21st century, people are more concerned about making money more than their health. They don't spend enough time to check up their body regularly in this highly polluted environment. So, we have designed one handy module which can detect heart pulse and display it on the screen, so we can easily check it by our own. Our project is divided into two modules - One is heart beat detection module and the other is heart beat display module. Heart beat detection module consists of one finger chip circuit (IR transmitter and receiver), integrator, amplifier and comparator. The output of this module is given as an input to the heart beat display module which has counter ICs and 7 segment displays. One timer circuit is also introduced to count and display pulses only for 1 minute. These types of arrangements are also available in highly accurate electronic instrument like ECG, but our motive is to design a handy, small and reliable module at low cost such that ordinary people can use it in their day to day life without spending more money and time.

Block Diagram

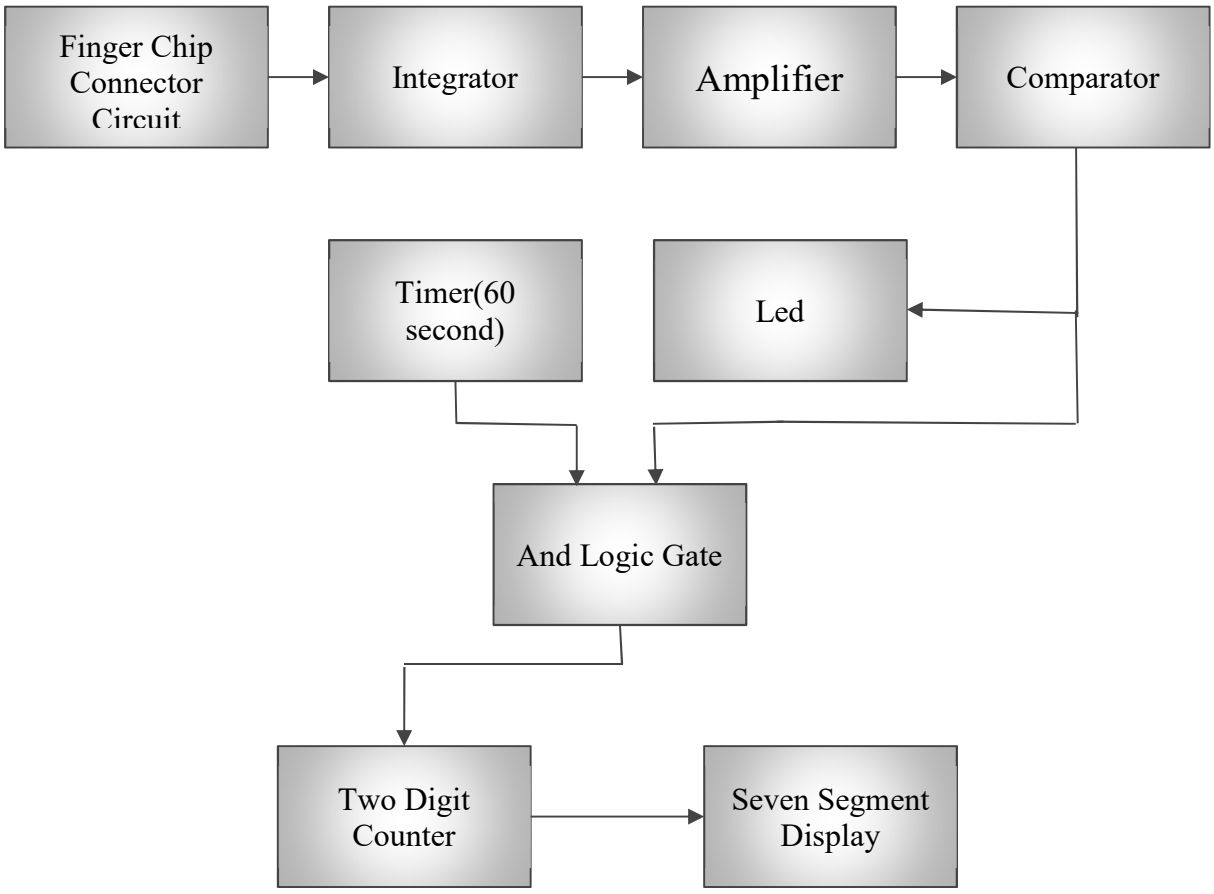

Fig 1.1 Block Diagram of Heart Beat Detection and Measurement Module

Circuit Diagram

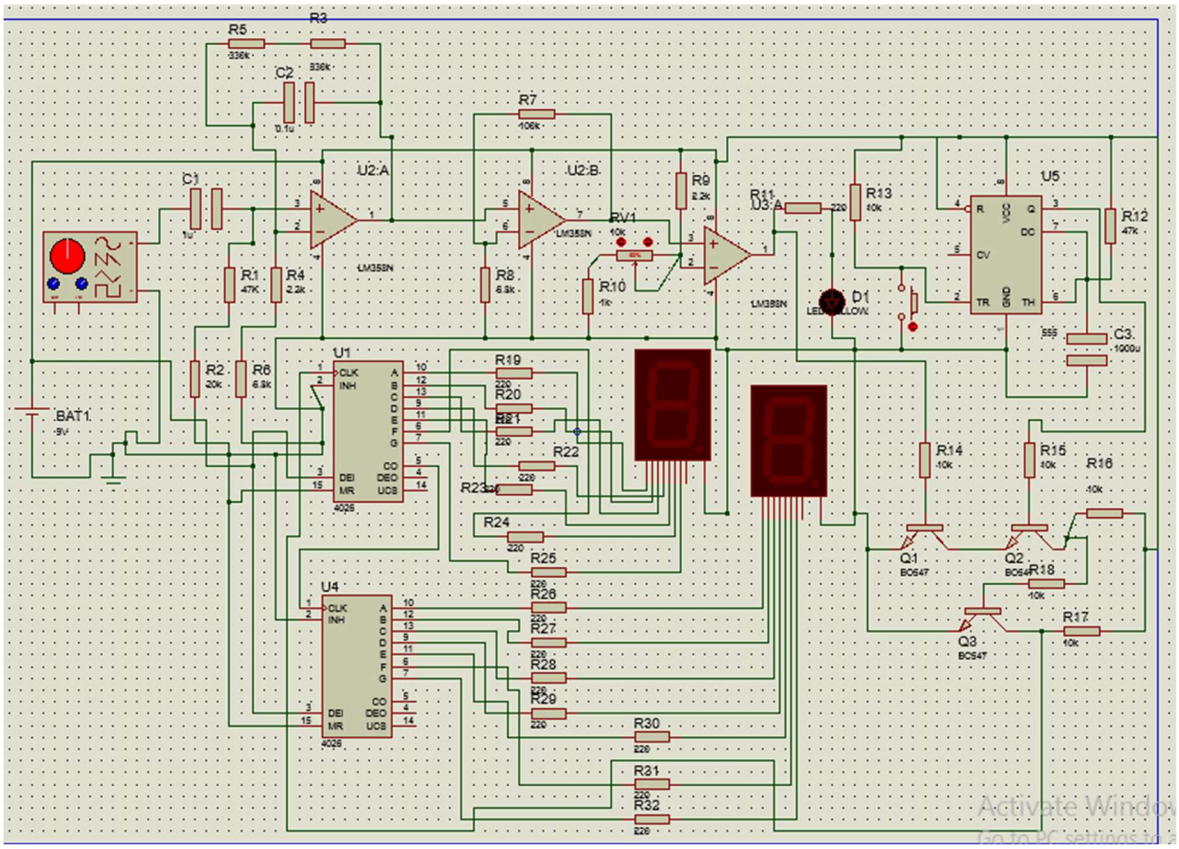

Fig 1.2 Circuit Representation and Simulation Layout

Component Description

1. IR Transmitter and Receiver:

Fig 1.1 IR Transmitter and Receiver

IR transmitter emits an infrared light, which means it emits light in the range of Infrared frequency. We cannot see Infrared light through our eyes, they are invisible to human eyes. The wavelength of Infrared(700nm - 1mm) is just beyond the normal visible light.IR transmitter looks like a normal LED and also operate the same. Means it consumes 20mA current and 3Volt power. It has a light emitting angle of approx. 20-60 degree and range of approx. few centimetres to several feet. Signal which is transmitted by the transmitter is received by the IR receiver. It converts information signal to an electrical signal.

2. LM 358 :

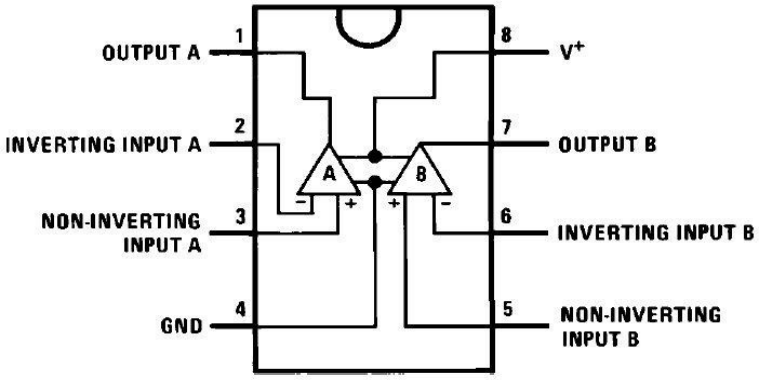

Fig 1.2 Pinout Diagram of LM 358 Low Power Operational Amplifier

LM358 is a dual op-amp IC integrated with two op-amps powered by a common power supply. It can be considered as one half of LM324 Quad op-amp which contains four op-amps with common power supply. The differential input voltage range can be equal to that of power supply voltage. The default input offset voltage is very low which is of magnitude 2mV. The typical supply current is 500uA independent of the supply voltage range and a maximum current of 700uA. The operating temperature ranges from 0℃ to 70℃ at ambient whereas the maximum junction temperature can be up to 150℃.

3. 555 timer:

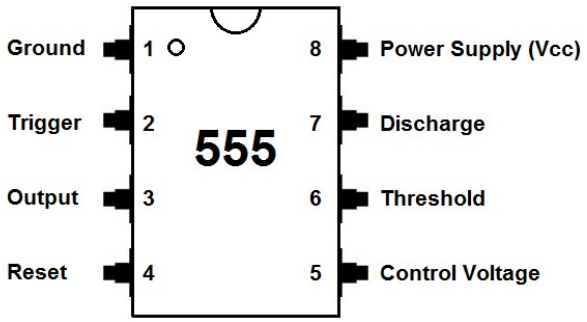

Fig 1.3 Pinout Diagram of 555 Timer

555 timers generally work either of three different mode.

1. Astable mode
2. Monostable mode

3. Bistable mode

We have used it here, as a monostable mode. This configuration consists of one stable and one unstable state. The stable state can be chosen either high or low by the user. If the stable output is set at high (1), the output of the timer is high (1). At the application of an interrupt, the timer output turns low (0). Since the low state is unstable it goes to high (1) automatically after the interrupt passes.

4. 4026 IC :

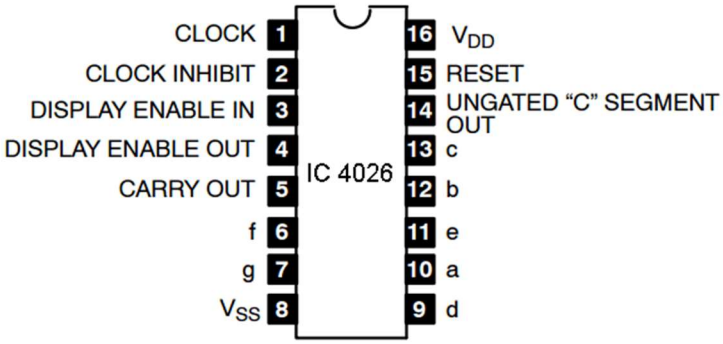

Fig 1.4 Pinout Diagram of 4026 IC

The IC CD4026 is an IC which can perform the function of both a counter and seven-segment Driver. One single IC can be used to count from zero (0) to nine (9) directly on a Common Cathode type seven-segment display. The count can be increased by simply giving a high clock pulse also, more than one digit (0-9) can be created by cascading more than one CD4026 IC. So, if you have a seven-segment (CC) display on which you have to display numbers that are being counted based on some condition then this IC will be a perfect choice.

5. Seven Segment Display (Common Cathode) :

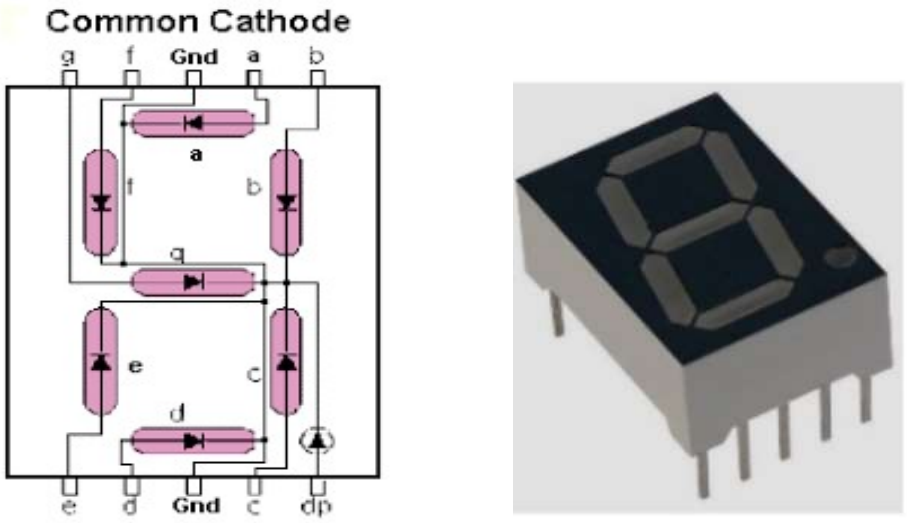

Fig 1.5 Seven Segment Common Cathode Display

The seven-segment display is the most common display device used in many gadgets, and electronic appliances like digital meters, digital clocks, microwave ovens and electric stove, etc. These displays consist of seven segments of light emitting diodes (LEDs) and that is assembled into a structure like numeral 8. Actually seven segment displays contain about 8-segments wherein an extra 8th segment is used to display dot. This segment is useful while displaying non integer number. Seven segments are indicated as A-G and the eighth segment is indicated as H. These segments are arranged in the form of 8 which is shown in the seven-segment display circuit diagram.

6. Basic Components:

➢ Resistors and Variable Resistor: Oppose the flow of electrons and used as current limiting component, and to provide enough voltage difference across the terminals.

- 15 x 220 ohm resistors
- 1K ohm resistor
- 2 x 2.2K ohm resistors
- 2 x 6.8K ohm resistors
- 6 x 10K ohm resistors
- 20K ohm resistor
- 2 x 47K ohm resistors

- 100K ohm resistors
- 2 x 330K ohm resistors
- 10K potentiometer

➢ Capacitors: Stores the charge, and here used as filtering component or charge saver.

- 1 uf capacitor
- 0.1 uf capacitor
- 1000 uf capacitor

➢ LED: emits the light, when current flows through it.

➢ Transistor: Current control active device, here used in switching mode to make AND operation.

- 3 x BC 547 NPN transistors

➢ Push Button Switch: Provides the connection, whenever pushed.

➢ Connecting Wires: Used to connect the component in the circuit.

➢ Battery(9V): Provides constant energy to the circuit.

Working of the Circuit

The project is divided into two modules- one is heart beat detection module and another is heart beat display module. Functionality of the whole module can be represented as below:

Let's first consider finger chip module which consist of IR transmitter and receiver and some resistors. To detect the heart pulse, we will put a finger between the clip. IR transmitter will transmit an infrared light which will pass through the finger and received by the receiver on the other side. The intensity of the received light will decide how much blood flow rate is there inside our body as haemoglobin cells have a property that they can absorb the IR light. So, when heart beats, movement of these cells increases and which leads to the variation in current and further voltage drop across the resistance will vary and we get pulses in the form of an electrical signal.

This received signal is not pure sine wave in nature but kind of triangular type so to proceed this signal further it is required to have pure sine wave. So the next block is Integrator cum filter which will smooth the signal and will give kind of sine wave signal. This signal is given to an amplifier block which will amplify the signal, as the original signal is in mV it will convert it into desired Volt. Now our aim is to have a rectangular signal so that it can be given as a clock to the counter IC. So further after amplifier there is one comparator block which will compare this amplified signal with some appropriate dc value. As a result, we will gate rectangular wave at the output side. There is one potentiometer connected with comparator to adjust the dc value which will be helpful to have an accurate and identical clock pulses.

The other side we want to display heart pulses only for 1 minute so using 555 timer in monostable mode, we have fulfilled this requirement. It will stop the counting after one minute, so we have to restart it using push button to count again. Here both the outputs- one from comparator and one from 555 timer is given as an input to an AND gate which is designed using transistors. Here comparator output will always be changing as heart beats are continuously coming but when timer output will go low means when 1 minute is completed, we have to stop counting. So, using this concept we can control display circuit. Further the comparator output is given to the 4026 counter IC which will count the pulses (heart beats) and will display the counts on the 7segment display connected to it.

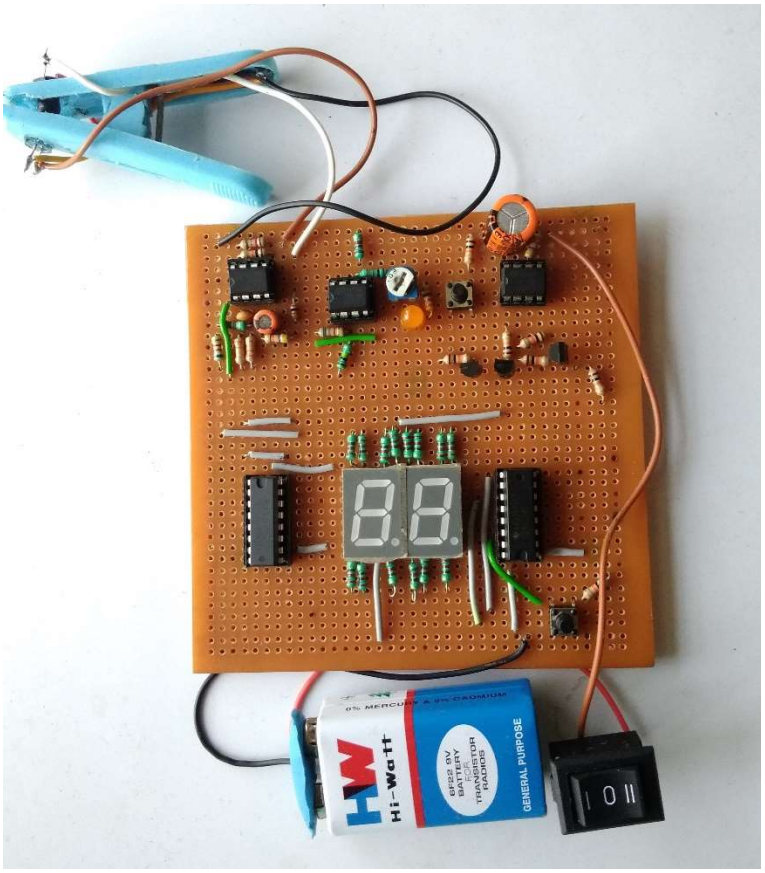

Fig. 1.6 PCB Layout of The Module

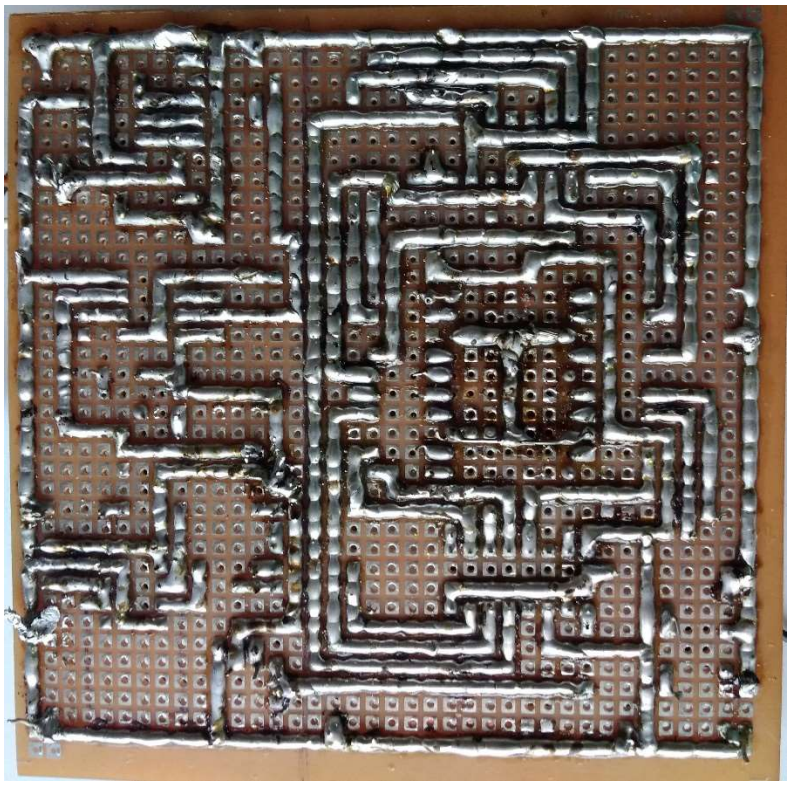

Fig. 1.7 Back Side of PCB Layout

Practical Setup and Troubleshooting

For Practical Setup all we have to do is, just place any finger in between the clip and hold the clip position such that normal pressure is felt on finger. and set the potentiometer knob to get perfect blink of yellow LED, after that just press the button to start timer which will connect the input to counter block, and just wait for one minute to get count of the pulses.

Our main task was to get an electrical signal from the finger clip module because without it we can't go ahead. As an IR transmitter and receiver are too sensitive components that initially we couldn't distinguish between the output and noise. So, we observed their response on digital storage oscilloscope, although we didn't get the desired output. But after study of transmitter we came to know that it radiates IR light in 180 degrees, so we decided to cut the top of the LED so that we can get more intense and focused light beam.

When we have tested the circuit on breadboard, we were not getting exact pulses, when direct sensor output is amplified and given to comparator. But, after studying the problem, we came to know that the waveform coming from the sensor is not the waveform that can be easily amplified because there is a rapid change in signal which cannot directly amplified (limited by Op-Amp parameter slew rate). So first we use a filter to filter out DC component present and then integrator to smoothen the waveform by filtering. After that we got proper desired output waveforms on digital storage oscilloscope.

After that also if we check heart pulses of different person then, we were getting sometimes incorrect output as we were getting very small pulses of output. By analysis we came to know that because of the variation of thickness of blood, for the same voltage reference line of comparator, in case of thicker blood number of detected pulses would be less. So, we decided to put a variable resistor, which can be used to vary reference line whenever it's needed.

Limitations of the Circuit

In accordance to limit the cost of the whole system we have to face some limitations of the system, which are given as follows:

- For abnormal condition, like if a person measure the heart beat after running too fast, the pulses would be too high and the system can't detect proper pulses.
- Also, the sensor designed is an Infrared light sensor, which is too sensitive so that movement of finger also sometimes considered as a pulse and accuracy of pulse decreases.
- From person to person thickness of blood varies, so that the output voltage may be lower so we have to set comparator line at lower voltage level, for which a variable resistor is given in the comparator.

Conclusion

Here, in this project we have designed and implemented a small module named Heart Beat Detection and Measurement System, which will first sense the blood flow rate by variation of received infrared light which is dependent on the haemoglobin cells present in the blood (because haemoglobin absorbs the infrared light). Then this signal is converted into rectangular pulses having beat rate frequency, which can be easily counted by counter ICs and displayed on seven segment display. To limit the count up to sixty seconds the input given to counter block is first logically anded with the output of sixty second timer. And we get the count on the seven-segment display, which is called the BPM (beats per minute) rate.

Applications and Future Work

Heart beats are one of the main reasons for human beings to live on the earth. So, worth of such module described above can be easily understood. For, an unhealthy person it is very much important to check out on his/her health regularly. And for that our designed module is very useful for every person.

Here we have only used the discrete components like resistors, capacitors, led, some basic ICs, and transistors. But the same thing can also be done by using a Microcontroller or an Arduino, which would be a more effective and easier way of operation, But the overall cost of the design would increase. We can further expand this project, by adding a comparator block which can check whether the heart pulses lie in desired range or not, according to the comparison it will indicate the healthiness of heart.

By using Microcontroller, we can add a few more features like display the message on the LCD Display about the current situation of heart, and we can also plot the graph of the pulses similar to the ECG, and it will be surely more preferable because of low cost module than the ECG.

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