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Heart-Rate Monitoring Using PIC16F72

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ABSTRACT

Heart rate measurement indicates the soundness of the human cardio-vascular system. The basic concept on which this project works is dependent on the concept of photopleythysmography (volumetric measurement of an organ .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 .It consist of an infrared LED that transmits an IR signal through fingertip of the subject parts of which is reflected by the blood cells .The reflected signal is detected by a photo diode sensors. The changing blood volume with heart beat results in a train of pulses at the output of the photodiode, the magnitude of which is too small to be detected directly by a micro-controller. Therefore, two – stage high gain ,active low pass filer is designed using Operational amplifier s (OpAmps) to filter and amplify the signal appropriate voltage level so that the pulses can be counted by micro controller .The heart rate is displayed on 3 digit seven segment display . The micro controller used in this project is **PIC16F72**.

Keywords: PIC16F72, Photopleythysmography, Amplifier, Microcontroller, CMOS/Eeprom, Lm7805, Human Cardio-Vascular System

I. INTRODUCTION

Heart rate measurement is one of the very important parameters of the human cardiovascular system. The heart rate of a healthy adult at rest is around 72 beats per minute (bpm). Athletes normally have lower heart rates than less active people. Babies have a much higher heart rate at around 120 bpm, while older children have heart rates at around 90 bpm. The heart rate rises gradually during exercises and returns slowly to the rest value after exercise. The rate when the pulse returns to normal is an indication of the fitness of the person. Lower than normal heart rates are usually an indication of a condition known as bradycardia, while higher than normal heart rates are known as tachycardia.

Heart rate is simply and traditionally measured by placing the thumb over the subject's arterial pulsation, and feeling, timing and counting the pulses usually in a 15 second period. Heart rate (bpm) of the subject is then found by multiplying the obtained number by 4. This method although simple, is not accurate and can give errors when the rate is high.

This project describes a technique of measuring the heart rate through a fingertip using a PIC microcontroller. The photodiode through which heart beat rate is being found is based on Photoplethysmography (it is the procees of optically estimating the volumetric measurement of organ). While the heart is beating, it is actually pumping blood throughout the body, and that makes the blood volume inside the finger artery to change too. This fluctuation of blood can be detected through an optical sensing mechanism placed around the fingertip. The signal can be amplified further for the microcontroller to count the rate of fluctuation, which is actually the heart rate.

The device has the advantage that it is microcontroller based and thus can be programmed to display various quantities, such as the average, maximum and minimum rates over a period of time and so on. Another advantage of such a design is that it can be expanded and can easily be connected to a recording device or a PC to collect and analyze the data for over a period of time.

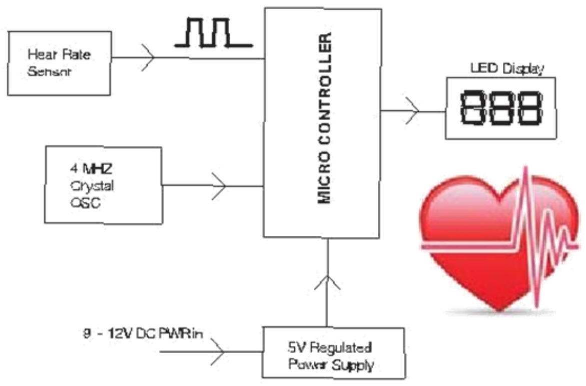

Figure 1. System

COMPONENT DESCRIPTION:

Micro-Controller (PIC16F72):

- High performance RISC CPU.
- Operating speed: DC - 20 MHz clock input DC - 200 ns instruction cycle.
- 4K-ROM
- 128 bytes RAM
- Low power, high speed CMOS/EEPROM technology fully static design.
- High sink/source current : 25mA

Figure 2. EEPROM

Seven Segment Display:

- Composed of seven LED segments.
- Combined to produce simplified representations of the Hindu-Arabic numerals and A to G alphabets can also be seen.
- Common anode display type is being used.

Heart Rate Sensor Module:

- Heart beat sensor is designed to give digital output of heat beat when a finger is placed on it.
- When the heart beat detector is working, the beat LED flashes in unison with each heartbeat. This digital output can be connected to microcontroller directly to measure the Beats Per Minute (BPM) rate.
- It works on the principle of light modulation by blood flow through finger at each pulse.

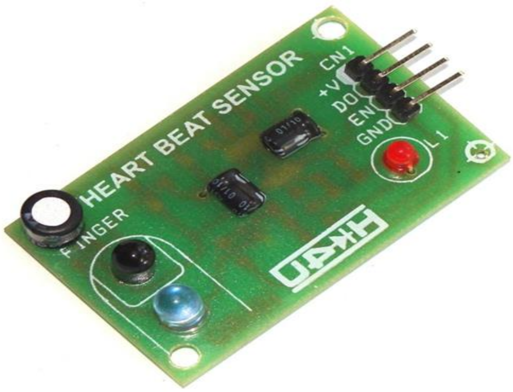

Figure 3. Heart beat sensor circuit

LM7805 (3 terminal voltage regulator):

- This is used to make the stable voltage of +5V for circuits.
- The LM7805 is three terminal positive regulators are available in the TO-220 - package and with several fixed output voltages, making them useful in a wide range of applications.
- Employs internal current limiting, thermal shut down and safe operating area protection, making itessentially indestructible.

Figure 4. LM7805

II. METHODS AND MATERIAL

The circuit used in this kit uses only one IC – the PIC16F72. It is pre-programmed with software to provide all the timing functions.. The display unit comprises of a 3-digit, common anode, seven segment module that is driven using multiplexing technique. The

segments “a” – “g” are driven through PORTB pins RB0-RB7, respectively. The unit’s, ten’s and hundred’s digits are multiplexed with RC5, RC6, and RC7 port pins. A tact switchs input is connected to RC2 and RC3 pin. This is to start/stop the heart rate measurement. Once the start button is pressed, the microcontroller Enable the Heart rate Sensor Module unit for 15 sec. During this interval, the number of pulses arriving at the T0CKI input is counted. The microcontroller runs at 4.0 MHz using an external crystal.The output from the heart beat Sensor goes to the T0CKI (RA4 – Pin 6) input of PIC MCU. Once the start the heart pulse counting Process, the microcontroller enable the Hear rate Sensor Module unit for 15 sec. During this interval, the number of pulses arriving at the T0CKI input is counted. The actual heart rate would be 4 times the count value, and the resolution of measurement would be 4. The sensor module is not activated continuously. Instead, it is turned on for 15 sec only.A 4 MHz crystal provides accurate timing and an easily divisible clock source for the internal hardware timers. This high frequency clock source is used to control the sequencing of CPU instruction. When interfacing more than one 7 -seg display the segment's (A to G) of all displays are connected together whereas their ANODE are switched ON one after another. . Multiplexing is a technique where each display is “active” for a short period of time
To Stat/Stop and Reset Heart rate Monitor operate by Press to On Switches. it’s interface to micro controller port, RC2 (pin no-13) and RC3 (pin no-14). Port Pin RC2 and RC3 is pulled up via 10K resistors (R12 and 13).Power is derived initially from standard 9V DC battery. This is fed to diode D2, the output of which is then filtered using 1000uf (C3) electrolytic capacitor and fed to U2(voltage regulator) +5V output powers the complete circuit. Diode D2 provides reverse polarity protection on the power input.

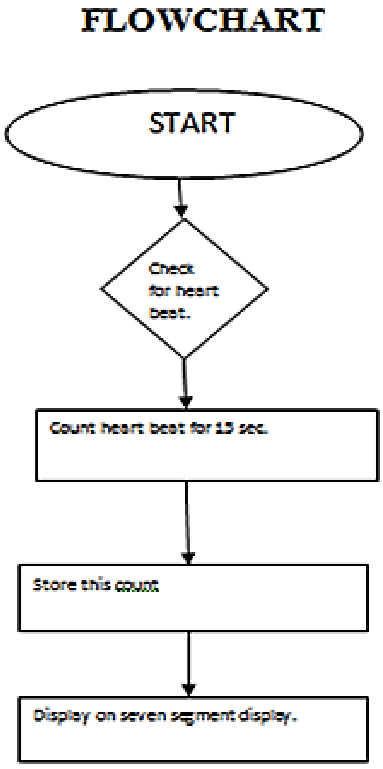

Figure 5. Flowchart

III. RESULTS AND DISCUSSION

Since it is portable device it can be easily available**.** Can be used to display various quantities, such as the average, maximum and minimum rates over a period of time and so on. It can be expanded and can easily be connected to a recording device or a PC to collect and analyze the data for over a period of time

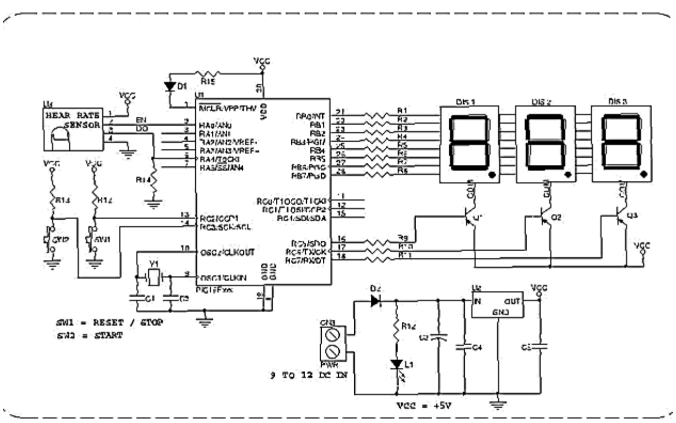

Figure 6. Circuit

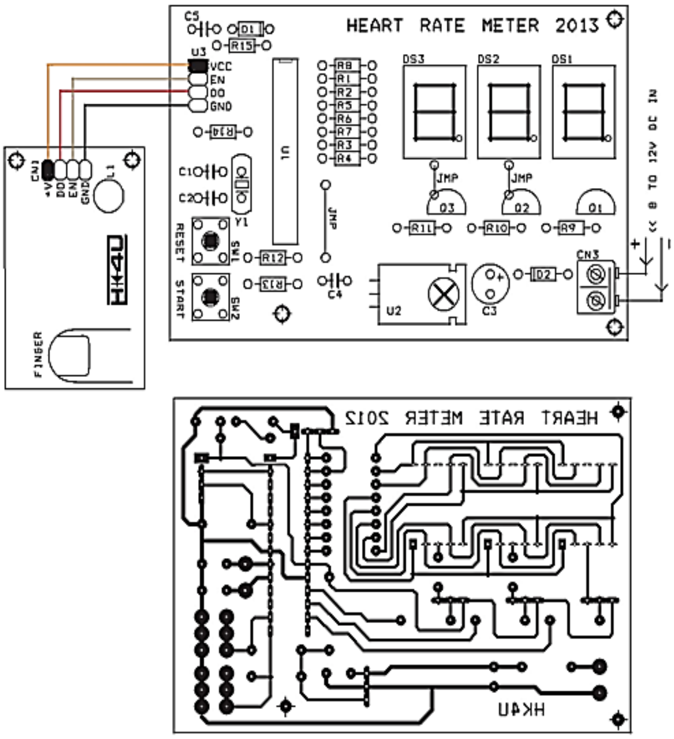

Figure 7. PCB Design

Figure 8. Implementation

IV. CONCLUSION

- Sound can be added to the device so that a sound is output each time a pulse is received.
- The maximum and minimum heart rates over a period of time can be displayed.
- Serial output can be attached to the device so that the heart rates can be sent to a PC for further online or offline analysis.

V. ACKNOWLEDGEMENT

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