Heartbeat Rate Monitoring System by Pulse Technique Using HB Sensor

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***Abstract*- This paper presents a prototype for the monitoring of Heartbeat rate. A Heart Beat (HB) sensor is being developed for acquainting the input signals using Light Dependent Resistance (LDR) and Light Emitting Diode (LED). It senses the heartbeat of a person and converts it in the form of electrical signals and pulses. The signals are amplified using a signal conditioning circuit and processed by a controller. The frequency of the signal depends on the heartbeat rate, this lays down the basic principle of the HB measuring system. The user needs to put his/her finger in the HB sensor for acquiring the input signals. Although number of methods has been proposed and implemented in this domain yet the proposed system in this text provides a simpler and robust method for measuring the heart rate. The proposed system is being implemented on the hardware and also simulated in Proteus ISIS 7.10 to prove its effectiveness. The proposed model is much more precise, straightforward and cheaper than other heartbeat rate measuring systems. This work has tried to make an easy and stout system for the monitoring of heart beat.**

Keywords— ***Heartbeat, prototype, pulse measurements, Light Emitting Diode, frequency.***

I. INTRODUCTION

In today's fast moving world, human body is getting more prone to heart related diseases and there is an increase in number of deaths due to heart diseases. So this paper describes the design and development of a heart rate monitoring system which tells the heart beat rate of the person. If the exact heartbeat of the person is known then the problems related to heart can be detected and cured. This system has been developed by other researchers also but they followed different algorithms. For example, Yang proposed a ring type heart rate sensor and developed some prototypes [1],[2]. After that, Jeff Bachiochi has designed the technique to mimic the hardware peak detector [3],[4]. In our heartbeat rate monitoring system, the heartbeat of the human is measured and displayed on the display device like alphanumeric LCD. Development of HB sensor is the most important part in this project as it senses the heart beat and converts it into pulses and this paper developed that HB sensor using an operational amplifier LM324, a Bright LED and LDR. We have to put our finger on the sensor for measurement of the heart rate. The main logic behind the HB sensor is that when the finger is kept in between light beam and LDR then the intensity of light falling on the LDR varies due to the movement of the blood in the human body. These variations are amplified and further converted in the form of pulses. This HB sensor mainly converts the heartbeat into the corresponding pulses then we can measure these pulses using counter and timer of microcontroller. After measuring the heart rate, it will be displayed on the LCD display. The LCD used in our project is 16*2 alphanumeric LCD. Normally when the ECG test of the patient is done then number of electrodes needs to be connected to the body of the patient to obtain the ECG graph on the CRO. In our algorithm there is no need of connecting number of electrodes and heartbeat rate can be displayed simply. We made this system with minimum possible hardware and this costs us very less, about $4. So this system is very affordable and it is easy to implement by electronics hobbyists or students because of its simple design.

II. DEVELOPMENT OF HB SENSOR

It is very important to know the designing and development of the HB sensor. Firstly we would like to explain the working principle of HB sensor. The HB sensor reads the relative change in blood volume. The HB sensor is based on the principle of absorption of oxygenated and deoxygenated hemoglobin. We have used red light as light source because oxygenated hemoglobin allows more red light to pass through and deoxygenated hemoglobin absorbs more red light. This HB sensor mainly consists of LM324 which is quad op-amp [5], LDR (light dependent resistor), Ultra Bright LED, fixed resistors and capacitors and variable resistance for varying the sensitivity of the sensor. Firstly the LED and LDR are placed opposite to each other and whole light of LED falls on the LDR. Now the patient needs to

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place the finger in between LED and LDR and due to blood flow in the finger of the patient, the intensity of the light falling on the LDR varies with the blood flow. We have used two op-amps in cascade and general circuit diagram of sensor is shown in figure 1 where R1 is 10KΩ fixed resistor, R2 is 47KΩ fixed resistor, R3 is 1KΩ fixed resistor, R4 is 100KΩ fixed resistor, C1 is 1uF fixed capacitor, VR1 is 10KΩ variable resistor, VR2 is 10KΩ variable resistor, AMP1 and AMP2 are LM324. In this VR1 and VR2 are used to vary the sensitivity of the sensor. We have used LM324 as operational amplifier and it contained four op amps but other op-amp like LM358 or LM741 op-amp can be used.

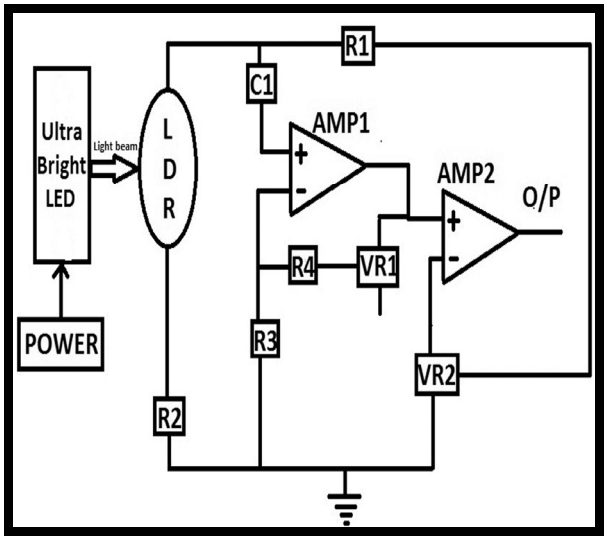

Figure1. General Circuit diagram of Sensor

III. Simulational Result of HB Sensor

We have developed this sensor in the simulation software Proteus ISIS 7.10 by Lab center electronics. Proteus is very popular software for simulation results due to its simplicity and ease of use [6]. The circuit diagram of the HB sensor developed in the Proteus is shown in figure 2.

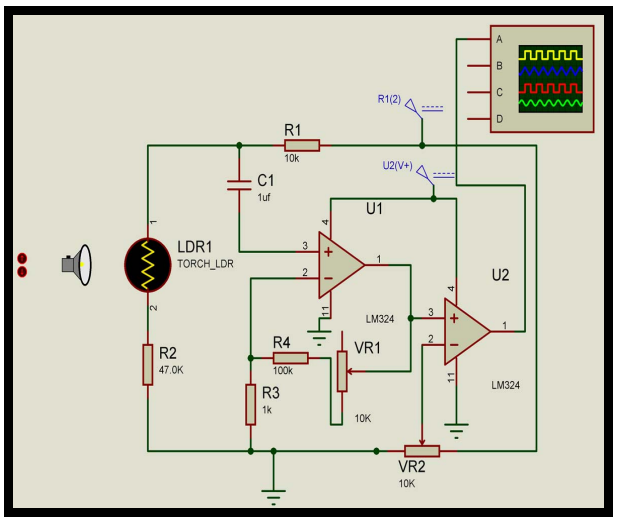

Figure 2. Circuit diagram of Sensor in Proteus

In Proteus, we have used torch as light source and light directly falls on the LDR. The remaining circuit is same as figure 1 except the oscilloscope is connected at the o/p to observe the o/p waveform as shown in figure 2. It is not possible to vary the light falling on LDR using human finger in the simulation so we simply vary the distance between the light source and LDR at different time intervals for varying the intensity of light. We have seen the corresponding output on the digital oscilloscope of Proteus. Different waveforms are observed on the digital oscilloscope in the simulation shown in figure 3 and figure 4. When the heartbeat is slow then the light falling on the LDR will vary slowly and frequency of pulses will be low as shown in figure 3. When the heartbeat is fast then the intensity of light falling on the LDR will vary faster and frequency of pulses will be high as shown in figure 4. So by this method, we have simulated the result of HB sensor.

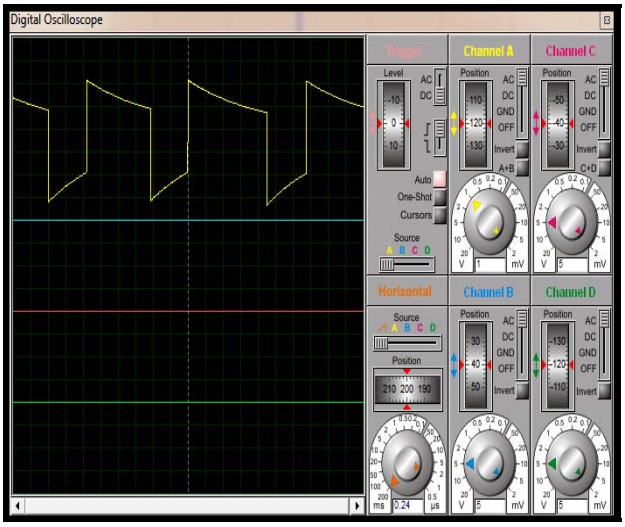

Figure 3. Simulation of HB sensor when variation in intensity of light is slower

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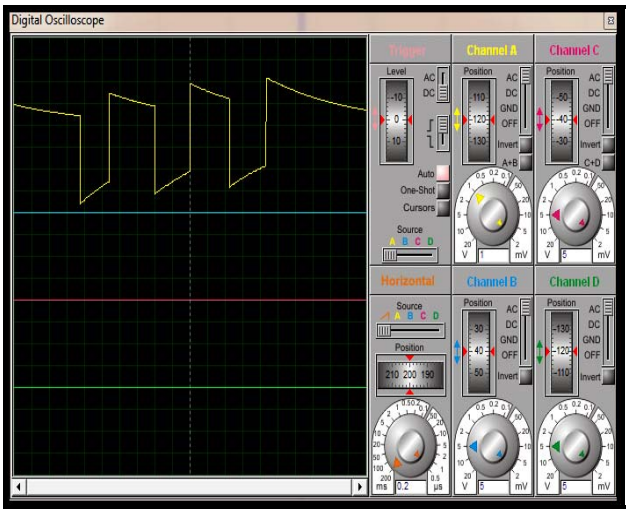

Figure 4. Simulation of the sensor when variation in intensity of light is faster

IV. Simulation Result of Microcontroller and LCD Section

We have used AT89S52 microcontroller for measuring the pulses in this system. AT89S52 is an 8 bit microcontroller developed by Atmel Corporation [7]. After the formation of heartbeat rate into pulses by the use of HB sensor, we need to measure these pulses and to display it. It is very important to have accurate measurement because the heartbeat can be measured accurately only if the measuring technique is good. So we have used the timer of microcontroller to measure the width of the pulses as well as we have used the counter of microcontroller to measure the number of pulses in a specified time. After this measurement, we have used 16*2 alphanumeric LCD for displaying the heartbeat rate. The system will not respond immediately and the patient needs to keep his finger in the sensor for 5 seconds so that the measurement may be accurate. We have done the programming in Embedded C language using Micro C pro for 8051 compiler [8]. This compiler has internal libraries which provide ease to the user. Moreover the user can create own libraries in it. In this simulation we have given different pulses to the microcontroller by manual pulses to P1.0 and then P1.1 sends the signal to P3.4 (T0) for measurement of pulses as shown in figure 5.

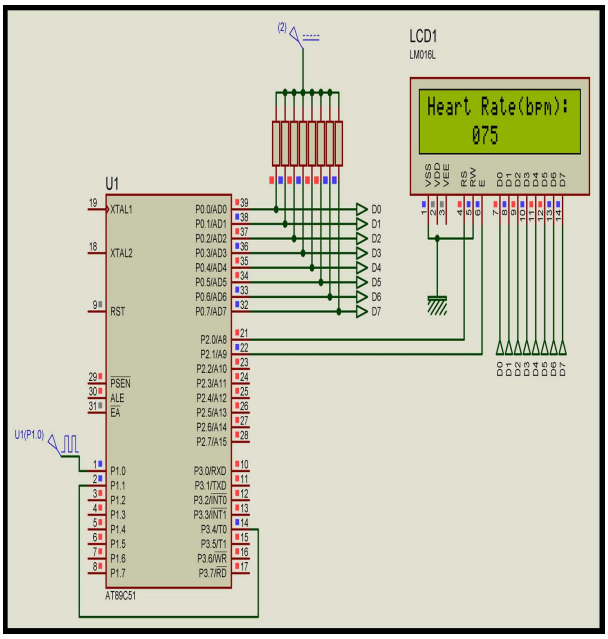

Figure 5. Simulation result of the measuring and display section on Proteus

In this when the pulse is started then timer of microcontroller is started and the duration of pulse is measured. Number of pulses is counted up to certain time by the counter of microcontroller. After this the same reading is multiplied number of times to make it heartbeat rate of one minute. If the finger is placed for more time then the reading becomes more accurate but we have set the minimum time of keeping finger in the HB sensor is 5 seconds. In this system we have used AT89S52 but other microcontrollers like PIC16F676, ATmega16 can be implemented.

V. Hardware Implementation of Complete System

It is very important to observe hardware results for implementation it in the real world so hardware implementation of this system is done and is shown in figure 6. We use ultra-bright LED as light source in the hardware because of its high light intensity reliability and low cost. We have implemented the circuit of sensor on the general purpose PCB.

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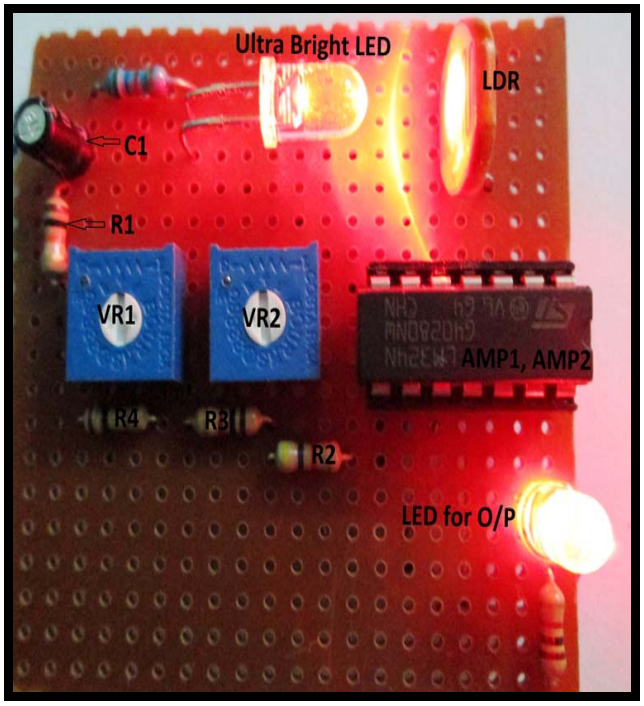

Figure 6. Hardware implementation of HB sensor

As shown in figure 6 the ultra-bright LED is placed in such a manner that complete light falls on the LDR. There is some little space left between LED and LDR for proper placement of finger of human being. The LED in the lower portion of figure 6 is for observing the output and the same output is given to the microcontroller. As shown in figure 6 when finger is not inserted in the HB sensor then o/p remains constant i.e. high. When finger is placed in the HB sensor it starts giving the ON/OFF pulses at the output due to oxygenated and deoxygenated hemoglobin. In this system, the ultra-bright LED of color is used because oxygenated hemoglobin allows red light to pass while deoxygenated hemoglobin absorbs more red light to pass. So by this way the light falling on LDR varied which results in the pulses at output of HB Sensor. These pulses can be easily measured by microcontroller. Output of HB sensor during the deoxygenated hemoglobin in blood is shown in figure 7 and output during deoxygenated hemoglobin in blood is shown in figure 8.

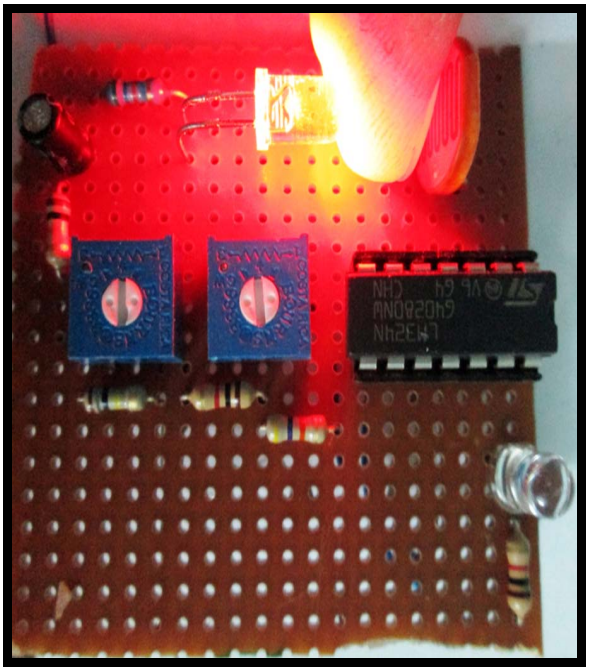

Figure 7. Output of HB Sensor during deoxygenated hemoglobin in blood

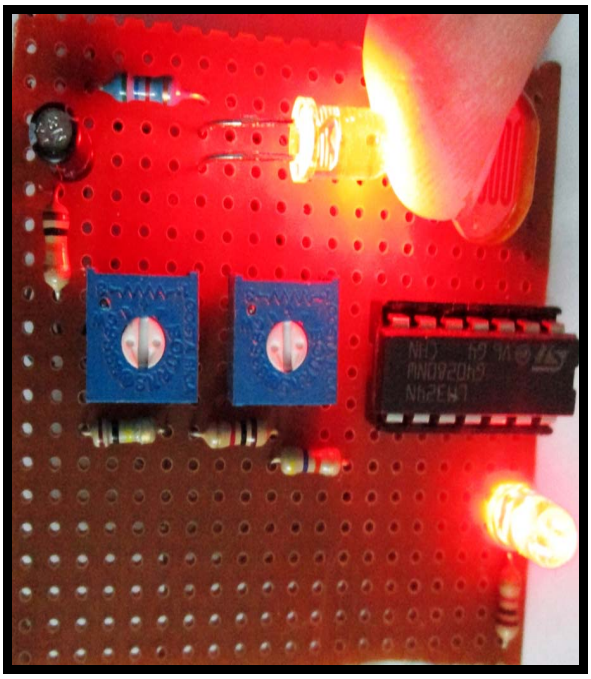

Figure 8. Output of HB Sensor during oxygenated hemoglobin in blood

The hardware implementation of display and measuring section is shown in figure 9. In the hardware implementation of the measuring and display section, we have used AT89S52 microcontroller interfaced with Alphanumeric LCD (16*2). The hardware implementation of display and measuring section is shown in figure 9. Although we have implemented hardware on the general PCB but PCB can be designed and

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implemented for the compact size.

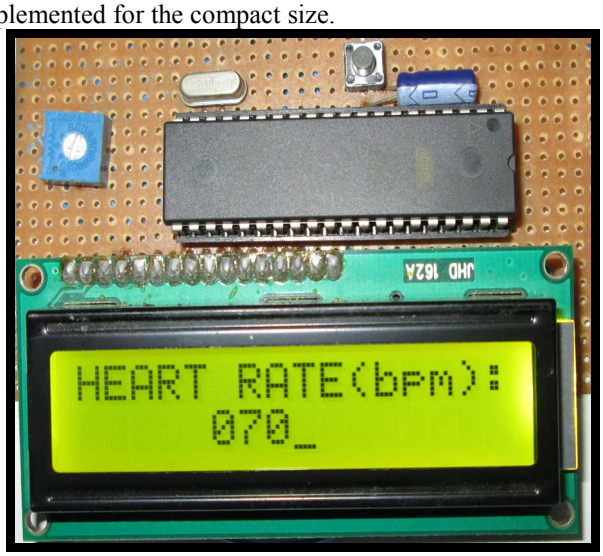

Figure 9. Hardware implementation of measuring and display section

VI. ADVANTAGES

This system is mainly used for heartbeat measurement of human beings. There is no need of connecting number of electrodes to the body as in case of ECG and heartbeat can be simply measured by finger. It is not necessary to use it only in hospitals or clinics but the user can use it anywhere i.e. home, office, gym or any other place. This system is very cheap i.e. about $4 so it is quite affordable. Beside the benefits for users, engineers and researchers can develop this system easily due to its simplicity. Although we have used 40 pin 8 bit AT89S52 microcontroller in this but researchers can use other microcontrollers like PIC16F676 which are only 14 pin 8 bit microcontroller [9] so the size can be reduced.

VII. CONCLUSION

In this paper we have shown the simulation results and hardware result of "Heartbeat Rate Monitoring system by Pulse Technique using HB sensor". We have described how to measure the heartbeat rate of human beings accurately using the simplest and cheapest way. Moreover, we have given the circuit diagram of the complete system so that the engineering students, hobbyists and young researchers can develop this system at their own. We have used the Proteus software for simulation purpose which is most popular in the engineering students and hobbyists. The hardware used in this system is quite simple and cheap in price.

VIII. FUTURE RESEARCH

Although this system is good enough in the biomedical but advancement is always necessary in any kind of system from time to time. This system can be improved by interfacing the wireless modules like GSM module, RF module or ZigBee in which the information can also be transmitted to any distant place. Besides this, system can be interfaced with computer for display of the heart rate on the computer. At present we are developing complete health system which will describe the heartbeat of human beings, height, weight, body temperature and balance diet according to the user. We will complete this health system soon. So it will be another improved version of this system.

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