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Heart Rate and Temperature Monitoring System Using ARM 7 and LabVIEW Software

[1]Besta Shashidhar, [2]G Anand
[1]PG Scholar, Dept of ECE, J.B. Institute of Engineering and Technology, India
[2]Assistant Professor, Dept of ECE, J.B Institute of Engineering and Technology, India

***Abstract*:** In the Present Work, the heart rate, temperature sensors and LPC2148 Microcontroller Integrated Chip plays the main role. This is embedded project in this Microcontroller Integrated Chip and interfaced to all the peripherals. The timer program is inside the Microcontroller IC to maintain all the functions as per the scheduled time. Heart rate Sensor Device Emits and/or detects infrared radiation to sense a particular phase in the environment. The design of a simple, low-cost microcontroller based heart rate measuring device with LCD output. Heart rate of the subject is measured from the finger using optical sensors and the rate is then averaged and displayed on a text based LCD. Generally, thermal radiation is emitted by all the objects in the infrared spectrum. The infrared sensor detects this type of radiation which is not visible to human eye. Temperature sensor is device which senses variations in human body temperature across it. This result can be seen in LabVIEW software.

Keywords: heart rate sensor; temperature sensor; LPC2148; microcontroller IC; labview

1. INTRODUCTION

A heart rate, temperature monitor is a personal monitoring device that allows a subject to measure their heart rate, body temperature in real time or record their heart rate for later study. Early models consisted of a monitoring box with a set of electrode leads that attached to the chest. The heart rate of a healthy adult [6] at rest is around 72 Beats per Minute (BPM) & Babies at around 120 BPM, while older children have heart rates at around 90 BPM. The heart rate rises gradually during exercises [7] 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 is known as Tachycardia.

Heart rate is simply measured by placing the thumb over the subject's arterial pulsation, and feeling, timing and counting the pulses usually in a five second period. Heart rate (BPM) of the subject is then found by multiplying the obtained number by 12. This method although simple, is not accurate and can give errors when the rate is high. More sophisticated methods to measure the heart rate utilize electronic techniques. Electrocardiogram (ECG) is [8, 9] one of frequently used method for measuring the heart rate. But it is an expensive device. Low-cost devices in the form of wrist watches [10, 11] are also available for the instantaneous measurement of the heart rate. Such devices can give accurate measurements but their cost is usually in excess of several hundred dollars, making them uneconomical. So this heart rate monitor with a temperature sensor is definitely a useful instrument in knowing the pulse and the temperature of the subject or the patient.

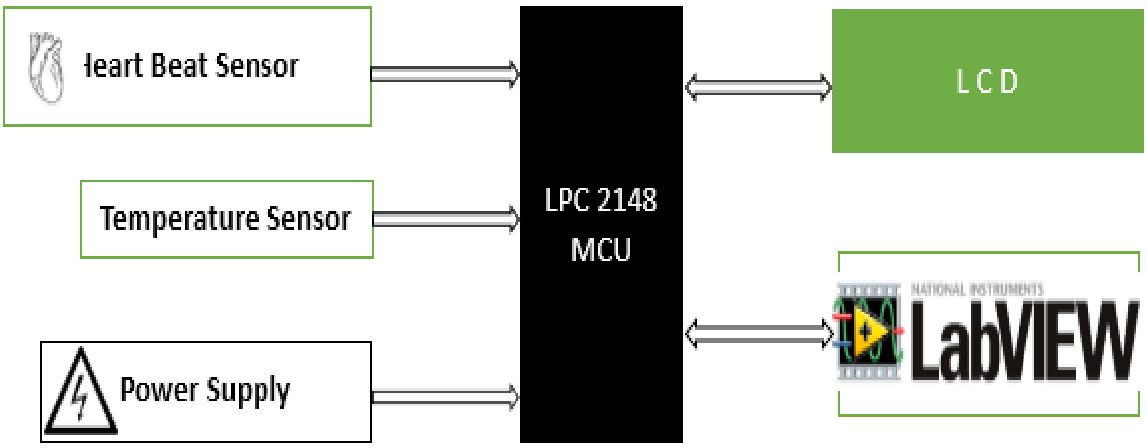

Fig. 1.1 Block Diagram of Heart Rate and Temperature Monitoring System Using ARM 7 and Labview Software

This paper describes the design of a very low-cost device which measures the heart rate of the subject by clipping sensors on one of the fingers and then displaying the result on a text based LCD and prototyping with FPGA technology.in Labview. 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 analyse the data for over a period of time. The building cost of the proposed device is around $20. One similar basic device from Cosy Communications [12] with no extension capabilities costs around $100.

1.1 The Importance of Heart

The heart acts as a pump that circulates oxygen and nutrient carrying blood around the body in order to keep it functioning. When the body is exerted the rate at which the heart beats will vary proportional to the amount of effort being exerted. By detecting the voltage created by the beating of the heart, its rate can be easily observed and used for a number of health purposes. Heart pounds to pump oxygen-rich blood to your muscles and to carry cell waste products away from your muscles. The heart rate gives a good indication during exercise routines of how effective that routine is improving your health.

1.2 The Importance of Body Temperature

Individual body temperature [25] depends upon the age, exertion, infection, sex, time of day, and reproductive status of the subject, the place in the body at which the measurement is made, the time of day, the subject's state of consciousness (waking or sleeping), activity level, and emotional state. The Body temperature Hypothermia, Normal, Fever, Hyperthermia, Hyperpyrexia Despite these factors, typical values are well established: axillary (under arm): 36.5 °C (97.7 °F), oral (under the tongue): 36.8 °C (98.2 °F).

2. SUGGESTED METHODS

2.1 System Description

Current technology consists of ECG Machine and optical devices. The ECG Machine is a method provides a bulky strap around one's chest. The optical method does not require the strap and can be used more conveniently than the electrical method. There are many constraints in producing a heart monitor. First, the technology used to measure the pulse has to be determined. A cost efficient way of measuring the pulse is the combination of a led and photo-sensor.

2.1 ECG Method

The chest strap of a heart rate monitor uses electrodes to monitor the electric volts that occur when your heart beats. The receiver detects this information from the electrodes via radio signal from the chest strap. The receiver, then, uses this information to determine your heart rate [1]. Some monitors also include a "coded signal" which uses a special code in the radio signal, so that the receiver does not receive radio signals from other nearby transmitters. This is not always a huge problem, but can be annoying or corrupt your data. This method has several disadvantages like inaccurate results hectic wired connections over the body etc.

2.2 Optical Method

Optical technique exploits the fact that tiny subcutaneous blood vessels (capillaries) in any patch of skin (fingertip, ear lobe, etc.) furnished with a good blood supply, alternately expand and contract in time with the heartbeat. An ordinary infrared LED/phototransistor pair can sense this rhythmic change as small but detectable variations in skin contrast. This method uses both transmittance and reflectance principles. It is a non-invasive method of finding heart rate i.e. no attachments or insertions on the body. It is precise and cost effective.

2.3 Circuit Explanation

The full circuit has been constructed in three steps: external biasing circuit, first stage signal conditioning circuit, and second stage signal conditioning circuit [4]. In this paper the circuit has been integrated with an LPC2148 and Labview software.

2.4 Signal Conditioning Circuit

The reflected IR signal detected by the photo diode is fed to a signal conditioning circuit that filters the unwanted signals and boost the desired pulse signal. The circuit diagrams below shows the IR LED (D1) and the photo diode (D2). The cut-off frequencies of both the filters are set to about 12 Hz, and so it can measure the pulse rate up to 3.3*60 = 200 bpm. The gain of each filter is about 100, which gives the total 2-stage amplification of 10000. This is good enough to convert the weak pulsating signal into a Heart pulse. At the output is connected a LED and Buzzer that will blink with heart beat buzzes alert if patient is in critical condition. The output of the sensor is sent to ARM port for monitoring and counting purpose.

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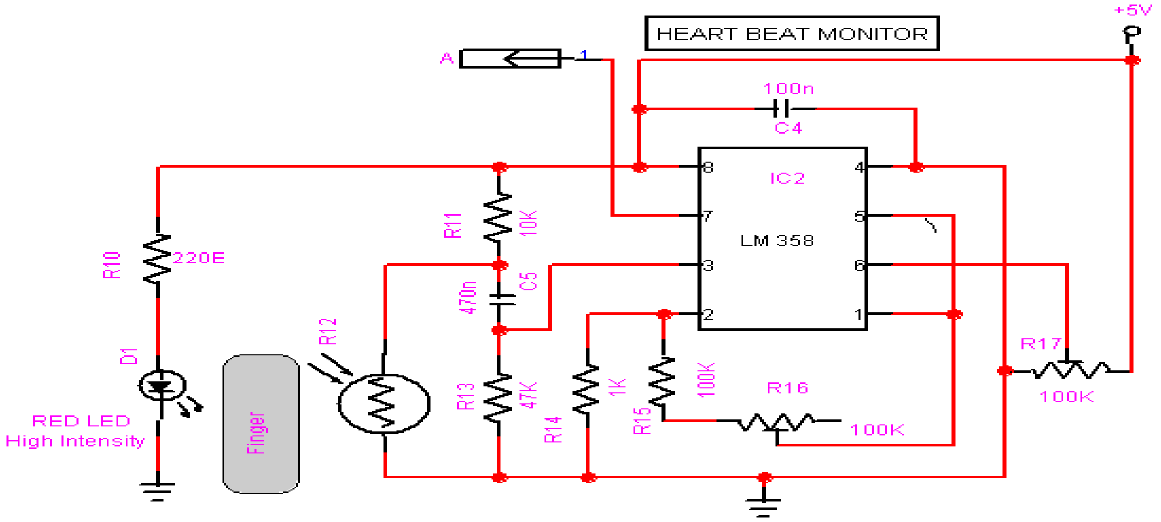

Fig. 2.1 Circuit Diagram of Sensor

2.4 IR Transmitter

An infrared emitter is an LED made from gallium arsenide, which emits near-infrared energy at about 880nm. The infrared phototransistor acts as a transistor with the base voltage determined by the amount of light hitting the transistor. Hence it acts as a variable current source. Greater amount of IR light cause greater currents to flow through the collector-emitter leads. As shown in the diagram below, the phototransistor is wired in a similar configuration to the voltage divider. The variable current traveling through the resistor causes a voltage drop in the pull-up resistor. This voltage is measured as the output of the device.

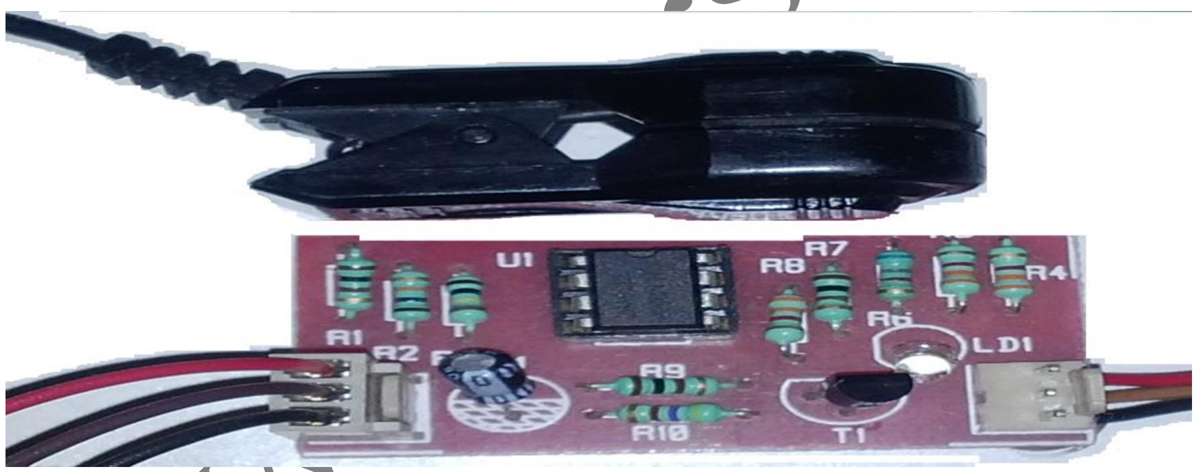

Fig. 2.2 Connection of IR Sensor

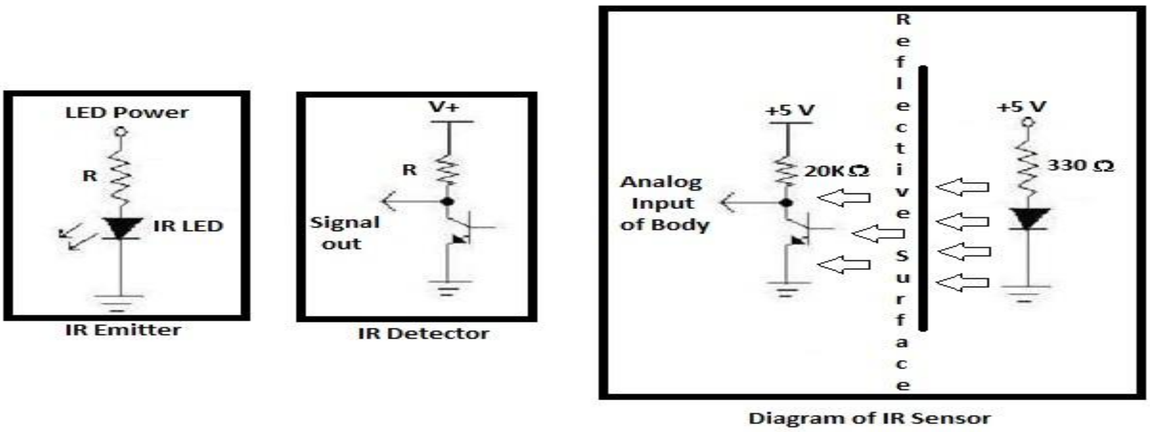

Fig. 2.3 Working of IR Sensor

2.5 Infrared Detector

Phototransistors also consist of a photodiode with internal gain. A phototransistor is in essence nothing more than a bipolar transistor that is encased in a transparent case so that light can reach the base-collector junction. The electrons that are generated by photons in the base-collector junction are injected into the base, and this photodiode current is amplified by the transistor's current gain.

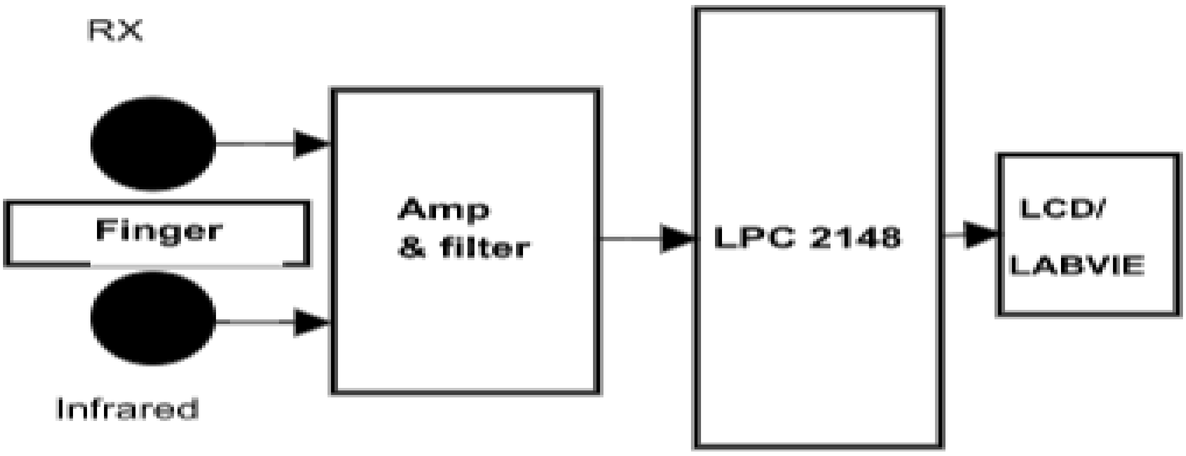

Fig. 2.4 Block Diagram of the Measuring Device

Fig. 2.5 Heartbeat Sensor Device

Table-2.1 Key Features of ARM 7

Package	16/31 Bit Bus
SRAM	40 KB
EEPROM	512 KB
Speed	60 MHz
2, 10 Bit ADC	Provide 14 analog I/P
1, 10 Bit DAC	
2 Timers / Counters	32 Bit
Serial Communication	2 UART
Protocol	1 I2C, SPI, SSP
One RTC, 9 Interrupts	
4 - CCM, 6 PWM, Watchdog Timer	

2.6 ARM 7 Hardware

The ARM 7(LPC 2148) [15] can be powered with an external power supply. ARM 7 is a microcontroller board based on the NXP, External power can come either from an AC-to-DC adapter or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector. The power should be 3.3 V.
which is shown in figure below.

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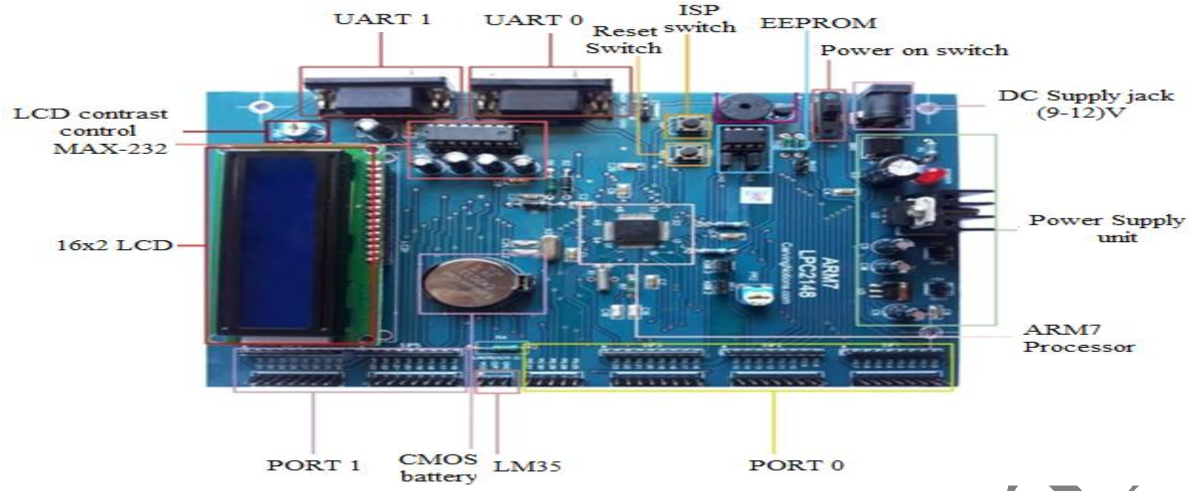

Fig. 2.6 LPC 2148 Hardware

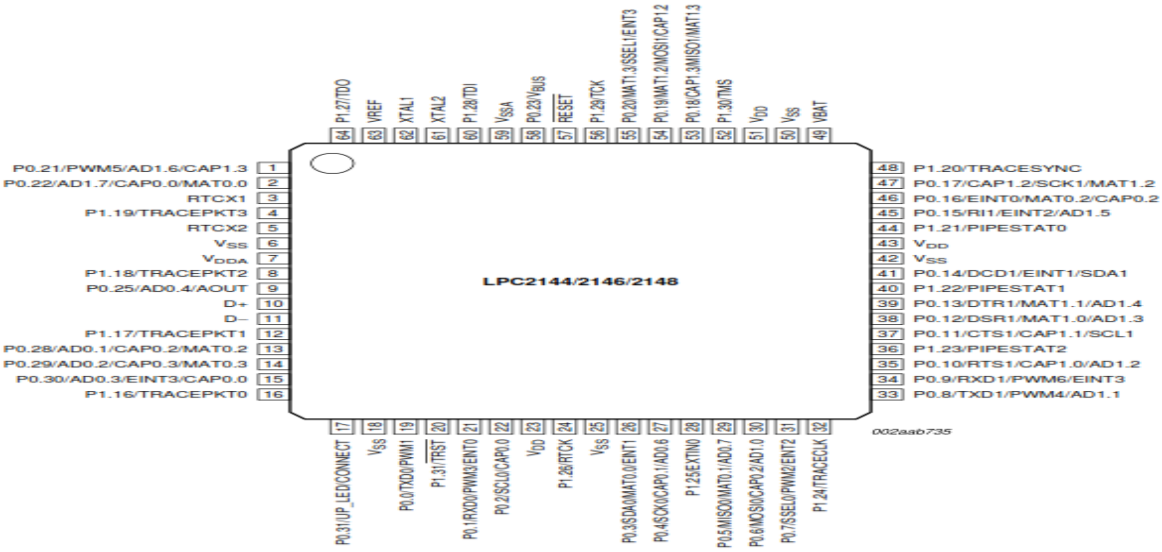

Fig. 2.7 Pin Diagram of LPC 2148

PROGRAMMING

```
// Heartrate and Temperature Monitoring
#include <LPC214X.H>
#include"lcd.h"
#include"uart.h"
#include"adc.h"
#include"inturrupt.h"
int main()
{
int temp_count=0;
PINSEL0=0X00;
PINSEL1=0X00;
IODIR0=0x00000f0;
IODIR1=0xffffffff;
PINSEL1=1<<18|1<<24;
uart_init();
init_timer();
timmer_int();
lcd_init();
IODIR1=0xffffffff;
lcd_cmd(0x80);
lcd_disp("Heart Rate : ");
```

```
lcd_cmd(0xc0);
lcd_disp("TEMP : ");
extint_init1();
while(1)
{
count=0;
timer(5);
lcd_cmd(0x8b);
if
(
(count>=5)&&(count<=7))
count=6;
lcd_int(count*12,3);
lcd_disp("    ");
lcd_cmd(0xcb);
lcd_int(temp_temp,3);
lcd_disp("  ");
}
}
```

3. LABVIEW SOFTWARE

Labview is a system-design platform and development environment for a visual programming language from National Instruments [21]. The graphical language is named "G". Originally released for the Apple Macintosh in 1986, Labview [24] is commonly used for data acquisition, instrument control, and industrial automation on a variety of operating systems (OSs), including Microsoft Windows, various versions of Unix, Linux, and mac OS. The development environment designed specifically to accelerate the productivity of engineers and scientists. With a graphical programming syntax that makes it simple to visualize, create, and code engineering systems, Labview is unmatched in helping you reduce test times, deliver business insights based on collected data, and translate ideas into reality. Labview is designed to interoperate with other software, whether alternative development approaches or open-source platforms, to ensure you can use all of the tools available to you. is an integrated development environment designed specifically for engineers and scientists building measurement and control systems. With a native graphical programming language, built-in IP for data analysis and signal processing, and an open architecture that enables integration of any hardware device and any software approach, Labview is the software you need to build the optimal solution that can meet your custom requirements and solve the challenges at hand. Labview is a flexible programming environment that can help you successfully build your unique application [20] lick. Automating Measurements and Processing Signal Data, Instrument Control, Automating Test and Validation Systems, Designing Embedded Control and Monitoring Systems, Academic Teaching, whether you're taking simple measurements or prototyping with FPGA technology.

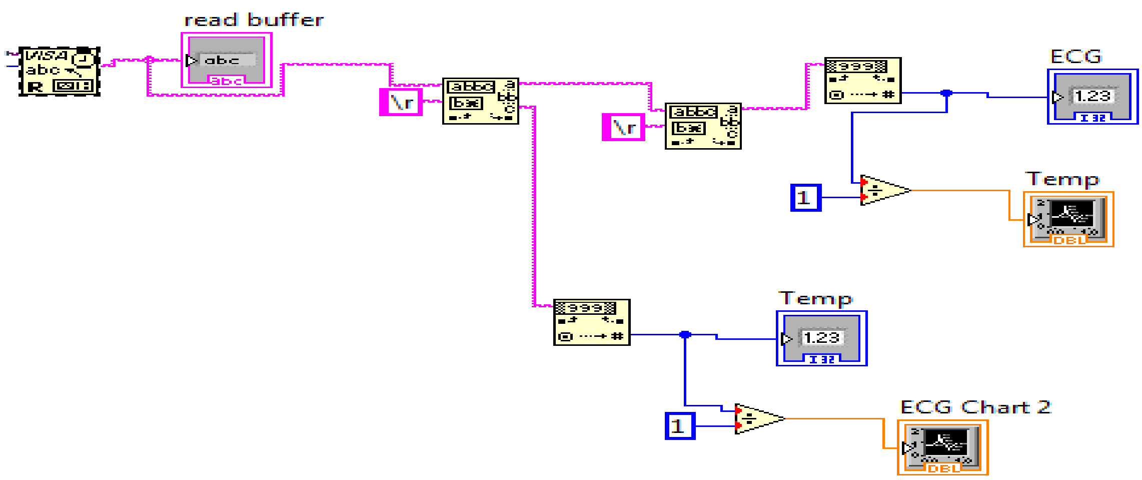

Fig. 3.1Block Diagram it shows ECG, Temperature, and VISA Libraries in Labview Software

3.1 Generation of Heartbeat and Temperature Pulse

The PC application first reads 5 Sec consecutive samples sent by ARM 7. Since the sampling rate was 5ms, it takes 5 sec to read the 5 Sec samples. The range of the samples is computed. If the range is less than 50 counts, the received Heartbeat is very weak, and is considered to be a noise. This could happen when no heartbeat pulse signal is detected through fingertip sensor is faulty or disconnected. The timer function is used for produce time delay 5 Sec. Heartbeat pulses are counted in 5 Sec at Interrupt function. If the range of ADC samples is greater than 50, it is considered as a valid Heartbeat signal and is displayed on the LabVIEW screen. The samples are scaled to infinity for full swing of display Using While loop. The filter is applied to remove the unnecessary high frequency components (usually noise) in the Heartbeat signal.

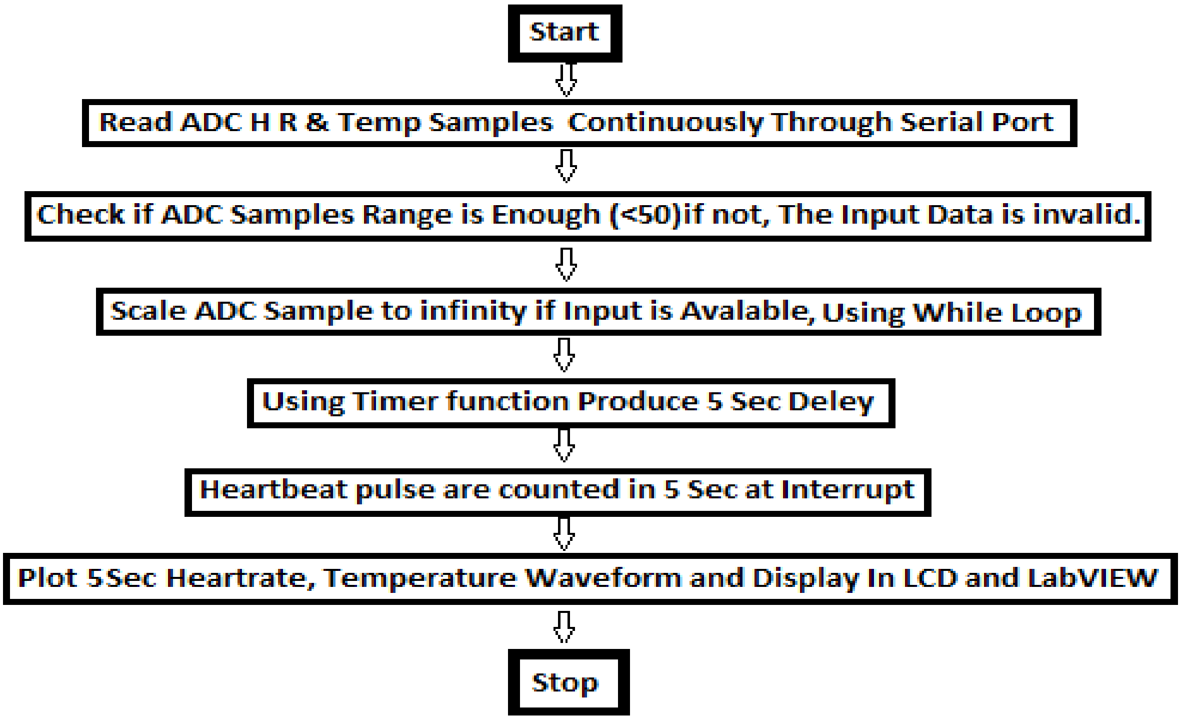

Fig. 3.2 Flow Chart for Computing Pulse Rate

The resulting samples are plotted against time to obtain a clean and smooth Heartbeat pulse waveform. The heart beat rate can be computed by knowing the time period of the Heartbeat Pulse waveform. Two consecutive samples are 5ms apart, time difference between any two peaks can be easily computed from their indices (or sequence numbers). Attach the LM 35 Temperature sensor to body it reads the body temperature [25] and by taking the signal of patient as a reference signal and is displayed on the LabVIEW screen.

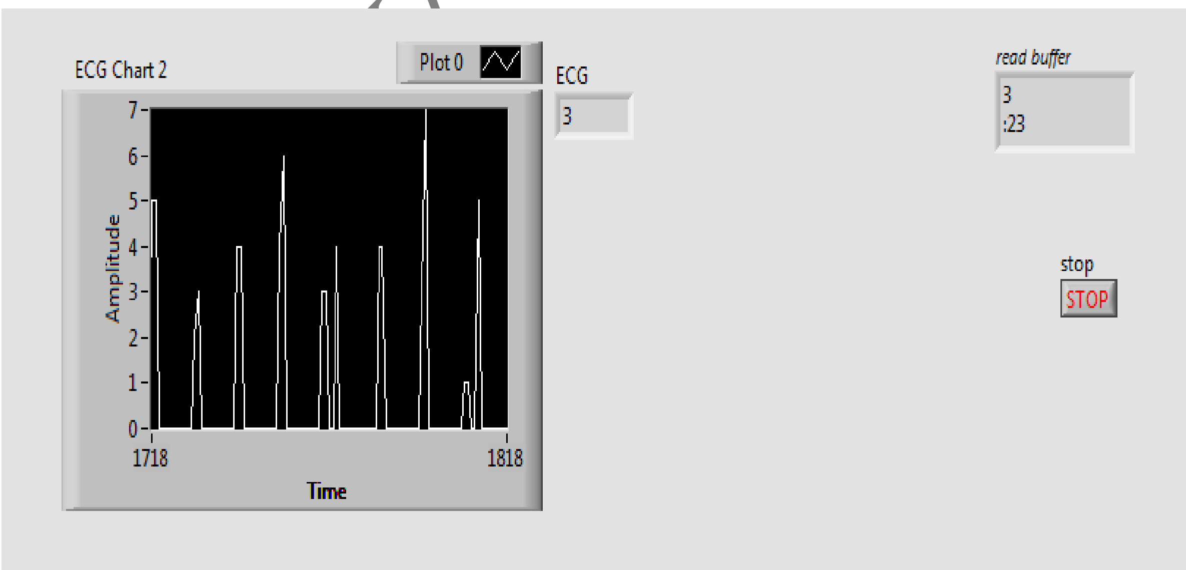

Fig. 3.2 Amplitude and Time Response Wave form of Heart Beat Monitoring (Obtained by connecting a PC Based LabVIEW Software to the Circuit)

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Fig. 3.3 LM 35 Sensor Which Measure the Body Temperature, the Sensor is Placed on the Hand

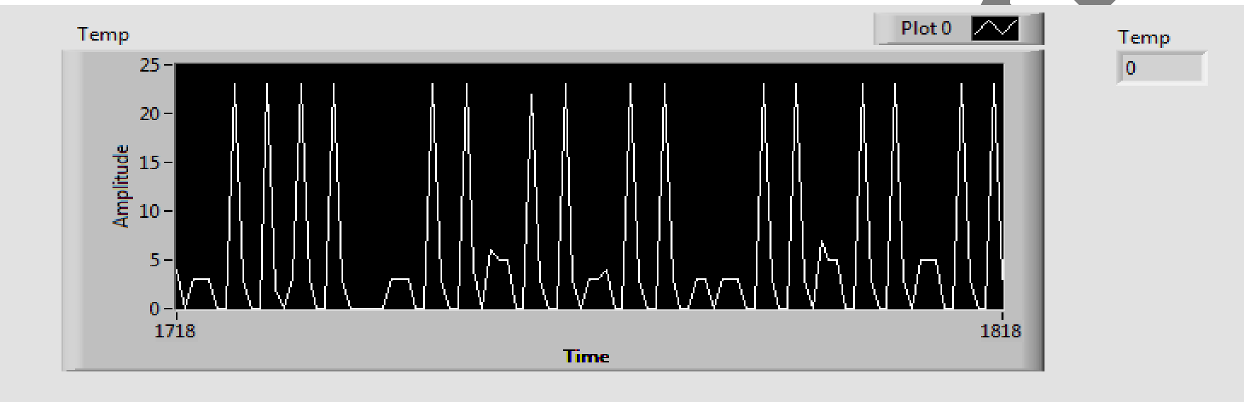

Fig. 3.4 Amplitude and Time Response Wave form Temperature Monitoring (Obtained by connecting a PC Based LabVIEW Software to the Circuit)

CONCLUSION

The design of a low-cost microcontroller based device for measuring the heart pulse rate has been described. The device has the advantage that it can be used by nonprofessional people at home to measure the heart rate easily and safely.

The device can be improved in certain areas as listed

- A graphical LCD can be used to display a graph.
- Sound can be added to the device so that a sound is an 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.
- Warning or abnormalities (such as very high or very low heart rates) can be displayed on the LCD or indicated by a LED or a buzzer.

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