HEART BEAT AND BODY TEMPERATURE MEASUREMENT WITH HEART BEAT AND TEMPERATURE SENSORS

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Abstract

The main purpose of this research work is intended to measure the blood pressure and body temperature of human body. The Arduino microcontroller Uno board, heart beat sensor, Temperature sensor (LM-35) and 20x4 Liquid Crystal Display are responsible for reliable operation. Heart beat sensor senses the blood pressure and temperature sensor senses the temperature of the body for human. The obtainable data from the sensors are sent to the Arduino microcontroller. Arduino microcontroller Uno board is used as main control circuit of this system. The software code for the proposed system is written by using C programming Language. The output is on the Liquid Crystal Display and serial plotter. Blood pressure and body temperature are very important for human body. The developed device is shown acceptable outcomes when compared with other measuring devices.

Keywords: Arduino Uno, Heart Beat Sensor, Temperature sensor (LM-35), 16 x 2 Liquid Crystal Display, C programming language.

Introduction

Health monitoring is important to be checked regularly in order to make sure our body constantly remains in healthy and excellent condition. The heart rate is a basic health sign, beneficial in both medical measurements and home health care. Heart rate simply indicates the soundness of our heart. Heart rate varies according to the demand of muscles to absorb oxygen and excrete carbon dioxide changes such thing happen during exercise or sleep. Normally the heart rate which is calculated for a resting person is about to 70 bpm for adult males and 75 bpm for adult females. A heart rate monitor is simply a device that takes a sample of heartbeats and calculates the heart beats per minute and the information can easily track the current heart condition. Body temperature is also a general indication of body condition. Normal human body temperature is (98.6°F ± 0.7°F) and it varies activity of the

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person as well as place of measurement. Since heart rate and body temperature are the most vital notable indexes of the human health, an affordable device to measure such indexes will be helpful for human health. In general, medical equipment is expensive. In emergency situation, time should not be wasted. Sometimes continuous assessment is also necessary. Therefore, an automated system for continuous measuring of heart rate and body temperature is very much essential. Heartbeat Sensor is an electronic device that is used to measure the heart rate. The normal body temperature is about 37°C or 98.6°F.

In this paper, a machine is designed and constructed. Different mechanical hardware are constructed and tested repeatedly, until an operation prototype is achieved. A machine design consists of an Arduino Uno, buzzer, LM35 temperature sensor, LCD display, pulse sensor and PC. Temperature can be measured by using different types of sensors. The temperature sensor produces analog output voltage which is proportional to the temperature. The temperature sensor requires analog to digital (A/D) converter so that the analog output voltage can be converted to digital form. The output of the temperature sensor is connected to the Arduino Uno. The Arduino Uno processes this data and displays it in LCD. This paper describes the design of a very low-cost remote patient monitoring system which measures heart rate and body temperature of a patient. This device is needed during emergency period or for saving time of both patient and doctor.

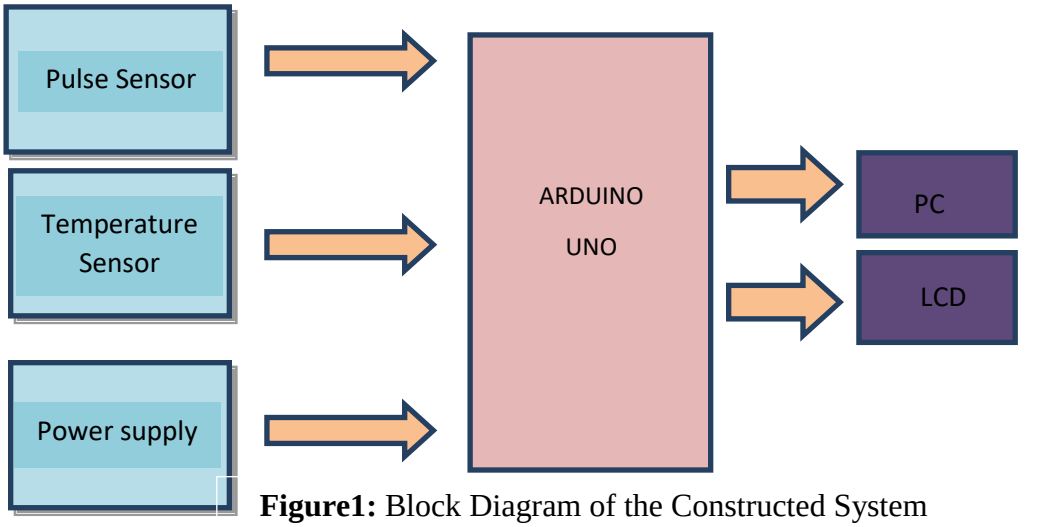

Figure1: Block Diagram of the Constructed System

Theoretical Background

Arduino Uno Microcontroller Board

Figure 2: Arduino UNO board

The Arduino is a microcontroller board based on the ATmega8. It has 14 digital -input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. "Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform.

IC LM35 Temperature Sensor

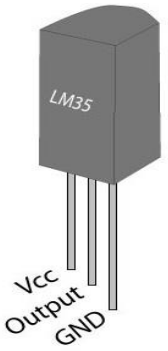

Figure 3: Pin diagram of IC LM35

The LM35 is a popular and inexpensive temperature sensor. It provides an output voltage of 10.0mV for each degree Centigrade of temperature from a reference voltage. The output of this device can be fed to A/D Converter; any microcontroller can be interfaced with any A/D Converter for reading and displaying the output of LM35. The circuit should be designed, so that output should be at 0V when the temperature is 0 degrees Centigrade and would rise to 1000mV or 1.0V at 100 degrees Centigrade. To get the temperature value accurately, output voltage must be multiplied with 100.

The LM35 series are precision integrated-circuit temperature devices with an output voltage linearly proportional to the Centigrade temperature. The LM35 device has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. The LM35 device does not require any external calibration or trimming to provide typical accuracies of ±1⁄ 4°C at room temperature and ±3⁄ 4°Cover a full 5°C to 150°C temperature range. Lower cost is assured by trimming and calibration at the water level. The low-output impedance, linear output, and precise inherent calibration of the LM35 device makes interfacing to readout or control circuitry especially easy. The device is used with single power 2 Applications supplies, or with plus and minus supplies. As the LM35 device draws only 60 μ A from the supply, it has very low self-heating of less than 0.1°C in still air. The LM35 device is rated to operate over a− 55°C to 150°C temperature range, while the LM35C device is rated for a− 40°C to 110°C range (− 10° with improved accuracy). The LM35-series devices are available packaged in hermetic TO transistor packages, while the LM35C, LM35CA, and LM35D devices are available in the plastic TO-92 transistor package.

Liquid Crystal Display (LCD)

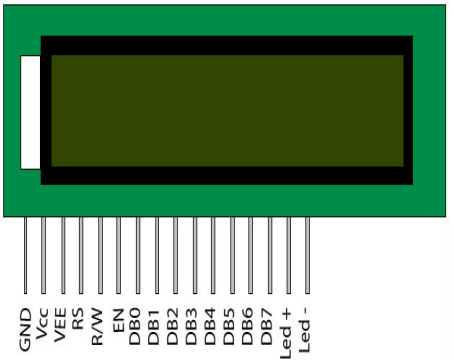

Figure 4: pin diagram of 16x2 LCD

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD.

Pulse sensor

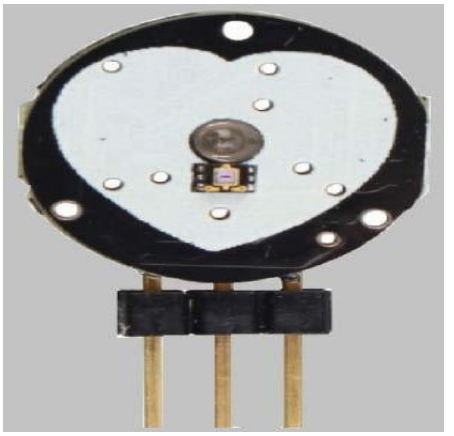

Figure 5: Pulse sensor

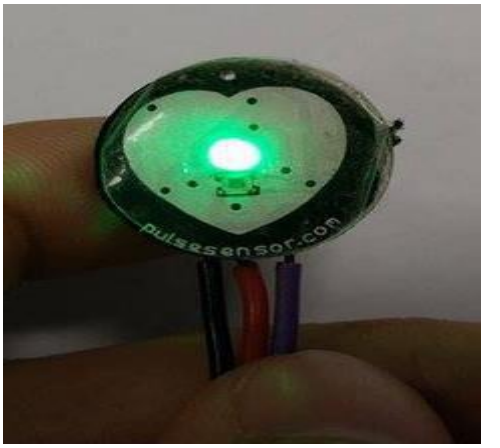

Figure 6: Image of visible greenlight sensor

Pulse sensor has three pin and connection of it with Arduino is very easy. Connection is made through 5V supply provided by Arduino, the ground pin of the pulse sensor is connected to the ground of the Arduino and the signal pin to the A0 of Arduino. There are several types of LED with a different wavelength that is suitable to detect the heart rate. The difference of the signal produce in between visible light and IR is demonstrated. The wavelength of the visible greenlight PPG ranging from 495–570 nm is normally being used due to the reason that it had shown to have a minimal influence from motion artefacts. The visible greenlight of 550 nm wavelength is used as shown in Figure (6). IR is an invisible light that cannot be seen directly by human eyes. It has a longer wavelength than visible light which is around 700 nm-1 mm, and it frequencies is lower than a visible light. IR is also commonly used to record the arterial heart rate directly from the skin.

Where nnn is an integer between 1 and 999. The body temperature of the patients and heart beat pulses per minute are displayed on the LCD display. After that, pulse sensor connected to Arduino Uno board, positive pin to +5V, negative pin to GND and S to A0 pin. Potentiometer connected to GND, V0 and Vcc of LCD. Potentiometer is connected to pin3 of LCD (contrast adjust pin). And then, Arduino Uno Board join to computer via USB Cable. Temperature sensor is used to measure the body temperature. Heartbeat

sensor is used to measure the function of heart by blood flow through Finger. The output of each sensor is interfaced with Analog to Digital circuit (ADC) pins of microcontroller.

Construction of the Circuit

The components are solder on the printed circuit board as design of the drawings on the printed circuit. There is only one circuit to make soldering components. Components and jumpers were inserted and soldered in the following procedure;

1. The wire jumper connections
2. Resistors
3. Switch and LED
4. LM 35
5. pulse sensor Arduino
6. buzzer
7. Potentiometer 10K

Instead of soldering the Arduino Uno directly on the board. And then, temperature sensor and pulse sensor are connected to the Uno board. Pins D_4, D_5, D_6, D_7 of LCD are joined to Arduino Uno pins D_2, D_3, D_4, D_5, D_6, D_7. LM 35 is an analog temperature sensor which outputs an analog signal. Arduino Uno has an analog pin, LM 35 analog output pin connected to analog input pins A0 of Arduino. The LCD screen is display the temperature in Celsius. Pulse sensor connected to Arduino pin. The calculated heart rate is displayed on an LCD in beats- per- minute in the following,

Rate = nnn bpm

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Operation of the circuit

Heartbeat Measurement

The circuit operation of Arduino Uno based heartrate monitor system is constructed. Upload the code to Arduino Uno and power on the system. Firstly, any finger (except the Thumb) attach the pulse sensor, it can be detect the pulse easily. Then the pulse sensor is measure the change in volume of blood, which occurs when every time heart pump, blood in the body. This change in the light intensity through that organ. The Arduino is converted this change into the heart beat per minute (BPM). While the sensor is collecting the data, sit down and relax, do not shake the wire as it might result in a faulty values. The heart rate reading for visible greenlight and IR respectively. It indicates that both of the signals are simultaneous and given a similar heart rate value but visible greenlight show smoother output signal of heart rate. After the result is displayed on the LCD and PC monitor.

Temperature Measurement

LM35 is an analog temperature sensor which outputs an analog signal. Microcontrollers don't accept analog signals as their input directly. Thus, need to convent analog output signal to digital before feeding to a microcontroller's input. For this reason, use an ADC. Modern day boards like Arduino and most modern day microcontroller come with inbuilt ADC. Arduino Uno has an in built 10-bit ADC (6 channel). Make use of this in built ADC, there are 6 analog input pins numbered from A0 to A5. Connect analog out of LM35 to any of these analog input pins of Arduino. When the power is turned on, a LED on PCB start glowing, indicating that circuit is working properly. A temperature sensor LM 35 which gives us room temperature in °C. That temperature is displayed on the LCD.

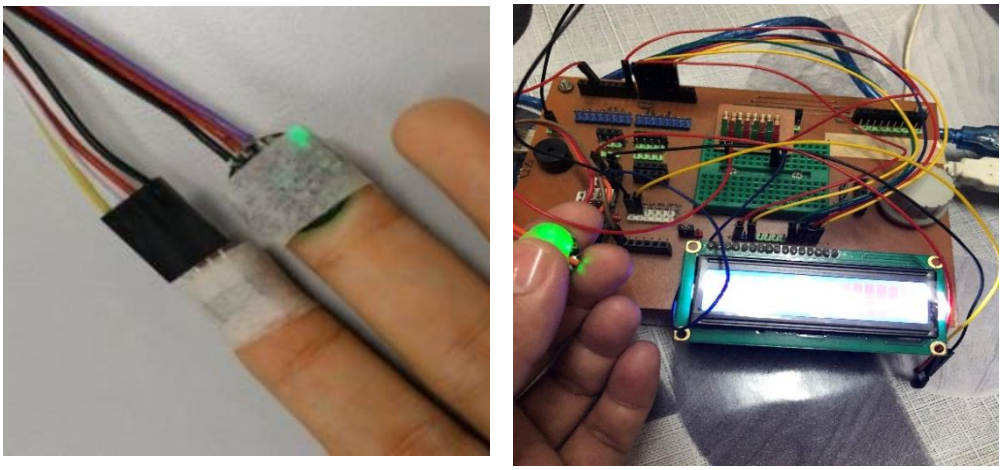

Figure 7: pulse rate Output display on LCD

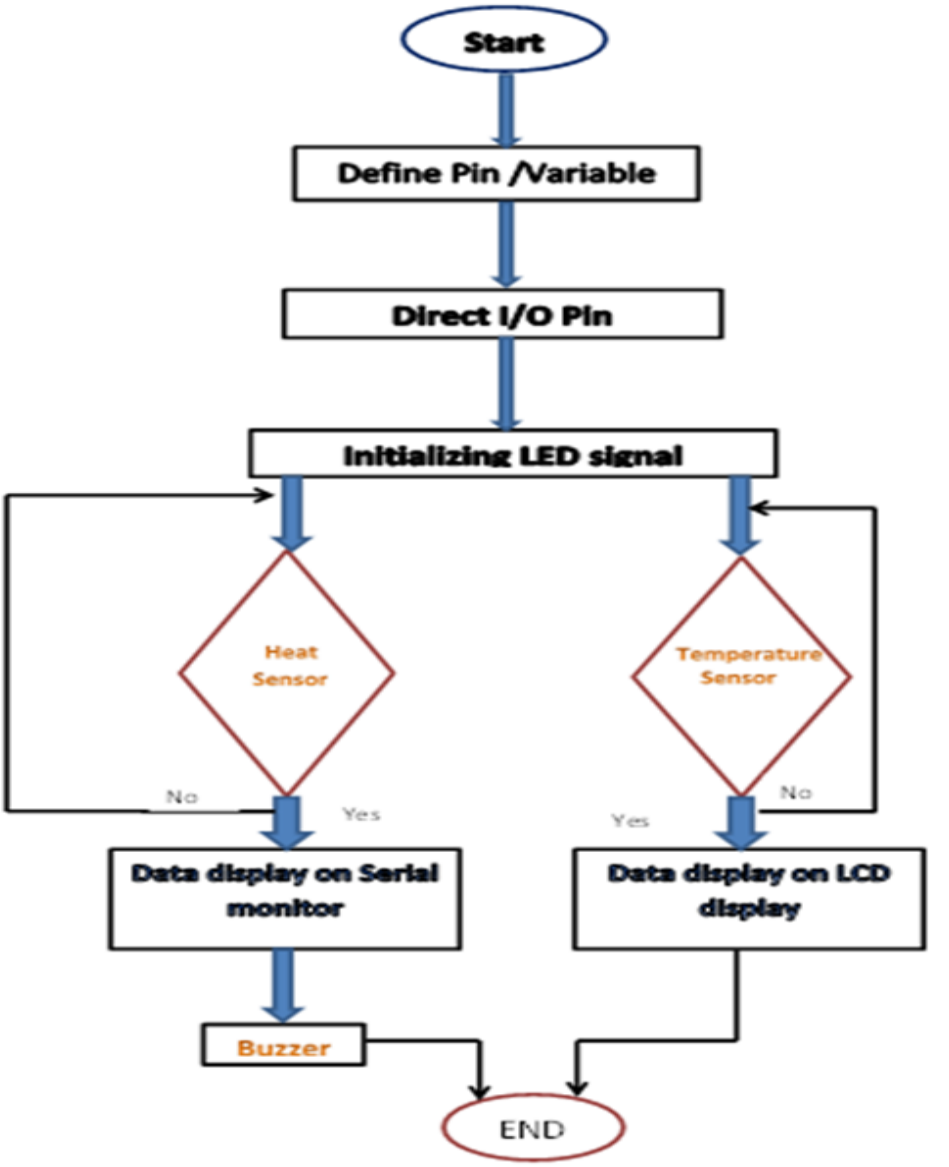

Figure 8: Flow diagram of the whole System

Result and Discussions

Once the circuit has built, codes have been uploaded into the Arduino Uno then the project is ready for testing. The heart rate was obtained using the pulse sensor to determine the accuracy of the project's circuit. The circuit is supplied by 3.3V power. For accurate reading as much as possible, the finger needs to be placed close to sensor. The output result as an ECG in the monitor. The results were outputted via the Serial Monitor as shown in Figure 9 below.

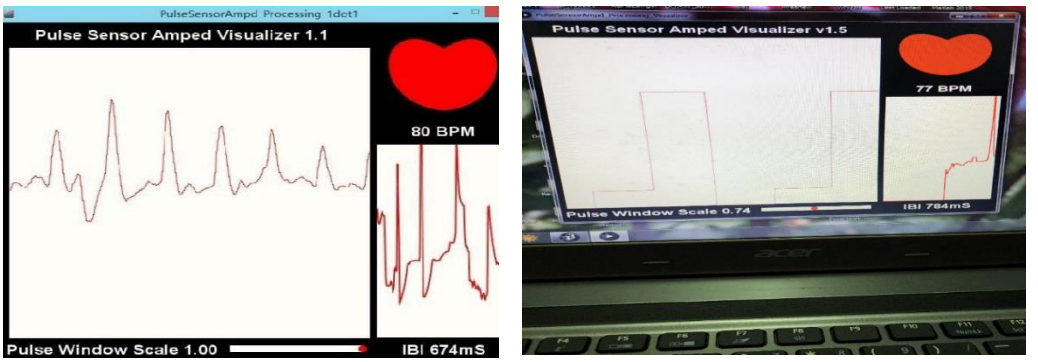

Figure 9: Pulse rate output display on PC monitor

Body temperature was obtained by interaction between the fingertip and the LM35. First we measured the temperature using thermometer then we measured it again using LM35 to compare the results. At the time of testing, measured temperature was almost 27°C and Figure 10 showed the body temperature measured by sensor and displayed in the LCD continuously.

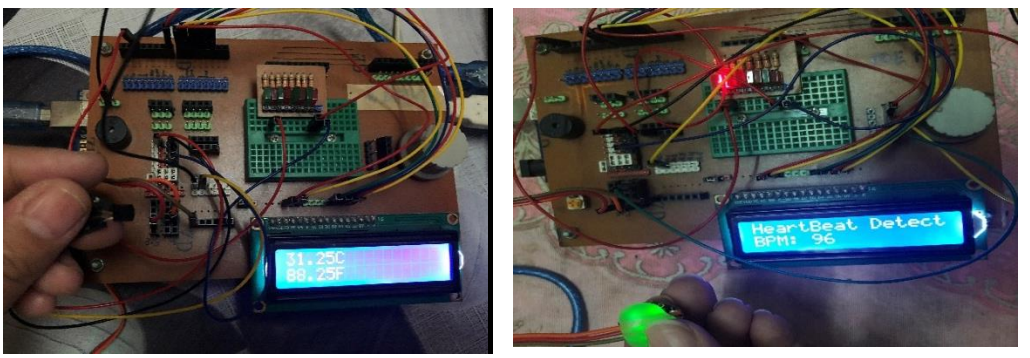

Figure 10: Sensor placement while taking the reading

Conclusions

The pulse rate sensor senses the hart beat and the result is displayed on serial monitor as spectrums. The output spectrums look like ECG spectrums. To show these spectrums, the Pulse Sensor Amped Visualizer 1.1 application need to installed in PC. The display screen contains two windows. The display spectrums of each windows are not different from each other. The measured heart rate is displayed on the screen by BPM unit. The body temperature is measured by temperature sensor LM35. The output voltage (mV) is sent to the AT mega 328 microcontroller input. These analog inputs are converted digital signal and gave the measure data in °F and °C. The result is not much different with the other thermometer results.

Table 1:The constructed system is designed and constructed for medical purpose.

Construct (°C)	Thermometer (°C)
29.30	30
31.25	31
33.32	32
34.67	33

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