Inspiring Excellence

CSE360 Assignment
Section:03

Title: Newborn Health Observing System

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1 Introduction

Now-a-days at least 25% of neonatal deaths happen because of preterm birth. An incubator is the one which is used in the hospitals to protect the premature babies, who are extra vulnerable and are at increased risk of complications from infection, noise and light. But this incubator is very costly. So the hospitals in rural areas can't have such facilities to protect the preemature babies. This system helps to prevent the death of such babies. The low cost baby health monitoring system helps to overcome the inhibitive cost of existing baby incubator. Therefore, everyone who is economically backward is benefitted by this.

This project is used for monitoring the baby health parameters like temperature, pulse rate and exhaled air. The major critical parameters are measured in real time. If any variation from the threshold level takes place, it automatically sends an alert message to the caretaker and do the necessary action immediately to safeguard the children. The traditional way for monitoring infant's vital sign is direct supervision from the hospital staff or the parents. This health monitoring system can provide constant update of infant health and alerts if any unexpected changes of vital signs happen.We can also conveniently monitor infant health situation in the NICU and at home while they go to their daily activities. Traditional monitoring systems are really difficult to wear all the time as it might make infant uncomfortable.

Sudden infant death syndrome (SIDS) is a syndrome for which an infant may die below the age of one year. This kind of death is unexplained and it usually happens without any warning signs during sleep. As it happens suddenly, it is really difficult to identify and predict. To overcome this kind of unfortunate events, our proposed monitoring system would be really efficient as it would be used in an effective way to predict the health condition of the prematured babies. On the basis of correct usage, it can help to fight against the SIDS.

2 Application Area

In today's world the development of technology, home healthcare and remote monitoring of physiological data are playing the major role. Implementation of home healthcare for patients is more important, particularly for premature babies.

An incubator is the one which is used in the hospitals to protect the premature babies, who are extra vulnerable and are at increased risk of complications from infection, noise

and light. Basically an infant monitoring system includes sensors and a micro controller. One of the most important physiological data to monitor is body temperature, i.e. infant fever. Rapid increase in body temperature may cause a vital damage. So the body temperature of the babies should be continuously monitored using the sensor. The maximum body temperature range for these babies should be 36-38oC.
Another crucial parameter is pulse rate, so continuously monitoring of the infant's pulse rate using the sensor may be required. The pulse is the number of heart beats per minute. The maximum pulse range for newborn babies should be 70 to 190 beats per minute and the pulse range for infants should be 80 to 160 beats per minute.
Technological advancement has a huge impact in the medical field. Infant health care is one of the major parts of the medical health care system. Some premature babies can be fragile and even a minor health issue can make big impact in the body. Hence, for giving better care to the newborns, they are kept in strict observation in the Neonatal Intensive Care Unit (NICU). This intensive care unit is specially made for infants as they have higher risk of getting infected and very easily indeed. In NICU,the infants are checked constantly if they have any errors in their vitals, heartbeats etc. But sometimes it becomes hard even to the doctor and nurses to keep track of every infant's health condition and which can result in SIDS, or even certain organ damage.
So to make things easier for the medical system, we designed this newborn health observation system. It is really feasible in the case of keeping track of infants vitals. This system can give alert by sending alarm signals to the medical authorities if there is a major change in the health condition of any newborn and the authorities can take immediate actions according to it . We think it is really useful to the medical authorities as well as for the parents. Parents can use this system in their home and keep track of their newborn's vitals all the time. So if alarm goes out, they can immediately call the doctor or take their newborn to the hospital.

3 Technology and Tools

3.1 Arduino

For this system the microcontroller that we are using Arduino Uno[Fig 3.1].It is an Open-source electronic prototyping platform enabling users to create interactive electronic objects.Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment).

Figure 3.1: Arduino Uno

3.2 Piezo Buzzer

Piezo buzzer is a GPIO device that is used to generate basic beep,sound and alerts[Fig 3.2]. It has simple construction and is very light weighted.

Figure 3.2: Piezo Buzzer

3.3 LCD

LCD (Liquid Crystal Display) is a type of flat panel display which uses liquid crystals in its primary form of operation[Fig 3.3].In the 16x2 displayed LCD we are using 4 bit mode to transfer data.

Figure 3.3: 16x2 LCD

3.4 Temperature Sensor

A temperature sensor is an electronic device that measures the temperature of its environment and converts the input data into electronic data to record, monitor, or signal temperature changes. We are using an LM35 temperature sensor[Fig 3.4]. This is more convenient in long term than traditional thermometer.

Figure 3.4: LM35 Sensor

3.5 Gas Sensor

The MQ-135 Gas sensors are used in air quality control equipments and are suitable for detecting or measuring of NH3, NOx, Alcohol, Benzene, Smoke, CO2[Fig 3.5].To monitor the breathing of the baby we are using MQ135 gas sensor.

Figure 3.5: MQ135 Sensor

3.6 Heart Rate Sensor

Heartbeat Sensor is an electronic device that is used to measure the heart rate i.e. speed of the heartbeat.[Fig 3.6]To monitor the heart rate of the baby we are using Heart rate sensor.

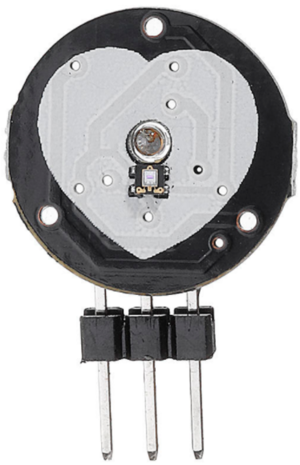

Figure 3.6: Heart Rate Sensor

3.7 Bluetooth HC-06 Module

HC-06 is a Bluetooth module designed for establishing short range wireless data communication between two microcontrollers or systems. The module works on Bluetooth 2.0

communication protocol and it can only act as a slave device. This is cheapest method for wireless data transmission and more flexible compared to other methods.

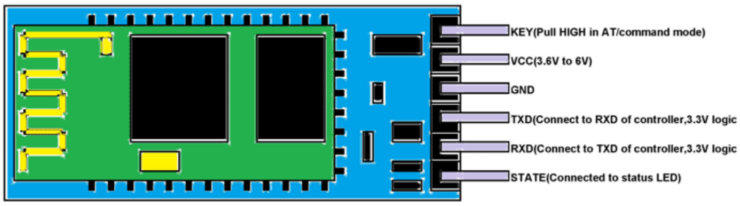

Figure 3.7: Bluetooth Module

4 Language

We have used Arduino Programming Language to code the system. The Arduino programming language is based on a very simple hardware programming language called processing, which is similar to the C language.

5 Working Mechanism Of Sensors

5.1 Temperature Sensor

Traditional method for measuring temperature is using a thermometer, which is inconvenient in case of long term monitoring. We propose a continuous temperature monitoring system using an LM35 sensor and wirelessly transferring the data to an LCD.
LM35 is an analog, linear temperature sensor whose output voltage varies linearly with change in temperature. LM35 is three terminal linear temperature sensor from National semiconductors. It can measure temperature from-55 degree celsius to +150 degree celsius. The voltage output of the LM35 increases 10mV per degree Celsius rise in temperature. LM35 can be operated from a 5V supply and the stand by current is less than 60uA.
There are two transistors in the center of the drawing. One has ten times the emitter area of the other. This means it has one tenth of the current density, since the same current is going through both transistors. This causes a voltage across the resistor R1 that is proportional to the absolute temperature, and is almost linear across the range.The

”almost” part is taken care of by a special circuit that straightens out the slightly curved graph of voltage versus temperature.
The amplifier at the top ensures that the voltage at the base of the left transistor (Q1) is proportional to absolute temperature (PTAT) by comparing the output of the two transistors.
The amplifier at the right converts absolute temperature (measured in Kelvin) into either Fahrenheit or Celsius, depending on the part (LM34 or LM35).The little circle with the ”i” in it is a constant current source circuit.
The two resistors are calibrated in the factory to produce a highly accurate temperature sensor.

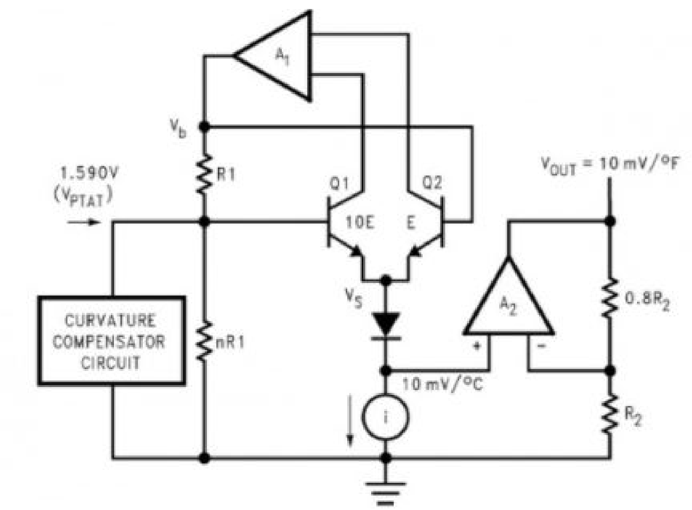

Figure 5.1: Temperature Sensor Circuit Diagram

The integrated circuit has many transistors in it – two in the middle, some in each amplifier, some in the constant current source, and some in the curvature compensation circuit. All of that is fit into the tiny package with three leads. Figure 5.1 shows the mechanism of Temperature sensor.

5.2 Gas Sensor

We are proposing a method using CO2 sensors placed around the infant to monitor the exhaled air concentration from the infant. The data is sent wirelessly to activate the alarm if and when it crosses a certain threshold level.
The MQ-135 alcohol sensor consists of a tin dioxide (SnO2), a perspective layer inside aluminum oxide microtubes (measuring electrodes), and a heating element inside a

tubular casing. The end face of the sensor is enclosed by a stainless steel net and the backside holds the connection terminals. Ethyl alcohol present in the breath is oxidized into acetic acid passing through the heating element. With the ethyl alcohol cascade on the tin dioxide sensing layer, the resistance decreases. By using the external load resistance the resistance variation is converted into a suitable voltage variation. Figure 5.2 shows the mechanism of Gas sensor.

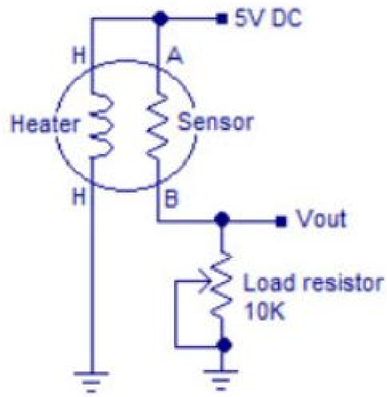

Figure 5.2: Gas Sensor Circuit Diagram

5.3 Heart Rate Sensor

The principle behind the working of the Heartbeat Sensor is Photoplethysmograph. According to this principle, the changes in the volume of blood in an organ is measured by the changes in the intensity of the light passing through that organ.

Usually, the source of light in a heartbeat sensor would be an IR LED and the detector would be any Photo Detector like a Photo Diode, an LDR (Light Dependent Resistor) or a Photo Transistor.

The sensor part of the Heartbeat Sensor consists of an IR LED and a Photo Diode placed in a clip.

The Control Circuit consists of an Op-Amp IC and few other components that help in connecting the signal to a Microcontroller. The working of the Heartbeat Sensor can be understood better if we take a look at its circuit diagram. [Figure 5.3]

The circuit[Fig 5.3] shows the finger type heartbeat sensor, which works by detecting the pulses. Every heartbeat will alter the amount of blood in the finger and the light

from the IR LED passing through the finger and thus detected by the Photo Diode will also vary.
The output of the photo diode is given to the non – inverting input of the first op – amp through a capacitor, which blocks the DC Components of the signal. The first op – amp cats as a non – inverting amplifier with an amplification factor of 1001.
The output of the first op – amp is given as one of the inputs to the second op – amp, which acts as a comparator. The output of the second op – amp triggers a transistor, from which, the signal is given to a Microcontroller like Arduino.
The Op – amp used in this circuit is LM358. It has two op – amps on the same chip. Also, the transistor used is a BC547. An LED, which is connected to transistor, will blink when the pulse is detected.

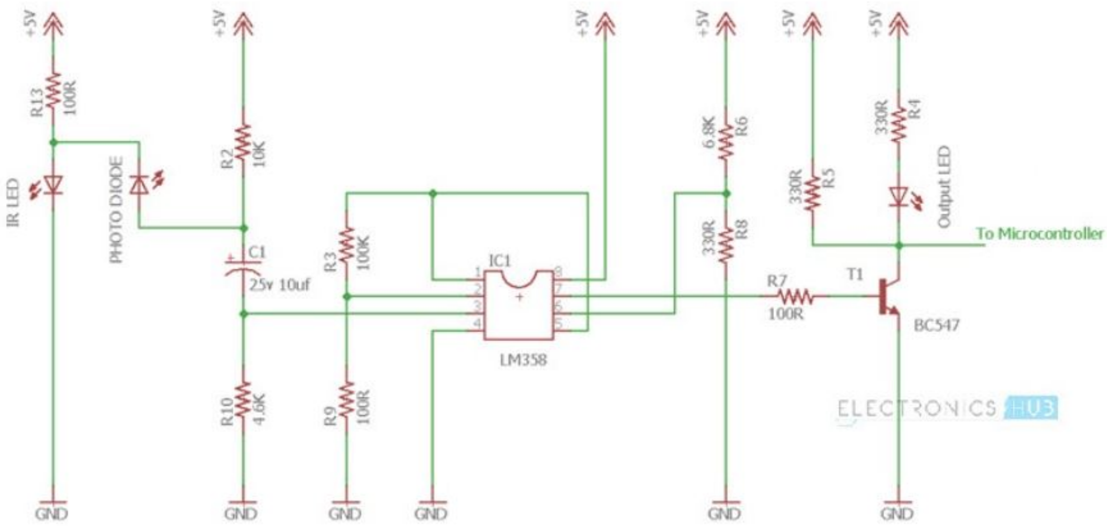

Figure 5.3: Heart Rate Sensor Circuit Diagram

6 Connection with ICs

We are using the 4 bit mode of the 16x2 LCD display therefore we have connected D4-D7 with the PIN 11, 10, 9, 8 I/O pins of Arduino and RS, E pin is connected with Pin 13, 12. We have connected the VEE pin with GND to use the maximum contrast of the screen and RW is grounded because we want to use only the write mode. The HC-06

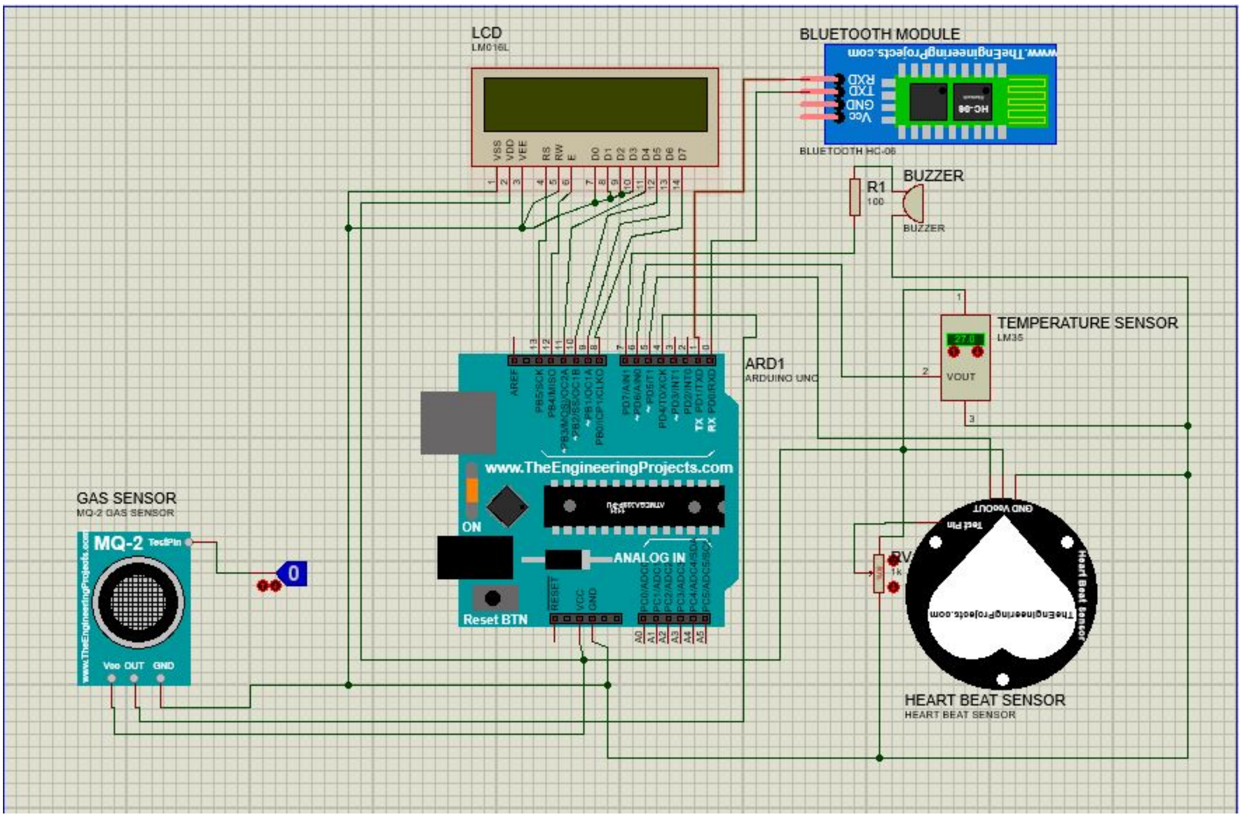

Figure 6.1: Circuit Diagram

Bluetooth module's RXD, TXD pin is connected with the TX and RX pin of Arduino respectively. We have connected the buzzer with PIN 7 (will be used as Output pin) via a 100-ohm resistor. The resistor is used in order to protect the micro-controller from any damage due to the audio output of the device. Lastly, gas sensor, heart rate sensor, Temperature sensor are connected with Pin 4, 5, 6 respectively.

7 Data Flow

The signals detected by the sensors are passed through a signal conditioning circuit for further processing and to convert analog signal to digital signal. The microcontroller which is used is ATmega328 interfaced using and aurdino uno kit.
A bluetooth module is also connected with the system for the purpose of communication. The data is combined into packet and sent bit by bit on a single wire between two communnicating devices. This is costly approach but the synchronization between two communication devices are necessary. Separate wires can be used for long distance communication which can be used in home as well as hospitals. This is reliable and high

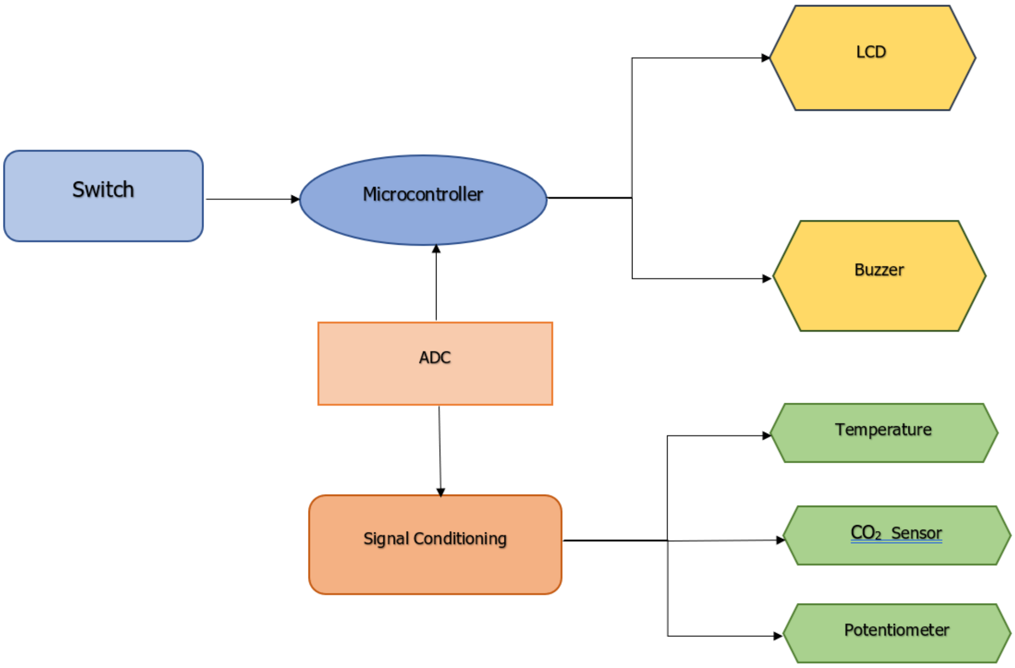

Figure 7.1: Data Flow

speed communication.
Piezo buzzer is an electronic device that is used to produce sound. We used an upper and lower threshold limit. This activates the buzzer. A LCD monitor is also connected which we use is 16x2 display. It will show output of the processed signals.

8 Estimated cost analysis

The interesting point of this important system is that it is less costly and requires minimum maintenance. This is built as a reliable monitoring system for all standard of hospitals and every type of parents; hence we tried to make this as affordable as possible. To make the system less costly here we used Arduino Uno instead of Raspberry Pi. Here is the table that shows the cost analysis of the entire system:

Components	Price (BDT)
Arduino Uno	400
LCD 16x2	165
ADC	190
Piezo Buzzer	50
Potentiometer	50
Switch	10
HC-06 Bluetooth Module	290
MQ135 Gas Sensor	194
LM35 Temperature Sensor	85
Heart Rate Pulse Sensor	280
Total	**1714**

Figure 8.1: Cost Estimation

9 Conclusion

Our cost efficient system is built as a reliable monitoring system for all standard of hospitals and every type of parents. It is hoped that this could help doctors and nurses in monitoring premature infants in hospital. Furthermore, they can also provide fast response if the infants are in danger conditions. In order to further improve the project in the future, the data from both sensors will be sent via the internet to a laptop or mobile phone. This can help the doctors and nurses to monitor the infants conditions anywhere at all time. Most doctors in the hospital have very tight schedule and cannot always be in the NICU. They also have responsibilites to other patients at the same time. With this transmission of data via the Internet, caregivers will be able to monitor infant environment condition and health situation from a laptop or mobile phone with much ease.

10 Code

```
#include <LiquidCrystal.h>

// initialize the library with the numbers of the interface
   pins
LiquidCrystal lcd(12, 11, 5, 4, 3, 2);
#include <WiFi101.h>
//#include <WiFiClient.h>
//#include <WiFiServer.h>
//#include <WiFiSSLClient.h>
//#include <WiFiUdp.h>

#include <Wire.h>
#include <SPI.h>

char ssid[] = "Zzzzzzz";      //  network SSID (name)
char pass[] = "xxxxxxx";    //  network password
int keyIndex = 0;                  // network key Index
   number (needed only for WEP)

char lm35address = 0x48; //A1 A0 are grounded
char buffer[2];
int tempcode;
float tempf;
int tempi;
int tempcode2;

int lighti;
int sensor_pin = 0;

int led_pin = 13;
volatile int heart_rate;
volatile int analog_data;
volatile int time_between_beats = 600;
```

```
volatile boolean pulse_signal = false;
volatile int beat[10];          //heartbeat values will be sotred in this array
volatile int peak_value = 512;
volatile int trough_value = 512;
volatile int thresh = 525;
volatile int amplitude = 100;
volatile boolean first_heartpulse = true;
volatile boolean second_heartpulse = false;
volatile unsigned long samplecounter = 0;   //This counter will tell us the pulse timing
volatile unsigned long lastBeatTime = 0;


int status = WL\_IDLE\_STATUS;
WiFiServer server(80);

tone( pin number, frequency in hertz);

// Variable Setup
long lastConnectionTime = 0;
boolean lastConnected = false;

// Temperature measurement every 1 min
unsigned long previousMillis = 0;
int interval\_1m = 1 * 60 * 1000;     // 1 min

// Initialize Arduino Ethernet Client
WiFiClient client;




//################################ INIT - SETUP ##########################################
```

```
void setup() {
  cd.begin(16, 2);
  lcd.print("");
  Serial.begin(9600); // sets the serial port to 9600
  Serial.println("Gas sensor warming up!");
  delay(20000); // allow the gas sensor to warm up

  pinMode(6, OUTPUT);
  pinMode(7, OUTPUT);
  // Start Serial for debugging on the Serial Monitor
  Wire.begin();
  Serial.begin(9600);
  pinMode(led_pin,OUTPUT);

  Serial.begin(115200);

  interruptSetup();
  TCCR2A = 0x02;  // This will disable the PWM on pin 3 and
      11

  OCR2A = 0X7C;   // This will set the top of count to 124
      for the 500Hz sample rate

  TCCR2B = 0x06;  // DON'T FORCE COMPARE, 256 PRESCALER

  TIMSK2 = 0x02;  // This will enable interrupt on match
      between OCR2A and Timer

  sei();          // This will make sure that the global
      interrupts are enable


  // check for the presence of the shield:
  if (WiFi.status() == WL_NO_SHIELD) {
    Serial.println("WiFi shield not present");
```

```
    // don't continue:
    while (true);
  }

  // attempt to connect to Wifi network:
  while ( status != WL_CONNECTED) {
    Serial.print("Attempting to connect to SSID: ");
    Serial.println(ssid);
    // Connect to WPA/WPA2 network. Change this line if
       using open or WEP network:
    status = WiFi.begin(ssid, pass);

    // wait 10 seconds for connection:
    delay(10000);
  }
  // you're connected now, so print out the status:
  printWifiStatus();
}



//################################## MAIN LOOP
   #######################################
void loop() {
  // read values from pins and store as strings
  lcd.setCursor(0, 1);
  lcd.print(millis() / 1000);
  tone(piezoPin, 1000, 500);
  Serial.print("BPM: ");

      Serial.println(heart_rate);

      delay(200); //  take a break

```

```
   sensorValue = analogRead(MQ2pin); // read analog input pin 0
  Serial.print("Sensor Value: ");
  Serial.print(sensorValue);

  if(sensorValue > 300)
  {
    Serial.print(" ");
  }

  Serial.println("");
  delay(2000); // wait 2s for next reading
  //tone(piezoPin, 1000, 500);
  //delay(1000);
  //String temp   = String(10); //Just to have a defaul value
  //String light  = String(20); //Just to have a defaul value
  //String sound  = String(30); //Just to have a defaul valu
   if (analog_data < thresh && pulse_signal == true)
    {
      digitalWrite(led_pin,LOW);
      pulse_signal = false;
      amplitude = peak_value - trough_value;
      thresh = amplitude/2 + trough_value;
      peak_value = thresh;
      trough_value = thresh;
  }
 if (N > 2500)
    {
      thresh = 512;
      peak_value = 512;
      trough_value = 512;
      astBeatTime = samplecounter;
      first_heartpulse = true;
```

```
        second_heartpulse = false;
    }
  sei();
}
```