

CS321 PROJECT REPORT

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SMART HEALTH PROJECT FOR (ELDER PEOPLE/PHYSICALLY CHALLENGED/PATIENTS).

OBJECTIVE

The project is aimed towards patients/elder people who stay in home either after post treatment or those people who require detailed medical attention. And our idea is to continuously monitor their health statistics, vitals, etc. through the internet and the storage of the data which would serve for self-assessment.

FEATURES:

- Parameters like temperature, heart beat are checked continuously and are sent to the caretaker and the doctor who see these stats once they come online.
- Warning for abnormal variations will be sent to them.
- In cases of emergency such as heart attack or the body temperature gets too cold we send an emergency alert to the care taker, doctor and few related people who can reach him as fast as possible. (BY ONLINE AND BY CALL and MESSAGE means).

- This prototype can be extended and used as a dashboard in hospitals to monitor the health of the patients by adding additional health parameters.
- This device uses IoT since pi is connected to Internet (wirelessly) and can be extended to use MQTT protocol.

Equipment Used:

1. Arduino x 2: For receiving data from the sensors used and make the output available for reading.
2. Raspberry Pi 2 : For reading the arduino data and accelerometer's readings.
3. Pulse rate Sensor : Reading the pulse rate.
4. GSA modem : For calling(missed call)/messaging with the message during cases of emergency /high caution.
5. Temperature and Humidity Sensor: Read body temperature
6. Accelerometer (or) PIR motion Sensor : Detecting movement
7. Buzzer : Initially used as a prototype for the GSM modem
8. Arduino Base Shield: To connect multiple sensor to arduino with ease making the circuit simple and compact.

BRIEF DESCRIPTION OF IMPLEMENTATION

The product is a wearable device consisting of all the above components.

Inside the wearable device are the two arduinos connected to the pi and the accelerometer connected with the pi. Also present is the GSM module.

We place the DHT11 temperature sensor and pulse sensor at their respective appropriate locations on the patient's body.(Pulse sensor tied to the fingertip and temperature sensor near the armpit region). Of the 2 arduinos one is solely dedicated for the use of pulse sensor while the other takes care of the remaining sensors except the accelerometer (connected to Pi).

These values are sent to Pi from Arduino which sends it to the server we host from which the doctor/caretaker can see the data of our vitals.

A graph of the heart rate is plotted using the values obtained from the pulse sensor and on open software Processing 3 of which screenshots will be sent to the page for every 1 minute.

Temperature = 98.2 deg F (Normal)

Body State : Moving (Normal)

Pulse Rate = **151 BPMS (Normal)**



simple webserver displaying data

During emergency situations like:

- a) Pulse rate falls below certain rate or exceeds a certain rate .
- b) Temperature rate exceeds certain value or is below a certain value.
- c) Accelerometer detects sudden decrease or a sharp spike and becomes constant later.

A message is sent to the doctor and people concerned with the patient. A missed call is also given to them.

Setting up the Hardware:

1. Raspberry Pi set up:

(a) Boot the Raspbian Operating System on to the memory card from a PC.

(b) Set a static IP on to Raspberry pi Add this code in the end of /etc/dhcpd.conf file

```
interface eth0
```

```
static ip_address=192.168.0.10/24
```

```
static routers=192.168.0.1
```

```
static domain_name_servers=192.168.0.1
```

interface = This defines which network interface you are setting the configuration for.

static ip_address = This is the IP address that you want to set your device to. (Make sure you leave the /24 at the end)

static routers = This is the IP address of your gateway (probably the IP address of your router) static domain_name_servers = This is the IP address of your DNS (probably the IP address of your router).

(c) Accessing Pi Remotely:

Connect Raspberry pi and your PC with a Lan Cable and directly ssh it with the static IP SSH COMMAND :

```
ssh -X pi@static_ip
```

Software Assembly:

1. Setting up the internet in pi:

Add this lines in the `/etc/apt/apt.conf` file

```
Acquire::http::proxy "http://username:password@proxy:port/";  
Acquire::https::proxy "https://username:password@proxy:port/";
```

2.Installing LAMP and Arduino software in pi:

It is same as installing LAMP in Ubuntu .Follow the instructions from this website. Similarly, install the Arduino software (Linux version)

<https://www.digitalocean.com/community/tutorials/how-to-install-linux-apache-mysql-php-lamp-stack-on-ubuntu>

3. Reading the data of Arduino and sending it to a webpage.

Arduino sends the data to serial monitor. The following python script takes this data from the serial monitor and stores it in a file (*data.txt* in our case).

```
import serial  
  
ser = serial.Serial('/dev/ttyUSB0', 9600)  
  
# Send data (a string)  
sending_string = str.encode("what")  
ser.write(sending_string)  
  
  
# Read data  
while True:  
    data = bytearray()  
    data += ser.read()  
    received_str = data.decode()  
    print(received_str)  
    file = open("data.txt", "a")  
    file.write(str(received_str))  
    file.close()
```

The following PHP code writes the data from data.txt file to a webpage dynamically (you need not refresh the webpage. Whenever

any data is added or changed, it gets changed automatically on the webpage).

```
<?php
    echo "\n Data : ";

    $fh = fopen('data.txt','r');

    $data = "";

    while ($line = fgets($fh)) {
        echo($line);

        $data += ($line + "<br></br><br></br>"); }

    fclose($fh);

    echo str_replace(PHP_EOL, '<br></br><br></br>', $output);
?>
```

Create a new folder in /var/www/html in pi and add the above two files in it along with the *index.html*

ARDUINO

ARDUINO 1

The DHT11 sensor , PIR sensor and buzzer sensors are connected to it and its output is connected to pi. The Serial rate set in this Arduino is 9600.

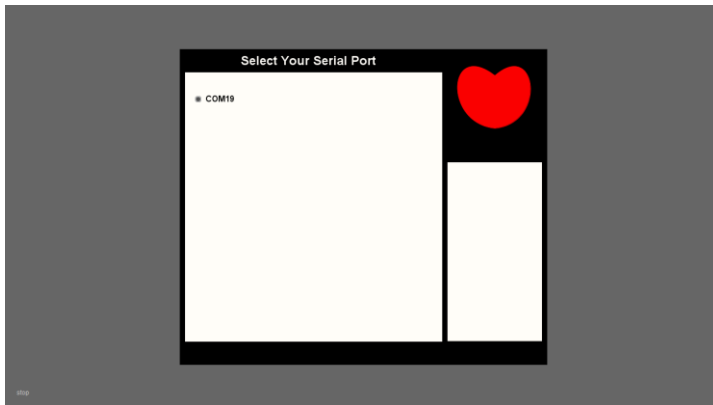
Sensors were connected through the usage of data shield and GSM 's (TX and RX pins were connected carefully).

ARDUINO 2

Pulse sensor connected to it.

Works at Serial Rate of 115200.

Its serial port is listened to by the Processing software.



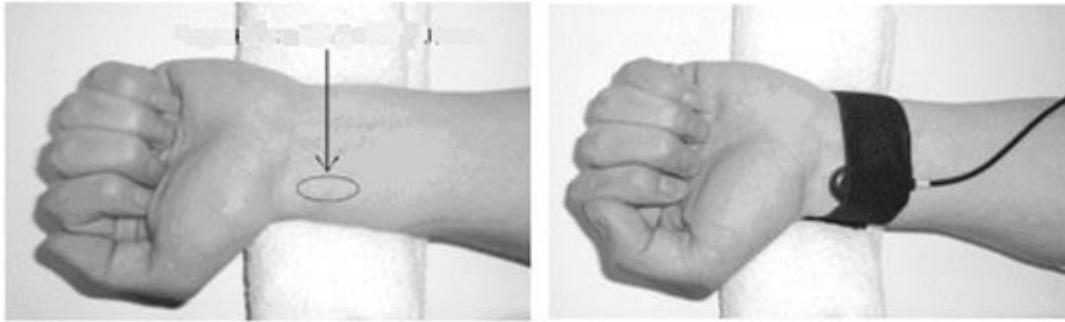
Outputs the BPM (beats per minute) to the Pi which it obtains from Processing.

PULSE SENSOR



Contains 3 pins of which one is connected to the analog pin of the Arduino board one to the ground.

It is connected to the patient in the following way.



Emergency measures are taken when the pulse is out of the given range(120 – 180) bpm.

Code (for reading pulse sensor 's data)

```

PulseSensorAmped_Arduino_1dot4 | Arduino 1.6.11
File Edit Sketch Tools Help
PulseSensorAmped_Arduino_1dot4 AllSerialHandling Interrupt Timer Interrupt Notes
#include <Boards.h>
#include <Firmata.h>

// Variables
int pulsePin = 0; // Pulse Sensor purple wire connected to analog pin 0
int blinkPin = 13; // pin to blink led at each beat
int fadePin = 5; // pin to do fancy classy fading blink at each beat
int fadeRate = 0; // used to fade LED on with PWM on fadePin

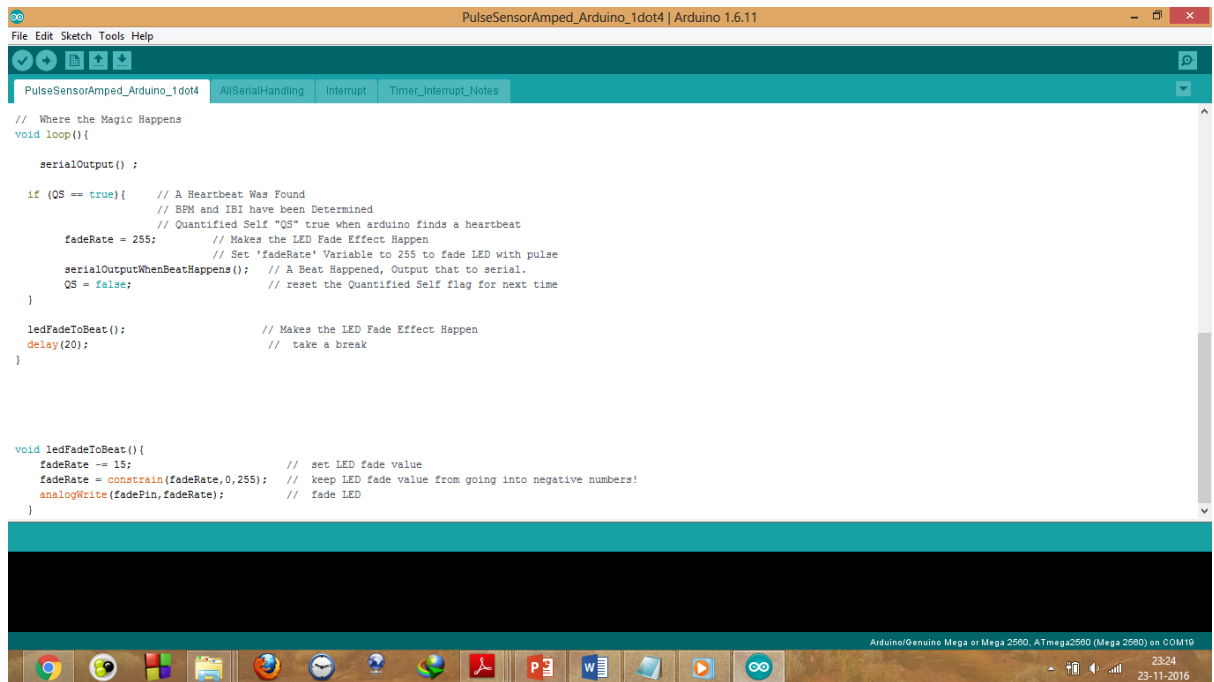
// Volatile Variables, used in the interrupt service routine!
volatile int BPM; // int that holds raw Analog in 0. updated every 2mS
volatile int Signal; // holds the incoming raw data
volatile int IBI = 600; // int that holds the time interval between beats! Must be seeded!
volatile boolean Pulse = false; // "True" when User's live heartbeat is detected. "False" when not a "live beat".
volatile boolean QS = false; // becomes true when Arduino finds a beat.

// Regards Serial OutPut -- Set This Up to your needs
static boolean serialVisual = false; // Set to 'false' by Default. Re-set to 'true' to see Arduino Serial Monitor ASCII Visual Pulse

void setup(){
  pinMode(blinkPin,OUTPUT); // pin that will blink to your heartbeat!
  pinMode(fadePin,OUTPUT); // pin that will fade to your heartbeat!
  Serial.begin(115200); // we agree to talk fast!
  interruptSetup(); // sets up to read Pulse Sensor signal every 2mS
  // IF YOU ARE POWERING The Pulse Sensor AT VOLTAGE LESS THAN THE BOARD VOLTAGE,
  // THE PULSE SENSOR WILL NOT WORK!
}

void loop(){
  // ...
}

```

```
// Where the Magic Happens
void loop() {

    serialOutput() ;

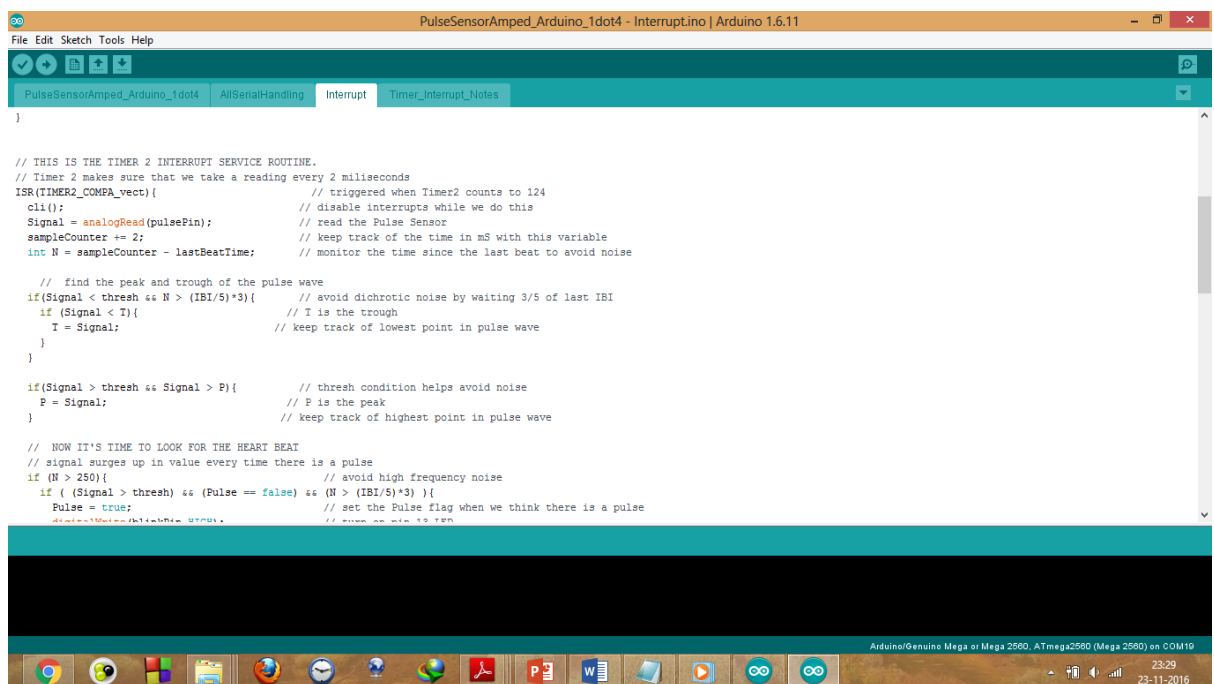
    if (QS == true){ // A Heartbeat Was Found
                    // BPM and IBI have been Determined
                    // Quantified Self "QS" true when arduino finds a heartbeat
        fadeRate = 255; // Makes the LED Fade Effect Happen
                    // Set 'fadeRate' Variable to 255 to fade LED with pulse
        serialOutputWhenBeatHappens(); // A Beat Happened, Output that to serial.
        QS = false; // reset the Quantified Self flag for next time
    }

    ledFadeToBeat(); // Makes the LED Fade Effect Happen
    delay(20); // take a break
}

void ledFadeToBeat(){
    fadeRate -= 15; // set LED fade value
    fadeRate = constrain(fadeRate,0,255); // keep LED fade value from going into negative numbers!
    analogWrite(fadePin,fadeRate); // fade LED
}
```

We use Interrupts while using this sensor so we cant use functions like tone other time related functions,etc.

Usage of Timer interrupt service:



```
// THIS IS THE TIMER 2 INTERRUPT SERVICE ROUTINE.
// Timer 2 makes sure that we take a reading every 2 milliseconds
ISR(TIMER2_COMPA_vect){ // triggered when Timer2 counts to 124
    cli(); // disable interrupts while we do this
    Signal = analogRead(pulsePin); // read the Pulse Sensor
    sampleCounter += 2; // keep track of the time in mS with this variable
    int N = sampleCounter - lastBeatTime; // monitor the time since the last beat to avoid noise

    // find the peak and trough of the pulse wave
    if(Signal < thresh && N > (IBI/5)*3){ // avoid dichrotic noise by waiting 3/5 of last IBI
        if (Signal < T){ // T is the trough
            T = Signal; // keep track of lowest point in pulse wave
        }
    }

    if(Signal > thresh && Signal > P){ // thresh condition helps avoid noise
        P = Signal; // P is the peak
    } // keep track of highest point in pulse wave

    // NOW IT'S TIME TO LOOK FOR THE HEART BEAT
    // signal surges up in value every time there is a pulse
    if (N > 250){ // avoid high frequency noise
        if ( (Signal > thresh) && (Pulse == false) && (N > (IBI/5)*3) ){
            Pulse = true; // set the Pulse flag when we think there is a pulse
            // Serial.println("Pulse detected");
        }
    }
}
```

Precautions:

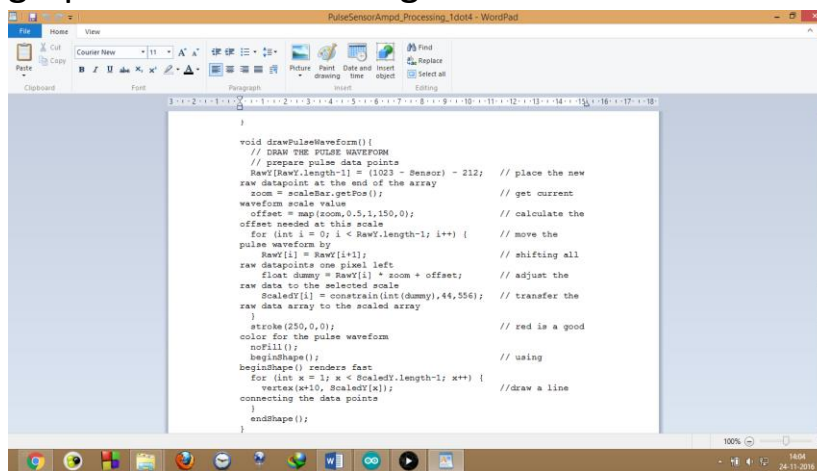
- 1) The back portion of the pulse sensor should be insulated as the moisture affects its values and also it would remain longer for usage.

- 2) Connection should be done in the proper fashion. For this sake a LED has been provided in the sensor to indicate the correct connection/arrangement.

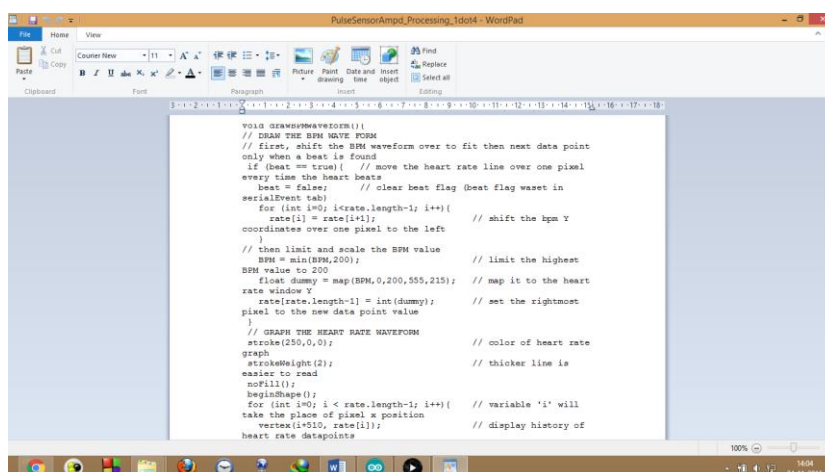
PROCESSING :

Using the Pulse sensor we receive data that is rather complicated but is useful in plotting graphs by using open software like this one.

Software listens to the serial data from the Arduino and plots graphs based on the algorithm it uses.



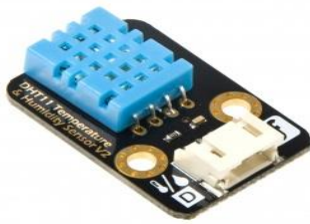
```
void drawPulseWaveform() {
  // DRAW THE PULSE WAVEFORM
  // prepare pulse data points
  Raw[Raw.length-1] = (1023 - Sensor) - 212; // place the new
  raw datapoint at the end of the array
  sum = scaler.getSum(); // get current
  waveform scale value // calculate the
  offset = map(sum, 0.5, 1, 150, 0); // move the
  offset needed at this scale // shifting all
  for (int i = 0; i < Raw.length-1; i++) { // adjust the
    Raw[i] = Raw[i+1]; // transfer the
    float dummy = Raw[i] + sum + offset; // data array to the scaled array
    Scaled[i] = constrain(int(dummy), 44, 556);
    raw data array to the scaled array
  }
  stroke(250, 0, 0); // red is a good
  color for the pulse waveform
  noFill(); // using
  beginShape();
  beginShape() renders fast
  for (int x = 1; x < Scaled.length-1; x++) { //draw a line
    vertex(x*10, Scaled[x]); //connecting the data points
  }
  endShape();
}
```



```
void drawBPMWaveform() {
  // DRAW THE BPM WAVE FORM
  // first, shift the BPM waveform over to fit then next data point
  only when a beat is found
  if (beat == true) { // move the heart rate line over one pixel
    every time the heart beats
    beat = false; // clear beat flag (beat flag waset in
    serialEvent tab)
    for (int i=0; i<rate.length-1; i++) { // shift the bpm Y
      rate[i] = rate[i+1];
      coordinates over one pixel to the left
    }
    // then limit and scale the BPM value
    BPM = min(BPM, 200); // limit the highest
    BPM value to 200
    float dummy = map(BPM, 0, 200, 555, 215); // map it to the heart
    rate window Y
    rate[rate.length-1] = int(dummy); // set the rightmost
    pixel to the new data point value
  }
  // GRAPH THE HEART RATE WAVEFORM
  stroke(250, 0, 0); // color of heart rate
  graph // thicker line is
  strokeWeight(2); // easier to read
  noFill();
  beginShape();
  for (int i=0; i < rate.length-1; i++) { // variable 'i' will
    take the place of pixel x position
    vertex(i*10, rate[i]); // display history of
    heart rate datapoints
  }
}
```

Screenshots from the Graph Plotting Algorithm

DHT11- Humidity and Temperature Sensor



This DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. It is highly reliable and has excellent long-term stability. Connected to the digital pin 8.

The DHT11 temperature and humidity sensor has the measurement range of 20-90%RH and 0-50 degree Celsius. And in terms of accuracy it gives $\pm 5\%$ RH and ± 2 degree Celsius.

DHT11's power supply is 3-5.5V DC. When power is supplied to the sensor, do not send any instruction to the sensor in within one second in order to pass the unstable status.

(Individual) Code which involves Temperature reading part.

```
PPAP | Arduino 1.6.11
File Edit Sketch Tools Help
PPAP
#include <dht.h>
// #include <dht.h>

dht DHT;

#define DHT11_PIN 8

void setup() {
  Serial.begin(9600);
}

void loop()
{
  int chk = DHT.read11(DHT11_PIN);
  Serial.print("Temperature = ");
  float a=DHT.temperature*1.8+32;
  Serial.println(a);
  Serial.print("Humidity = ");
  Serial.println(DHT.humidity);
  delay(1000);
}
```

Arduino/Genuino Mega or Mega 2560, ATmega2560 (Mega 2560) on COM10
23:36
23-11-2016

Libraries used : DHTLib available in Arduino playground.

Precautions

DHT11 should be mounted at the place as far as possible from parts that may generate heat.

The quality of connection wires will affect the quality and distance of communication and high quality shielding-wire is recommended.

SIM900A GSM Modem



Used for communicating through offline means in cases of emergency.(as mentioned above).The module supports communication in 900MHz band.

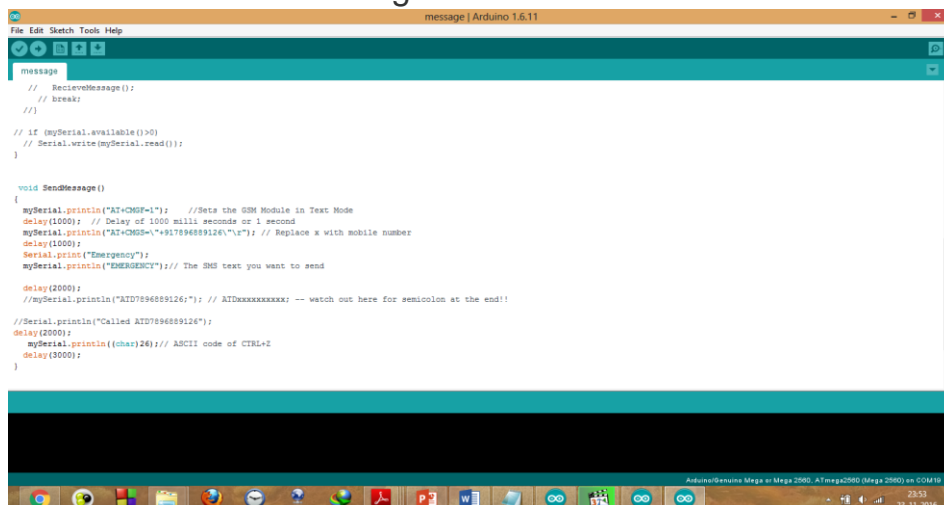
CONNECTING WITH ARDUINO:

Connection with Arduino is to be done with a great deal of care because our GSM module uses a power supply of 2 amperes and 12 volts and if power taken from Arduino or any incorrect connections will damage the Arduino. An adaptor is used(the one provided with Arduino).

The communication between Arduino and GSM module is serial. So we are supposed to use serial pins of Arduino (Rx and Tx). We may connect the Tx pin of GSM module to Rx pin of Arduino and Rx pin of GSM module to Tx pin of Arduino BUT we faced a

PROBLEM->The problem with this connection is while programming. Arduino uses serial ports to load program from the Arduino IDE. If these pins are used in wiring, the program will not be loaded successfully to Arduino. So you have to disconnect wiring in Rx and Tx each time you burn the program. Once the program is loaded successfully, you can reconnect these pins and have the system working! To avoid this difficulty, we use an alternate method in which two digital pins of arduino are used for serial communication. We need to select two PWM enabled pins of arduino for this method. So I choose pins 9 and 10 (which are PWM enabled pins). This method is made possible with the **SoftwareSerial Library** of Arduino. SoftwareSerial is a library of Arduino which enables serial data communication through other digital pins of Arduino. The library replicates hardware functions and handles the task of serial communication.

Screenshot of the message related code:



```
message | Arduino 1.6.11
File Edit Sketch Tools Help

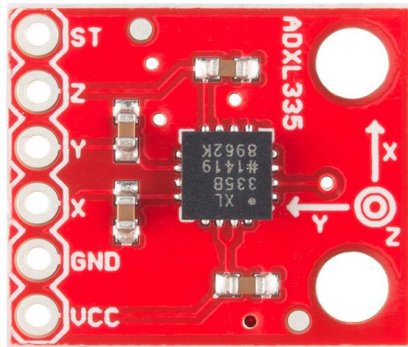
// Receives message
// break:
//

// If (mySerial.available() > 0)
// Serial.write(mySerial.read());
}

void SendMessage()
{
  mySerial.println("AT+CMGF=1"); // Sets the GSM Module in Text Mode
  delay(1000); // Delay of 1000 milli seconds or 1 second
  mySerial.println("AT+CMGS=\"+917896889126\""); // Replace x with mobile number
  delay(1000);
  Serial.println("Emergency");
  mySerial.println("EMERGENCY");// The SMS text you want to send

  delay(2000);
  //mySerial.println("ATD7896889126"); // ATDxxxxxxxxxx -- watch out here for semicolon at the end!!
  //Serial.println("Called ATD7896889126");
  delay(2000);
  mySerial.println((char)26); // ASCII code of CTRL+Z
  delay(3000);
}
```

ACCELEROMETER :



In our project we use this to detect motion, that means whenever there is a sudden motion something like falling down out of balance control or some fainting, we get the reading for the same.

RANGE :

Most accelerometers will have a selectable range of forces they can measure. These ranges can vary from $\pm 1g$ up to $\pm 250g$. Typically, the smaller the range, the more sensitive the readings will be from the accelerometer. Precautions:

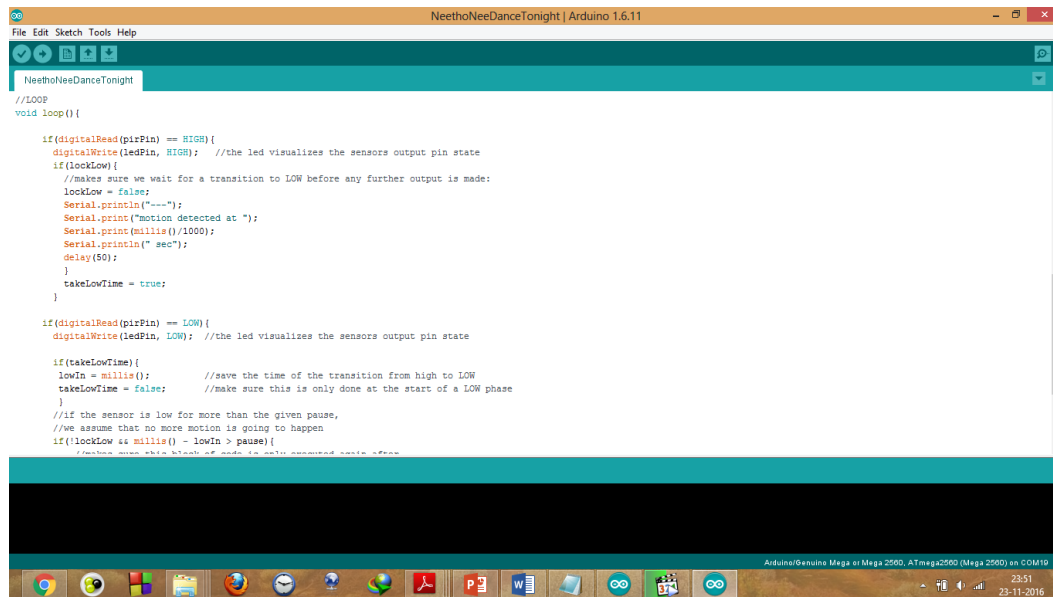
1. Look out for the sharp spikes.
2. Care is to be taken while setting the default parameters of the three parameters.

PIR Motion SENSOR:



In our project initially we used this sensor for our need of motion detection, but later shifted to sparkfun accelerometer as this sensor is too sensitive and detects every motion that happens In its range specified. The sensor itself is housed in a hermetically sealed metal can to improve noise/temperature/humidity immunity.(Fresnel lens) Behind the window are the two balanced sensors.

```
NeethoNeeDanceTonight | Arduino 1.6.11
File Edit Sketch Tools Help
NeethoNeeDanceTonight
int calibrationTime = 10;
//the time when the sensor outputs a low impulse
long unsigned int lowIn;
//the amount of milliseconds the sensor has to be low
//before we assume all motion has stopped
long unsigned int pause = 5000;
boolean lockLow = true;
boolean takeLowTime;
int pirPin = 3; //the digital pin connected to the PIR sensor's output
int ledPin = 13;
////////////////////////////////////////////////////
//SETUP
void setup() {
  Serial.begin(9600);
  pinMode(pirPin, INPUT);
  pinMode(ledPin, OUTPUT);
  digitalWrite(pirPin, LOW);
  //give the sensor some time to calibrate
  Serial.print("calibrating sensor ");
  for(int i = 0; i < calibrationTime; i++){
    Serial.print(" ");
  }
}
```



Also used was the buzzer which served as an prototype for the GSM modem implementation. Beep (with the tone function).

SCOPE FOR FUTURE IMPLEMENTATION:

1. Include more sensors like Blood Pressure sensor and Breath sensor, muscle sensor etc. which couldn't be included due to their high cost and complexity.
2. Increase the scope of the webpage and create a connected system between the doctors and patients.
3. Automated assessment and analysis of data.