Human Body Posture Detection & Correctness System

IOT Project Report

by

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April 2018

DECLARATION

I hereby certify that,

a) the work contained in this report is original and has been done by me under the guidance of my supervisor(s).
b) the work has not been submitted to any other Institute for any degree or diploma.
c) I have followed the guidelines provided by the Institute in preparing the report.
d) I have conformed to the norms and guidelines given in the Ethical Code of Conduct of the Institute.
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Name of the Students and Roll Number

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Date: 9th May 2018

CERTIFICATE

This is to certify that the Dissertation Report entitled, "Human Body Posture Detection & Correctness System" submitted by "Ayush Shrivastava, Sangeet Sagar & Suyash Mishra " to The LNM Institute of Information Technology, Jaipur, India, is a record of bonafide Project work carried out by them under my supervision and guidance and is worthy of consideration for the award of the degree of Bachelor of Technology in Electrical Engineering of the Institute.

Mr Abhishek Sharm

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Jaipur

Date: 9th May 2018

ACKNOWLEDGMENT

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Abstract

Posture is a manner by which a human holds his body so that there is less strain on muscles amid development. Poor body posture prompts numerous medical problems. Wrong posture issues, which extend from back agony to weariness may ascend and influence our day by day exercises. The Nowadays most extreme populace experiences back pain, wounds, neck pain and shoulder issues and so forth., henceforth a need to build up a gadget is expanded.

The focal point of this task is to build from scratch a wearable gadget to distinguish user's posture; particularly bring down back posture and give haptic criticism via a webserver and an android app and in addition input in graphical arrangement to client's gadget.

The primary point of the framework is to recognize the right or wrong posture by identifying the changes happened in human body posture utilizing sensors i.e. accelerometer sensor (ADXL 345).

The changes happen in various ways (i.e. right, left, forward, in reverse) are distinguished utilizing accelerometer sensor, by calculating the angles as indicated by the tiltation of a body. Sign of the wrong posture is given by a red LED and a caution in the client's cell phone and the outcomes are shown on the versatile mobile application and the web server for the client to screen. The Device is intended for human comfort and great body posture, which is required to keep up body and mind sound.

Introduction

Proposal

In the survey conducted by Ismail Wilson Taifa et. al on her paper on "*Anthropometric measurements for ergonomic design of students' furniture in India*" among 290 males and 188 females, 243 of them reported back pain due to incorrect bodily alignment either while studying or while eating or while walking. Out of these 150 complained of sever back pain. 103 among the total complained of difficulty in breathing. While 196 suffered from Insomnia (sleeplessness).

As per the American Chiropractic Association Lower back pain is the second most basic explanation behind visits to a specialist, outnumbered just by upper-respiratory diseases. Because of off base body posture, stress or strain enforces on these spinal segments, brings about numerous reactions on body, for example, strain on muscles, herniated circle, squeezed nerve pain, depression, stretch, stomach related problem, breathing issue, back and neck pain, bear pain, migraine, slumping, adjusted shoulders, hunchback, bowed knees, tilting head forward, bolted knees, curving of low midsection and numerous more The different contributing elements to postural brokenness are absence of training or familiarity with redress posture, stationary way of life, occupational demands, decreased fitness, muscle shortcoming and poor ergonomic work-station, which brings about planning and improvement of a Wearable devices so it alarms the human time to time about the unsatisfactory posture amid sitting. There are different medications which are utilized to redress the poor body postures, for example, works out (like lower-back and stomach exercise, thigh extend, hamstring and neck, back, shoulder and upper back exercise and so on.), extend physiotherapy treatment, electrotherapy, looking after standing, sitting and strolling posture legitimately (for instance, to limit weight on bring down back, sit immovably back on the seat and pick a seat that solidly underpins your lower back and so on.)Our posture influences the soundness of our spine. The vertebrae in the lumbar locale are the biggest in the spine; with L4 and L5 being harmed generally much of the time. The human body isn't made to sit before PC screens for a considerable length of time, the body weight gets dispersed dominatingly to the lower back and pelvic territories.

Our wearable which is to be at the lower back i.e. at best of the lumbar spine will keep up posture inside a range. The arrangement we made is a little wearable gadget which will keep up posture inside a scope of point while tolerating a little type of slouching as breathing space. Not only this we have additionally executed an adaptable instrument to caution the client in the event of his mistaken body posture through his phone and toward the day's end the customer can likewise screen his whole day's report helping him breaking down his posture action.

Objective

Goals:

- Give discreet ongoing dynamic feedback and furthermore information like daily report chart, on an individual gadget like his/her cell phone as well in his/her email with respect to the posture of the his/her by means of sensors like accelerometer and NodeMCU (ESP8266).

Functions

- Collect information on the situation of the lower back through an accelerometer (ADXL 345).
- Convert the raw values from the sensors to precise estimations of the lower back.
- Send criticism through the NodeMCU (ESP8266) to the user's mobile app and his email alerting the user's need to revise their posture

LITERATURE SURVEY

Over the last decade an extensive amount of work has been tried and tested successfully in order to full fill the communication between normal people and paralytic/disabled people. D. Vishnu Vardhan et al. in his paper on " Hand Gesture Recognition Application for Physically Disabled People " proposed a dynamic model to establish communication between paralytic or disabled patients. This paper has totally clarified about the hand signal acknowledgment. An electronic hand glove has been made for the general population who are dumb or experiencing Quadriplegia and paraplegia, sicknesses caused because of the wounds to the spinal rope. In this glove 5 accelerometer sensors have been utilized on every last finger of the glove. Because of this they give more precision in little developments of the fingers too. The increasing velocities of a hand movement in three opposite ways are identified by accelerometers and quickening esteems were transmitted to microcontroller. Diverse hand signals were given the distinctive messages which were changed over into voice messages utilizing sound module.

A very excellent paper by Amarjot Singh, on " An Intelligent Multi-Gesture Spotting Robot to Assist Persons with Disabilities " exhibited a framework which can be utilized by disabled individuals to communicate with machines keeping in mind the end goal to utilize it to their daily life. The framework centers around pose estimation of gestures utilized by physically disabled individuals to give suitable signals to the machines. Pose is created using silhouettes took after by motion recognition using Mahalanobis distance metric. The framework was additionally implemented to control a wireless robot from different gestures utilized by disabled individuals. The basic American sign language symbols I Hand, II Hand, Aboard, All Gone, and so on were recognized and a specific signal as for each motion is transmitted which controls the robot. The robot is made to perform forward, in reverse, left, right and stop actions for each motion introduced to the framework by the disabled individual. The present framework can likewise be demonstrated to send wireless SMS or emails in more terrible situations. The framework showed power in the estimation of motion and pose for interpreting the sign language by using the silhouettes of the pose. The proposed framework recognizes sign language, in this manner providing disabled individuals a medium to communicate with machines, leading to simplicity in their everyday work.

PROPOSED SYSTEM

Problem Statement

Build a real time human body posture detection and correctness system using accelerometer sensor and NodeMCU (ESP8266). Also, build a mobile app to caution the user in case his/her posture is incorrect and a web server where the user can track his daily report of his posture.

Solution

For the purpose of this project we will be using ADXL335 accelerometer sensor which measures the acceleration force based on the principle of MEMS (MicroElectro-Mechanical systems)

● Initial step is to inquire about and comprehend the correctness of the general posture like standing, sitting, strolling and dozing. (Understanding of correct edge and position of each posture is required for making a brilliant posture recognition and adjustment gadget)

● Following stage will be to configure every one of the Accelerometers with the NodeMCU. (Programming will be done utilizing Android IDE, Accelerometer will yield the analog signal demonstrating the x,y and z axis of the movements)

● Next piece of the task is to investigate and compute the information came about by the accelerometer as analog output to give the desired outcome (i.e. device will compute the information and distinguish which posture individual is as of now in and check if client is in indicated limits of that posture or not)

● We will be establishing a simple Webserver using NodeMCU which is visited by the users who are in the same network of the server to check the body posture and alert will be pop-up in case of wrong body posture.

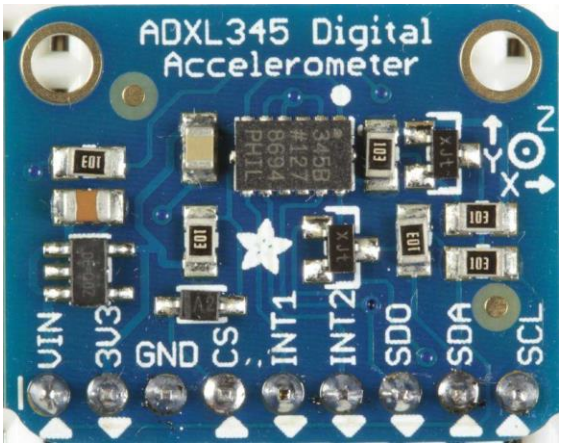
Components

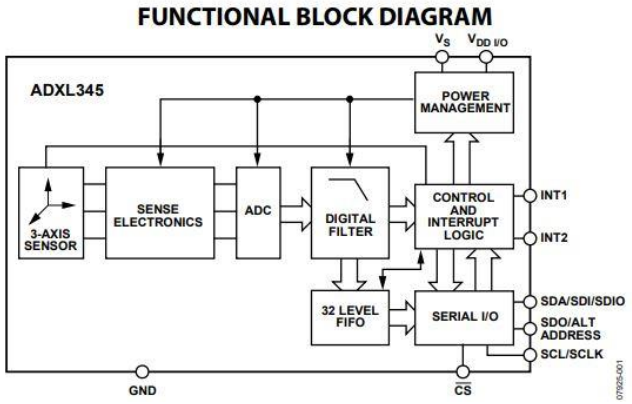
- **ADXL 345 Accelerometer**

  The ADXL345 is a low-control, 3-pivot MEMS accelerometer modules with both I2C and SPI interfaces.

  The ADXL345 highlights 4 affectability ranges from +/ - 2G to +/ - 16G. Furthermore, it bolsters output information rates going from 10Hz to 3200Hz.

The sensor comprises of a smaller scale machined structure on a silicon wafer. The structure is suspended by polysilicon springs which enable it to divert easily toward any path when subject to increasing speed in the X, Y and additionally Z axis. Redirection causes an adjustment in capacitance between settled plates and plates appended to the suspended structure. This adjustment in capacitance on every pivot is changed over to a yield voltage relative to the increasing speed on that hub.





The ADXL345 is appropriate for mobile gadget applications. It measures the static acceleration of gravity in tilt-detecting applications, and in addition dynamic speeding up resulting due to movement or shock. ts high resolution (4 mg/LSB) enables measurement of inclination changes less than 1.0°.

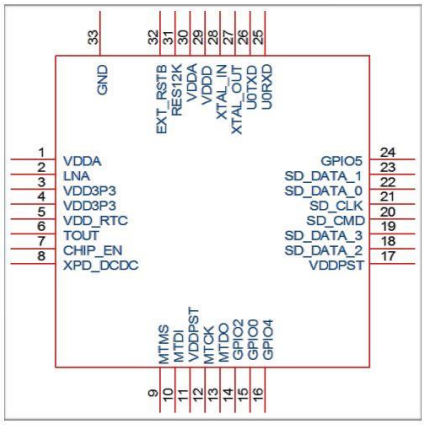
- **NodeMCU (ESP8266)**

Espressif Systems' Smart Connectivity Platform (ESCP) is an arrangement of superior, high integration wireless SOCs, intended for space and power compelled mobile stage planners. It gives amazing capacity to insert WiFi abilities inside different frameworks, or to work as an independent application, with the most reduced cost, and negligible space prerequisite.

The main features of **ESP8266** are listed below:

- Based on wireless standard 802.11 b/g/n
- The operating voltage is between 3 volts to 3.6 volts.
- Operating current is approximately 80 mA.
- Network Protocols IPv4, TCP/UDP/HTTP/FTP.
- Major applications:
  - Wearable Gadgets

- Smart home appliances
- Smart Home automation



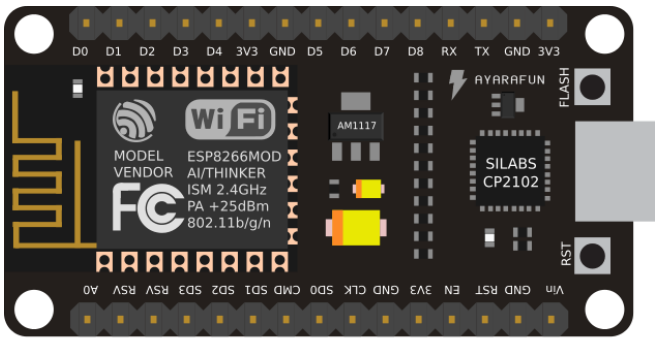
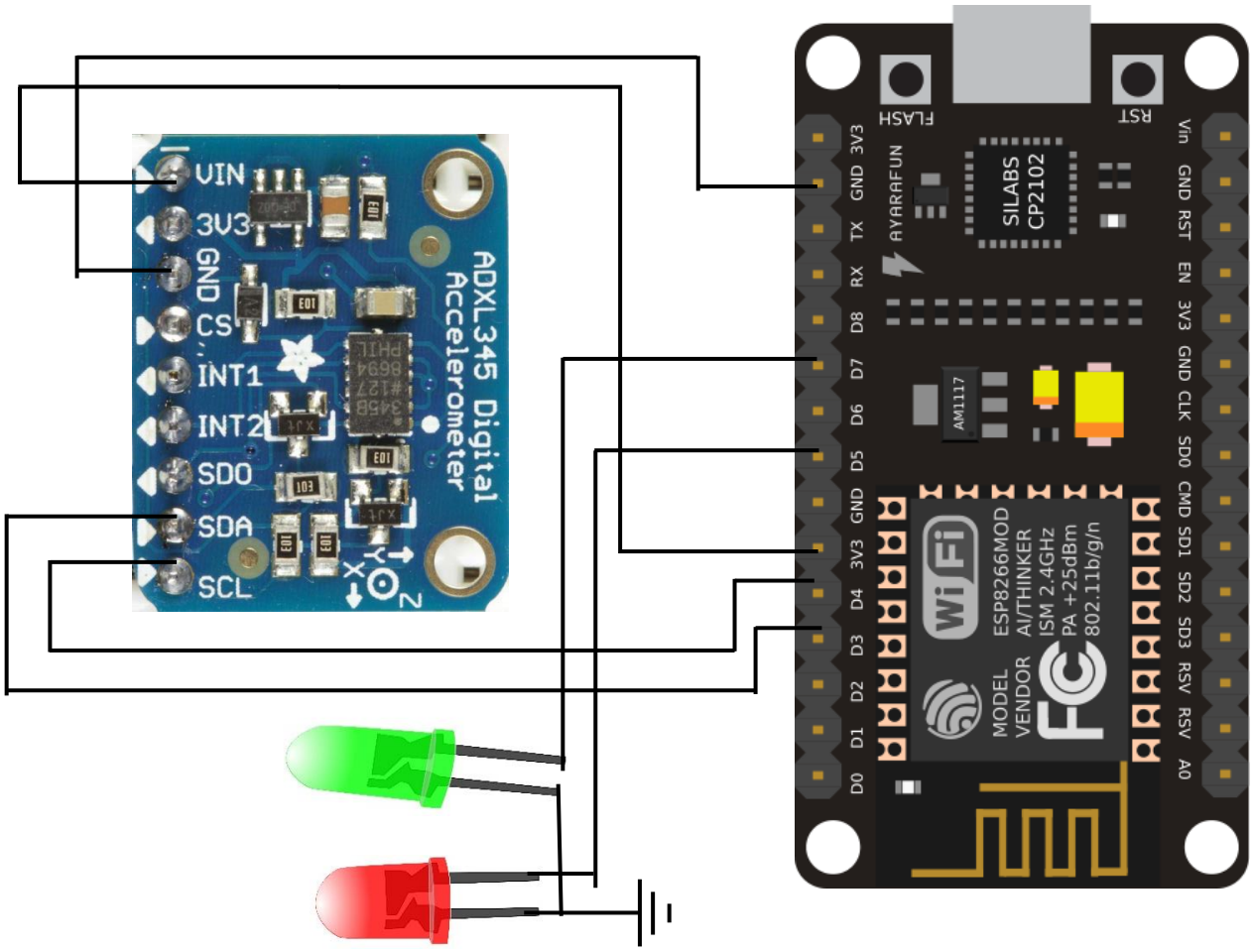
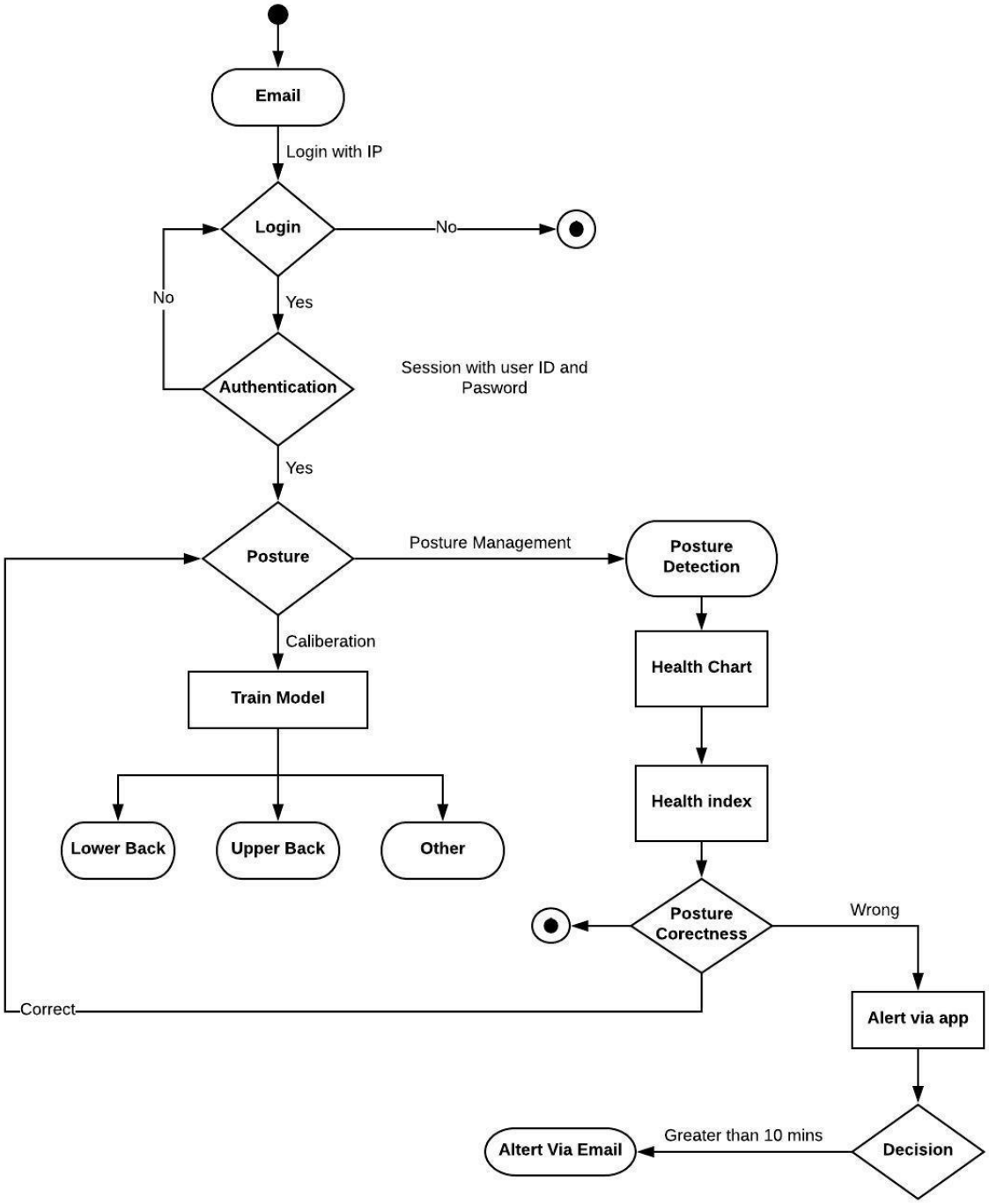


Figure 2 Pin Assignments

CIRCUIT DIAGRAM



ACTIVITY DIAGRAM



TECHNOLOGY USED

1. Client Side

- HTML(mixed with ASP .NET)
- CSS
- JavaScript
- jQuery

2. Server Side

- C/C++
- HTTP server
- AJAX

3. Database

- Google Database (Google Drive)

4. APIs/Framework

- JSWebkit API
- HTTP Wifi API
- Bootstrap framework
- Google GO framework

5. Algorithms

- BFS algorithm
- Reinier van Vliet and Remco Lam (Proposed)
- Convex Hull (Proposed)

DESCRIPTION OF TECHNOLOGIES USED

HTML, CSS, JavaScript, jQuery

Hypertext Markup Language (HTML) is the standard markup dialect for making pages and web applications. With Cascading Style Sheets (CSS) also, JavaScript it frames a set of three of foundation advances for the World Wide Web. Web programs get HTML records from a web server or from nearby capacity and render them into sight and sound site pages. jQuery is a cross-stage JavaScript library intended to improve the customer side scripting of HTML.

JavaScript is one of the three center advancements of the World Wide Web. JavaScript empowers intuitive pages and subsequently is a fundamental piece of web applications. Most by far of sites utilize it, and all significant web programs have a committed JavaScript motor to execute it.

JSWebkit API

This API's primary focus is content deployed on the World Wide Web, using standards-based technologies such as HTML, CSS, JavaScript and the DOM. However, we also want to make it possible to embed WebKit in other applications, and to use it as a general-purpose display and interaction engine.

HTTP

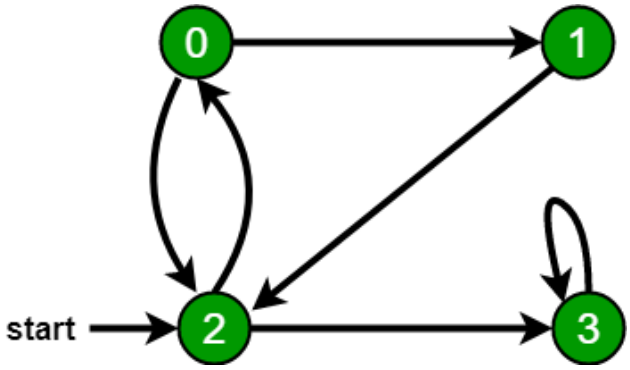
HTTP implies HyperText Transfer Protocol. HTTP is the basic convention utilized by the World Wide Web and this convention characterizes how messages are designed and transmitted, and what activities Web servers and programs should take because of different orders.

For instance, when you enter a URL in your program, this really sends a HTTP order to the Web server guiding it to bring and transmit the asked for Web page. The other primary standard that controls how the World Wide Web functions is HTML, which covers how Web pages are designed and shown.

DFS Algorithm

Breadths First Traversal (or Search) for a diagram is like Breadth First Traversal of a tree (See strategy 2 of this post). The main catch here is, dissimilar to trees, diagrams may contain cycles, so we may go to a similar hub once more. To abstain from handling a hub more than once, we utilize a boolean went to cluster. For effortlessness, it is accepted that all vertices are reachable from the beginning vertex. For instance, in the accompanying diagram, we begin traversal from vertex 2. When we come to vertex 0, we search for all nearby vertices of it. 2 is likewise a

neighboring vertex of 0. On the off chance that we don't stamp went by vertices, at that point 2 will be handled again and it will end up being a non-ending process. A Breadth First Traversal of the accompanying chart is 2, 0, 3, 1.



AJAX

AJAX = Asynchronous JavaScript and XML.

AJAX is a procedure for making quick and dynamic site pages.

AJAX permits pages to be refreshed asynchronously by trading little measures of information with the server in the background. This implies it is conceivable to refresh parts of a site page, without reloading the entire page.

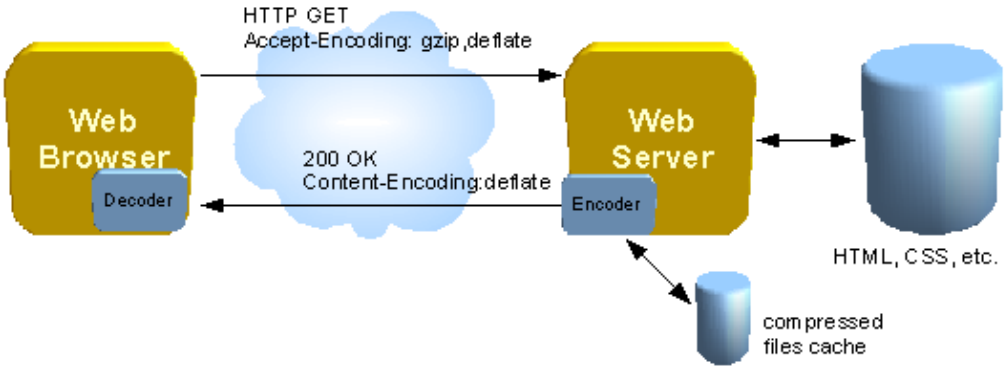
Exemplary pages, (which don't utilize AJAX) must reload the whole page if the substance should change.

‘

IMPLEMENTATION AND MODULES CREATED

Webserver

- NodeMCU supports multiple modes for WiFi setup such as Station, Access Point (AP) and other combinations.
- We have established the web server using <WiFiClient.h> and <ESP8266WebServer.h> library
- Frontend part of the web server was done using HTML,CSS and JavaScript. Since the nodemcu provides 128Kb memory only so all the libraries are uploaded online and are accessed on runtime.
- Using Accelerometer values of x, y and z axis are recorded and sent to the web server using AJAX




```
Serial.print("Configuring access point...");
Serial.println("Connecting to wifi: ");
Serial.println(ssid);
Serial.flush();

WiFi.begin(ssid, password);
while (WiFi.status() != WL_CONNECTED) {
  delay(500);
  Serial.print(".");
}
Serial.println(" IP address: ");
Serial.println(WiFi.localIP());
server.on("/", handleRoot);
server.on("/login", handleLogin);
server.on("/settings", handleSettings);
server.on("/inline", [](){
  server.send(200, "text/plain", "this works without need of authentification");
});
```

Mail-Service

Google App script has been created by our team for sending the appropriate mail using "GO" framework and is uploaded in our google drive.

In Nodemcu C Program SendValueToGoogle() function is created which will generate the interrupt and send arguments to the google script and Email is sent.

In Email user will get the IP address of nodemcu in the network for the authentication Purpose

SendValueToGoogle() function and snapshot of google script are attached below.

```
void sendValueToGoogle(String value){
  if (!client.connected()){
    Serial.println("Connecting to client again...");
    client.connect(host, httpsPort);
  }
  String urlFinal = url + "string=" + value;
  client.printRedir(urlFinal, host, googleRedirHost);
}
```

```
const char *GScriptId = "AKfycbzhtrErTHbp5RdznmUbvs09tf-pCcKYJdpg18XtJtKqEZJnvKA_";
const char* host = "script.google.com";
const char* googleRedirHost = "script.googleusercontent.com";
const int httpsPort =  443;
HTTPSRedirect client(httpsPort);
String url = String("/macros/s/") + GScriptId + "/exec?";
```

Reading values from accelerometer

```
float readAccel(int var)
{
  //Serial.print("readAccel");
  uint8_t howManyBytesToRead = 6; //6 for all axes
  readFrom( DATAX0, howManyBytesToRead, _buff); //read the acceleration data from the ADXL345
  short x =0;
   x = (((short)_buff[1]) << 8) | _buff[0];
  short y = (((short)_buff[3]) << 8) | _buff[2];
  short z = (((short)_buff[5]) << 8) | _buff[4];
  //Serial.println(x * ADXL345_MG2G_MULTIPLIER * SENSORS_GRAVITY_STANDARD);

  Serial.print("x :"); Serial.print(x);
  Serial.print(" y :"); Serial.print(y);
  Serial.print(" z :"); Serial.println(z);
  incr++;
  if(incr%100==0)
  {
    healthvalues[index1]=c;
    //Serial.println(healthvalues[index1]);
    index1++;

    if(index1==10)
    {
      index1=0;
    }
  }
```

ReadAccel() function take argument (1,2,3) as input. If value of variable is 1 than it will return analog value of X-axis, If value is 2 than Y-axis and 3 for Z-axis. Value is stored in an array named buffer values of accelerometer axis are left shifted by 8bits (Each axis reading comes in 16 bit resolution, ie 2 bytes. Least Significant Byte first!! thus we are converting both bytes in to one int) The accelerations in raw format are stored in registers – DATAX0, DATAX1, DATAY0, DATAY1, DATAZ0 and DATAZ1.

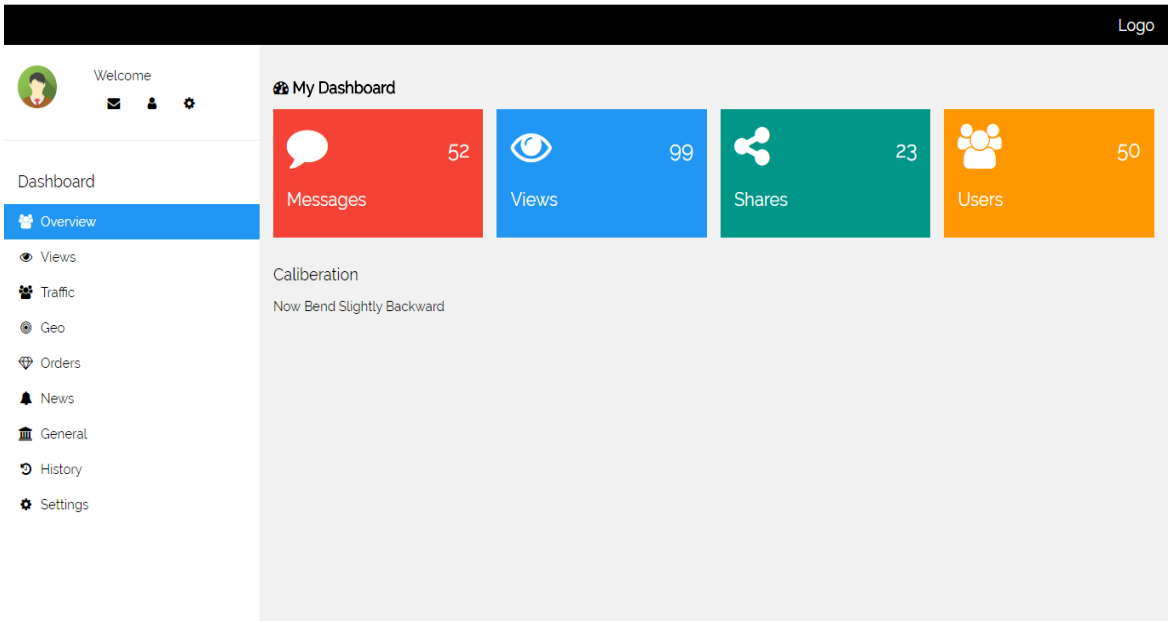
Code for posture detection

```
if(c>(coordinate1_z+int(10)) || c<(coordinate2_z-int(10)))
 {

          count++;
          textn += String("Wrong1")+"<br><br>";
          digitalWrite(13, LOW);
          digitalWrite(14, HIGH);
          wrong_p++;
          if(c>(coordinate1_z+int(10)))
          {
           textn += String("Your back is bend forward beyond the limit move backward")+"<br><br>";
          }
          else
          {
            textn += String("Your back is bend backward beyond the limit move forward")+"<br><br>";
          }

 }
```

```
else
{
       if((c<(center_z+int(15)) && c>(center_z-int(15))) && (current_value>(coordinate3_x+int(10)) || current_value<(coordinate4_x-int(10))))
       {
         //if(current_value>(coordinate3_x+int(10)) || current_value<(coordinate4_x-int(10)))
         {
             count++;
             textn += String("Wrong2")+"<br><br>";
             digitalWrite(13, LOW);
             digitalWrite(14, HIGH);
             wrong_p++;
             if(current_value>(coordinate3_x+int(10)))
             {
               textn += String("Your back is shifted towards left beyond the limit... shift towards the right")+"<br><br>";
             }
             else
             {
               textn += String("Your back is shifted towards right beyond the limit... shift towards the left")+"<br><br>";
             }

         }
       }
       else if((c>(center_z+int(15)) || c<(center_z-int(15))) && (current_value>(center_x+int(14)) || c<(center_x-int(14))))
       {
         //if(current_value>(center_x+int(14)) || c<(center_x-int(14)))
         {
           count++;
           wrong_p++;
```

Model Training

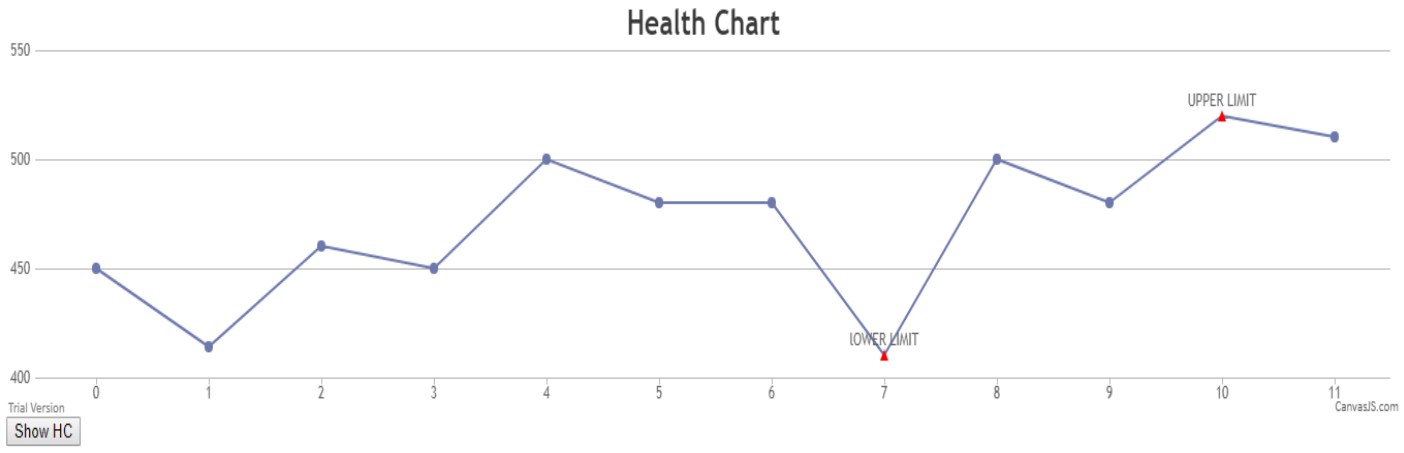
Module for training model is created which means that this module is responsible for calibrating user's posture by asking user to perform some basic movements. Values of users' calibrations are stored in a buffer in form of coordinates which is then pass to posture detection module which maps all the coordinate provided and generate the threshold (allowed) values for posture detection.



Snap of calibration function for training model is attached bellow.

```
function calib(){
  document.getElementById('mydiv').innerHTML = 'Keep Your Back Straight';
  var msg1 = new SpeechSynthesisUtterance('Keep Your Back Straight');
  setTimeout(function(){measure1(0);},5000);
  window.speechSynthesis.speak(msg1);
  setTimeout( "document.getElementById('mydiv').innerHTML = 'Nice Job';", 5000);
  setTimeout( "var msg2 = new SpeechSynthesisUtterance('Nice Job');window.speechSynthesis.speak(msg2);", 5000);

  setTimeout( "var msg2 = new SpeechSynthesisUtterance('Now Bend Slightly forward');window.speechSynthesis.speak(msg2);document.getElementById('mydiv').innerHTML
    = 'Now Bend Slightly forward';", 8000);
  //setTimeout(measure1,8000);
  setTimeout( "var msg2 = new SpeechSynthesisUtterance('Nice Job');window.speechSynthesis.speak(msg2);document.getElementById('mydiv').innerHTML = 'Nice Job';",
    12000);
  setTimeout(measure1(1),11000);
  setTimeout( "var msg2 = new SpeechSynthesisUtterance('Now Comeback to your initial position');window.speechSynthesis.speak(
    msg2);document.getElementById('mydiv').innerHTML = 'Now Comeback to your initial position';", 15000);
  setTimeout( "var msg2 = new SpeechSynthesisUtterance('Awesome');window.speechSynthesis.speak(msg2);document.getElementById('mydiv').innerHTML = 'Awesome';",
    20000);
  setTimeout( "var msg2 = new SpeechSynthesisUtterance('Now Bend Slightly Backward');window.speechSynthesis.speak(msg2);document.getElementById('mydiv').innerHTML
    = 'Now Bend Slightly Backward';", 23000);
  setTimeout( "var msg2 = new SpeechSynthesisUtterance('Cool!! you are half done...Now come back to your initial position');window.speechSynthesis.speak(
    msg2);document.getElementById('mydiv').innerHTML = 'Cool!! you are half done...Now come back to your initial position';", 28000);
  setTimeout(measure1(2),27000);
  setTimeout( "var msg2 = new SpeechSynthesisUtterance('Stand still and move your back slightly towards left');window.speechSynthesis.speak(
    msg2);document.getElementById('mydiv').innerHTML = 'Stand still and move your back slightly towards left';", 35000);
  setTimeout( "var msg2 = new SpeechSynthesisUtterance('Now Comeback to your initial position');window.speechSynthesis.speak(
    msg2);document.getElementById('mydiv').innerHTML = 'Now Comeback to your initial position';", 41000);
  setTimeout(measure1(3),40000);
  setTimeout( "var msg2 = new SpeechSynthesisUtterance('Stand still and move your back slightly towards right');window.speechSynthesis.speak(
    msg2);document.getElementById('mydiv').innerHTML = 'Stand still and move your back slightly towards right';", 46000);
  setTimeout( "var msg2 = new SpeechSynthesisUtterance('Congratulations!! Your body measurements are recorded');window.speechSynthesis.speak(
    msg2);document.getElementById('mydiv').innerHTML = 'Congratulations!! Your body measurements are recorded';", 51000);
  setTimeout(measure1(4),50000);
```

Health Chart



HealthChart module is responsible for the user's to see the chart which will generate the data of previous 10 time units So, User can keep record of their posture and see their "posture progress"

CONCLUSION & FUTURE WORK

- A system which is in the form of a belt is designed help correct incorrect body posture and maintaining body and mind healthy.
- System alerts the user about their inaccurate posture in time via a mobile app.
- User will also be able to track real time activity of his posture. A lot of back related problems can be cured by correcting postures during different works in life.
- HealthChart feature is introduced in the application through which user can see the chart which will generate the data of previous 10 time units So, User can keep record of their posture and see their "posture progress"
- Mobile Application is also created which is currently in beta version, Which provides the same functionalities as a web application
- For optimizing the results of model training better algorithm like convex hull is needed which will find at any given instance if given point is inside the polygon or not. Here polygon is the virtual area in which posture is correct if at any given instance point is beyond this area than wrong posture will be indicated
- We have planned in future to use more sensors so that more accurate and full body scan/mapping is possible

Full code here –

https://drive.google.com/file/d/1C1riHy1CMBKrxaB5gpGFSfSV8AaOuip2/view?usp=sharing

Android App APK –

https://drive.google.com/open?id=1Qeq64UyN7e_Ylmm0jMKZQgnICsRBt8od

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