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Project Title:

BEAT PLOT: Health analysis using ECG

Name of the subject:

Technical Answers for Real World Problems (TARP) ECE 3999

Batch 3

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BEAT PLOT: Health analysis using ECG

A Project Report

*Submitted in partial fulfilment of the requirement for the evaluation of
J component for the subject ECE3999 TARP by:*

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Under the Guidance of

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May, 2020

Declaration

I hereby declare that the project work entitled “**BEAT PLOT:Health analysis using ECG**” submitted by our team for J component evaluation for the subject ECE3999 TARP, the work reported in this report has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma in this institute or any other institute or university.

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Place : VIT, Vellore

Date: May, 2020

ACKNOWLEDGEMENT

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Besides, we would like to thank the authority of VIT UNIVERSITY for providing us the good environment and facilities to complete this report. Also, we would like to thank them for offering this subject. It gave all of us an opportunity to participate and learn which could be fruitful for our future and carrier. Finally, we would like to thank my family and friends for their support and understanding towards my project as without their help we couldn't even possibly have had been able to finish our assignment.

Thank you.

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Abstract

Instead of always going to a hospital for heart related issues, one can use this heart rate sensor to assess the heart rate and rhythm. By analyzing the pattern of the Electrocardiogram, we can often detect the heart disease, heart attack, an enlarged heart, or abnormal heart rhythms that may cause heart failures.

We will be able to monitor both the standing as well as exercise ECG for proper analysis of the patient / athlete. This would help as the patient or athlete would not need to go to hospitals or clinics for any minor inconvenience related to their heart. Like a portable BP machine which can be used by anyone to monitor their blood pressure, this machine would be able to analyze a person's heart rate and then using various algorithms tell the patient about his/ her heart condition.

In addition to the portable nature of this, what makes this unique is that the data can be sent directly to a website using which your doctor can easily access your records and then be able to direct you on what steps to take. This all has been made possible due to cloud computing.

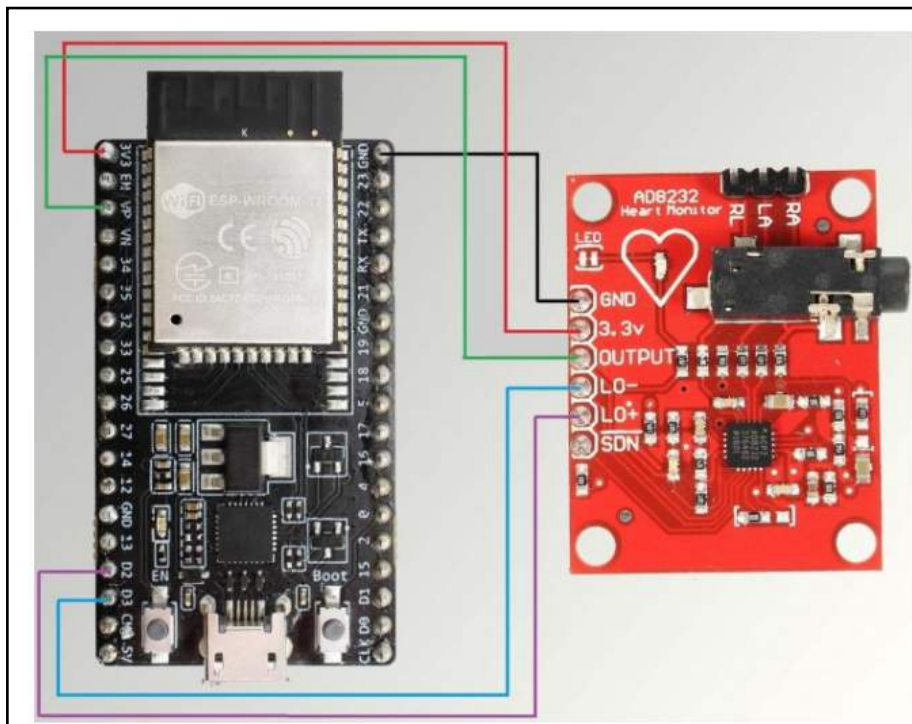
This device will be portable hence making it easier for the user to analyze their heart beat.

Theory

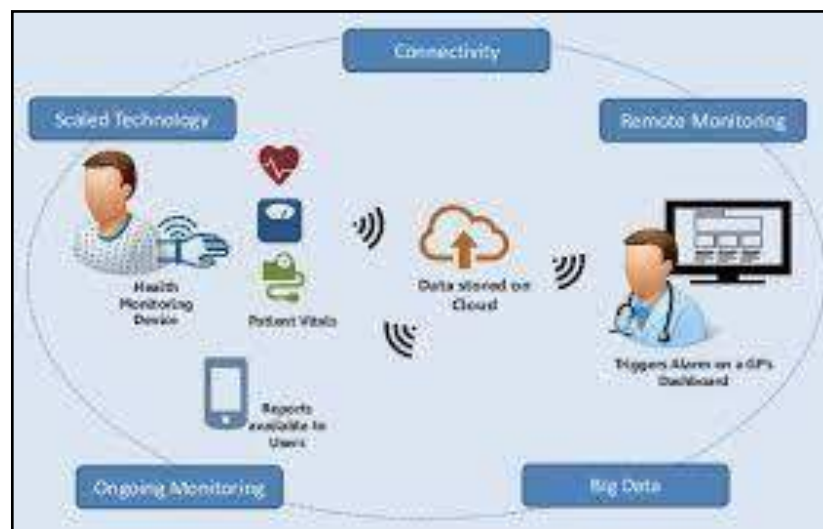
Here the main objective is to design a Remote Patient Health Monitoring System to diagnose the health condition of the patients. Giving care and health assistance to the bedridden patients at critical stages with advanced medical facilities have become one of the major problems in the modern hectic world. In hospitals where many patients whose physical conditions must be monitored frequently as a part of a diagnostic procedure, the need for a cost-effective and fast responding alert mechanism is inevitable.

Doctors and nurses need to visit the patient frequently to examine his/her current condition. In addition to this, use of multiple microcontroller based intelligent system provides high-level applicability in hospitals where many patients must be frequently monitored.

The system consists of an ECG device, a cloud-based analysis pipeline, and accompanied mobile applications for physicians and patient / athletes.



This will allow development of such low-cost devices based on natural human-computer interfaces. The system we proposed here is efficient in monitoring the different physical parameters of many number bedridden patients and then in alerting the concerned medical authorities if these parameters bounce above its predefined critical values. Thus, remote monitoring and control refer to a field of industrial automation that is entering a new era with the development of wireless sensing devices.



Proper implementation of such systems can provide timely warnings to the medical staffs and doctors and their service can be activated in case of medical emergencies. Present-day systems use sensors that are hardwired to a PC next to the bed. 5 The use of sensors detects the conditions of the patient and the data is collected and transferred using a microcontroller.

Components Required

- **ECG Electrode:** They analyze the electrical activity generated by heart muscle depolarizations, which propagate in pulsating electrical waves towards the skin. Although the electricity amount is in fact very small, it can be picked up reliably with ECG electrodes attached to the skin.



- **ECG Sensor module(AD8232):** They are used to record the readings from electrode in form of electrical potentials.



- **Microcontroller(NodeMCU):** A microcontroller is a compact integrated circuit designed to govern a specific operation in an embedded system.



- **Display:** A LED or a laptop to display the output of the project.

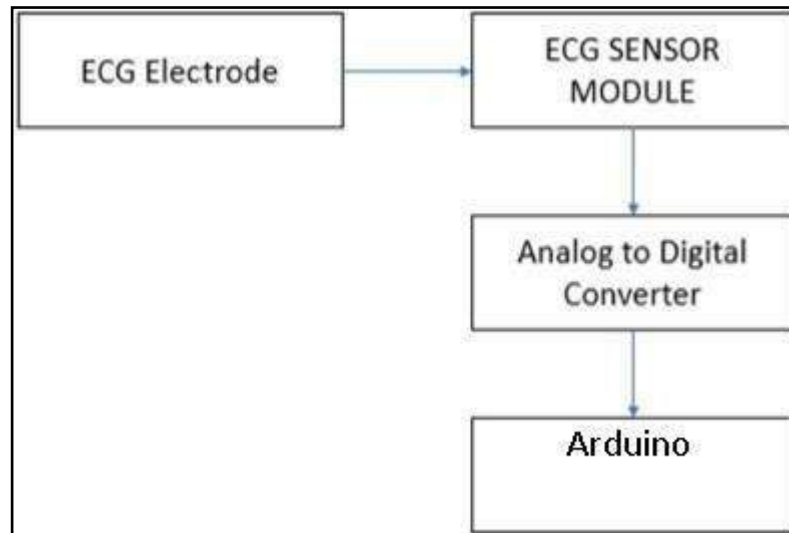


- **Jumper wires:** These are plastic coted metal wires used to interconnect the components of circuit.



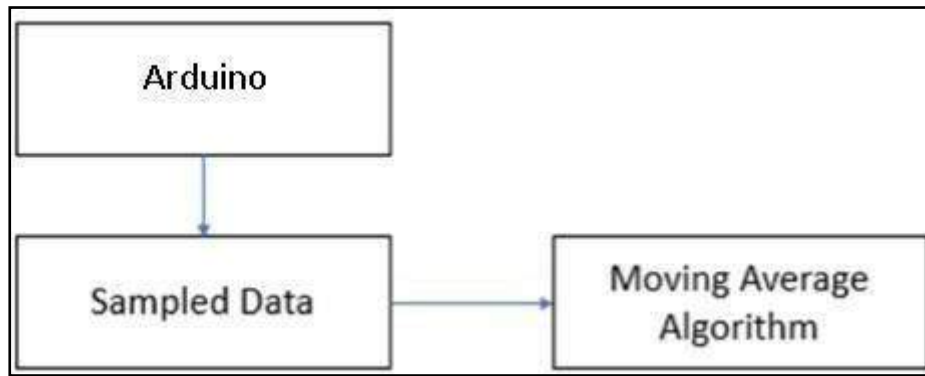
Working

Step 1:



The ECG Electrode block represents the three electrodes that are used to measure the readings from our body. The three electrodes have specific positions from where they work with maximum accuracy. The positions are Left Arm, Right Arm and Right Leg. The readings are recorded by the ECG Sensor module in the form of electrical potentials. Since we need to process the data, hence, we convert the Analog signal to a digital signal with the help of an Analog to Digital Converter. The Digital or rather say sampled values are taken as input in the single board computer. In our project, the single board computer used is Node MCU.

Step 2:



We receive the sampled data from the ADC into the Node MCU. This data is taken in form of a long list and Moving average algorithm is applied on it. This algorithm removes the sharp peaks at which the derivatives can't be found. The algorithm works by taking the mean of past, present and just future value and replacing the present value with this mean value. As a result, we get a much smoother curve which gives almost the same graph that original data would have given.

1. ECG sensor detects the heart rate and sends the data to Ubidots using node MCU.
2. We collect the data from Ubidots and make a data sheet which holds the heart rate of a person over a period of time.
3. That data sheet is saved and is loaded into Matlab. The values are used to calculate the Heart Rate in beats per minute.
4. If the heart rate is Normal the graph of the heart rate is shown on the browser and a message is given.
5. If the heart rate is too low or too high, a message is given on the browser and a Mail Alert is sent to the person's mail ID.
6. The mail alert informs the person about the high/low heart rate and gives a link to the nearest hospitals and contact details through Google.

Code

Arduino Code:

```
#include <ESP8266WiFi.h>
#include <PubSubClient.h>
#define WIFISSID "ecgbeat" // Put your WifiSSID here
#define PASSWORD "nikhil123" // Put your wifi password here
#define TOKEN "BBFF-Iv7bhxT8SqkZwUfNUJNGfldB4temD6" // Put your Ubidots'
TOKEN
#define MQTT_CLIENT_NAME "ecgbeatplot" // Enter client Name

/*****
 * Define Constants
 *****/
#define VARIABLE_LABEL "sensor" // Assing the variable label
#define DEVICE_LABEL "esp8266" // Assig the device label

#define SENSOR A0 // Set the A0 as SENSOR

char mqttBroker[] = "industrial.api.ubidots.com";
char payload[100];
char topic[150];
// Space to store values to send
char str_sensor[10];

/*****
 * Auxiliar Functions
 *****/
WiFiClient ubidots;
PubSubClient client(ubidots);

void callback(char* topic, byte* payload, unsigned int length) {
  char p[length + 1];
  memcpy(p, payload, length);
  p[length] = NULL;
  Serial.write(payload, length);
  Serial.println(topic);
}

void reconnect() {
  // Loop until we're reconnected
```

```

while (!client.connected()) {
    Serial.println("Attempting MQTT connection...");

    // Attempt to connect
    if (client.connect(MQTT_CLIENT_NAME, TOKEN, "")) {
        Serial.println("Connected");
    } else {
        Serial.print("Failed, rc=");
        Serial.print(client.state());
        Serial.println(" try again in 2 seconds");
        // Wait 2 seconds before retrying
        delay(2000);
    }
}

/*****
* Main Functions
*****/

void setup() {
    Serial.begin(115200);
    WiFi.begin(WIFISSID, PASSWORD);
    // Assign the pin as INPUT
    pinMode(SENSOR, INPUT);

    Serial.println();
    Serial.print("Waiting for WiFi...");

    while (WiFi.status() != WL_CONNECTED) {
        Serial.print(".");
        delay(500);
    }

    Serial.println("");
    Serial.println("WiFi Connected");
    Serial.println("IP address: ");
    Serial.println(WiFi.localIP());
    client.setServer(mqttBroker, 1883);
    client.setCallback(callback);
}

void loop() {
    if (!client.connected()) {
        reconnect();
    }
}

```


Website Code:

- **Back End:**

```
'use strict';

var express = require("express"),
    app = express(), path = require("path"),
    bodyParser = require("body-parser"),

    methodOverride =
        require("method-override");
var http = require('http').createServer(app);
var port = process.env.PORT || 1337;

app.use(methodOverride("_method"));
app.use(bodyParser.json());
app.use(bodyParser.urlencoded({ extended:
true })); app.set("view engine", "ejs");
app.use(express.static( dirname + "/public"));

app.get('/', function (req, res)
    { res.render("home/
    ECG_Home");
});
http.listen(port, process.env.IP, function ()
    { console.log("Server has been started!");
});
```


HTML:

```
<!DOCTYPE html>
```

```
<html>
```

```
<head>
```

```
<title>ECG Beat Plot</title>
```

```
<link rel="stylesheet" href="https://stackpath.bootstrapcdn.com/bootstrap/4.1.3/css/
bootstrap.min.css" integrity="sha384-MCw98/
SFnGE8fJT3GXwEOngsV7Zt27NXFoaoApmYm81iuXoPkFOJwJ8ERdknLPMO"
crossorigin="anonymous">
```

```
<link href="https://fonts.googleapis.com/css?family=Hanalei+Fill" rel="stylesheet">
<link rel="stylesheet" href="min.css">
```

```
</head>
```

```
<body>
```

```
<nav id="navtop" class="navbar navbar-expand-lg navbar-dark bg-primary nav-
pills">
```

```
<button class="navbar-toggler" type="button" color = "red" data-toggle="collapse"
data-target="#navbarSupportedContent" aria-controls="navbarSupportedContent"
aria-expanded="false" aria-label="Toggle navigation">
```

```
<span class="navbar-toggler-icon"></span>
```

```
</button>
```

```
<div class="collapse navbar-collapse" id="navbarSupportedContent"> <ul
```

```
class="navbar-nav mr-auto">
```

```
<li class="nav-item active selected">
```

```
<a class="nav-link items" href="index.html">Home <span class="sr-  
only">(current)</span></a>
```

```
</li>
```

```
<li class="nav-item active selected ">
```

```
<a class="nav-link items" href="http://maps.google.co.in/maps?  
q=hospitals+near">Nearest Heart Hospitals</a> </li>
```

```
<li class="nav-item dropdown active">
```

```
<a class="nav-link dropdown-
```

```
toggle active items" href="teammates.html" id="navbarDropdown" role="button"  
data-toggle="dropdown" aria-haspopup="true" aria-expanded="false"> Team-  
Mates</a>
```

```
</ul>
```

```
</div>
```

```
</nav>
```

```
<div id="outgraph" class="jumbotron">
```

```
<h1 class="logo">
```



```
<script src="https://cdnjs.cloudflare.com/ajax/libs/popper.js/1.14.3/umd/
popper.min.js" integrity="sha384-
ZMP7rVo3mIykV+2+9J3UJ46jBk0WLaUAdn689aCwoqbBJiSnjAK/
l8WvCWPIpm49" crossorigin="anonymous"></script>
</body>
```

```
</html>
```

Team members HTML

```
<!DOCTYPE html>
```

```
<html>
```

```
<head>
```

```
<title>ECG-TARP</title>
```

```
<link rel="stylesheet" href="https://stackpath.bootstrapcdn.com/bootstrap/4.1.3/css/
bootstrap.min.css" integrity="sha384-MCw98/
SFnGE8fJT3GXwEOngsV7Zt27NXFoaoApmYm81iuXoPkFOJwJ8ERdknLPMO"
crossorigin="anonymous">
```

```
<link href="https://fonts.googleapis.com/css?family=Hanalei+Fill" rel="stylesheet">
<link rel="stylesheet" href="min.css">
```

```
</head>
```

```
<body>
```

```
<nav id="navtop" class="navbar navbar-expand-lg navbar-dark bg-primary nav-
pills">
```

```
<button class="navbar-toggler" type="button" data-toggle="collapse" data-
target="#navbarSupportedContent" aria-controls="navbarSupportedContent" aria-
```

expanded="false" aria-label="Toggle navigation">

</button>

<div class="collapse navbar-collapse" id="navbarSupportedContent"> <ul
class="navbar-nav mr-auto">

<li class="nav-item active selected">

Home <span class="sr-
only">(current)

<li class="nav-item active selected ">

<a class="nav-link items" href="http://maps.google.co.in/maps?
q=hospitals+near">Nearest Heart Hospitals

<li class="nav-item dropdown active">

<a class="nav-link dropdown-

toggle active items" href="teammates.html" id="navbarDropdown" role="button"
data-toggle="dropdown" aria-haspopup="true" aria-expanded="false"> Team-
Mates

</div>

</nav>

<div id="outgraph" class="jumbotron" size = "50%">

<center>

<h1 class="logo">

Teammates

 Information

</h1>

Ayush Gurtu

Nikhil Bharadwaj

Saharsh Agarwal

Utkarsh Gandhi

Yeain Shukla

<p>

</p>

</div>

</div>

</nav>

<p>ECG Team is designed by VIT students under the guidance of Dr. Harish Kittur </p>

<p><small>From students for people.</small></p>

<script src="https://code.jquery.com/jquery-3.3.1.slim.min.js" integrity="sha384-q8i/X+965DzO0rT7abK41JStQIAqVgRVzpbzo5smXKp4YfRvH+8abtTE1Pi6jizo" crossorigin="anonymous"></script>

```
<script src="https://cdnjs.cloudflare.com/ajax/libs/popper.js/1.14.3/umd/
popper.min.js" integrity="sha384-
ZMP7rVo3mIykV+2+9J3UJ46jBk0WLaUAdn689aCwoqbBJiSnjAK/
l8WvCWPIpM49" crossorigin="anonymous"></script>
```

```
<script src="https://stackpath.bootstrapcdn.com/bootstrap/4.1.3/js/bootstrap.min.js"
integrity="sha384-
ChfqquxZUCnJSK3+MXmPNlyE6ZbWh2IMqE241rYiqJxyMiZ6OW/
JmZQ5stwEULTy" crossorigin="anonymous"></script>
```

```
</body>
```

```
</html>
```

CSS:

```
body {
background-image: url("heart.jpg");

background-position: left center;

background-repeat: no-repeat; background-
attachment: fixed; background-size: cover;

background-color: #464646;

}
```

```
#graph{ align-content:center;

}
```

PHP

```
use strict';

var express = require("express"),

app = express(), path = require("path"),

bodyParser = require("body-parser"),

methodOverride = require("method-override");

var http = require('http').createServer(app); var

port = process.env.PORT || 1337;

app.use(methodOverride("_method")); app.use(bodyParser.json());
app.use(bodyParser.urlencoded({ extended: true })); app.set("view engine", "ejs");
app.use(express.static( dirname + "/public"));

app.get('/', function (req, res) {

res.render("home/ECG_Home");

});

http.listen(port, process.env.IP, function () {

console.log("Server has been started!");

});
```


MATLAB CODE

main.m

```
clear all;
clc;
data = input('Enter the dataset : ','s');
hr = beatRate(data);
s = 'The beat rate is '+string(round(hr,1))+ ' BPM.';
if(hr < 60)
    s2 = 'The heart rate is very low! Please take him/her to the doctor!';
    fid = fopen('record.txt','wt');
    fprintf(fid,'%s\n%s',s,s2);
    fclose(fid);
    sendEmail(hr);
    dos('start index.html');
    dos("start http://maps.google.co.in/maps?q=hospitals+near");
else
    if(hr>100)
        s2 = 'The heart rate is very high! Please take him/her to the doctor!';
        fid = fopen('record.txt','wt');
        fprintf(fid,'%s\n%s',s,s2);
        fclose(fid);
        sendEmail(hr);
        dos("start index.html");
        dos("start http://maps.google.co.in/maps?q=hospitals+near");
    else
        s2 = 'The heart rate is normal';
        fid = fopen('record.txt','wt');
        fprintf(fid,'%s\n%s',s,s2);
        fclose(fid);
        dos('start index.html');
    end
end
end
```

sendmail.m

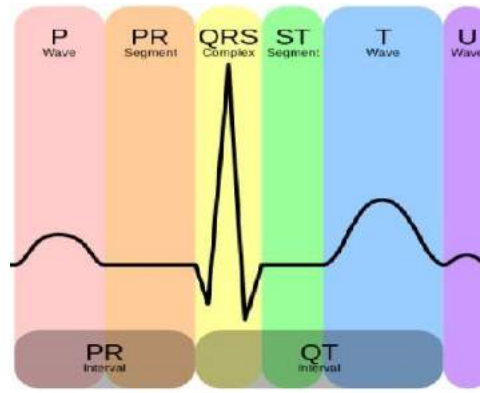
```
function sendEmail(hr)
clc
source = 'nikhilbharadwaj0@gmail.com';           %from address (gmail)
destination = 'ut261998@gmail.com';             %to address (any mail service)
myEmailPassword = 'Nikhil321!';                 %the password to the 'from' account
subj = 'Important Heart rate problem.'; % subject line
s1 = 'The heart rate of your dear one is at '+string(hr)+'BPM which is abnormal.';
s2 = 'Please click on the link to check the nearest hospitals: ';
msg = s1+s2+'http://maps.google.co.in/maps?q=hospitals+near'; % main body of
email.
%set up SMTP service for Gmail
setpref('Internet','E_mail',source);
setpref('Internet','SMTP_Server','smtp.gmail.com');
setpref('Internet','SMTP_Username',source);
setpref('Internet','SMTP_Password',myEmailPassword);
% Gmail server.
props = java.lang.System.getProperties;
props.setProperty('mail.smtp.auth','true');
props.setProperty('mail.smtp.socketFactory.class',
'javax.net.ssl.SSLSocketFactory');
props.setProperty('mail.smtp.socketFactory.port','465');
% Send the email
sendmail(destination,subj,msg);
% [Optional] Remove the preferences (for privacy reasons)
setpref('Internet','E_mail','');
setpref('Internet','SMTP_Server','');
setpref('Internet','SMTP_Username','');
setpref('Internet','SMTP_Password','');
disp('Email sent!');
end
```

beatrate.m

```
function heartRate = beatRate(data)  
n20x = load(data);  
dat = n20x.val;  
figure1 = figure;  
plot(dat)  
xlabel('milliseconds')  
ylabel('millivolts')  
saveas(figure1,'graph.jpg');  
  
% Remove trend from data  
detrendedECG = detrend(dat,5);  
  
% Find local maxima  
ismax = islocalmax(detrendedECG,'MinProminence',0.9);  
  
% Visualize results  
  
% Plot local maxima  
clc;  
maxIndices = find(ismax);  
msPerBeat = mean(diff(maxIndices));  
heartRate = 600/msPerBeat;  
end
```

Signs of a Healthy Heart (Peak in QRS Complex)

No	Feature	Duration
1	P wave	<80ms
2	PR interval	120ms-200ms
3	QRS complex	80ms-100ms
4	J,ST,T wave	100ms-160ms
5	QT interval	<440ms



Some life-threatening issues and diseases caused by an unhealthy heart include:

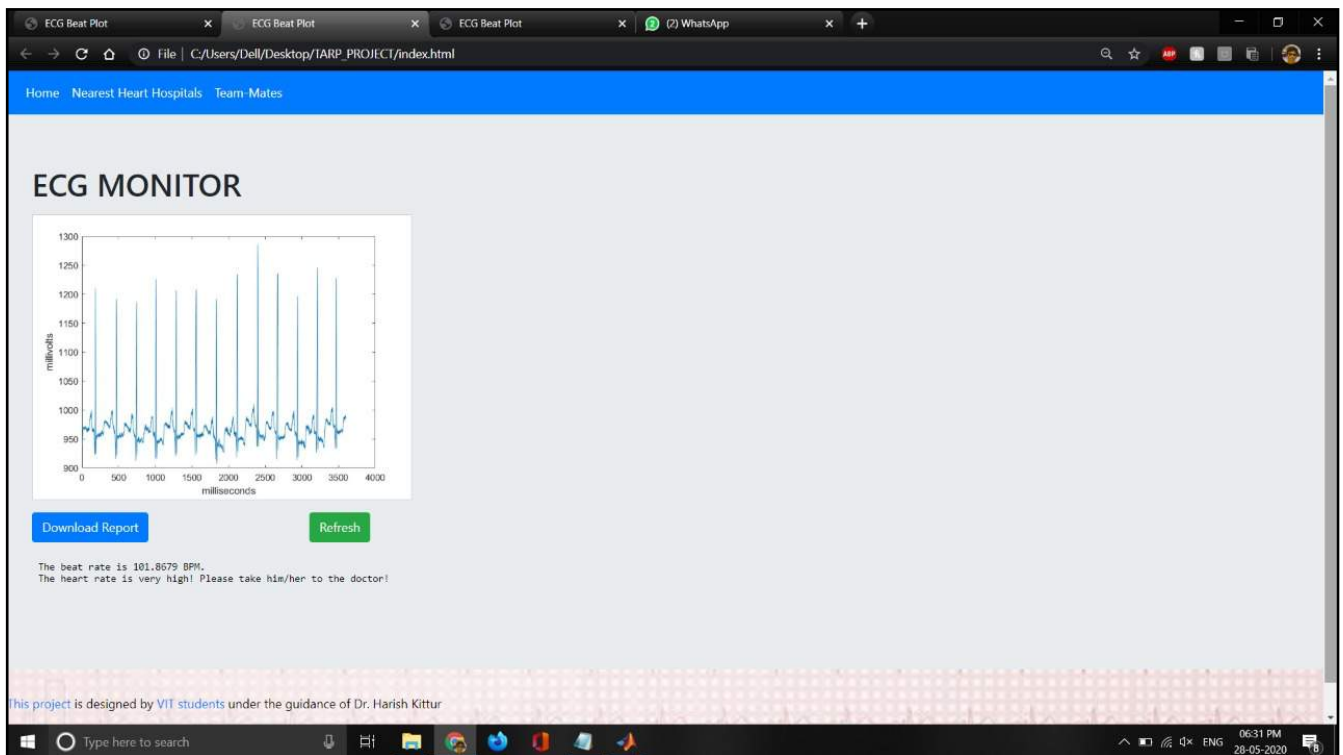
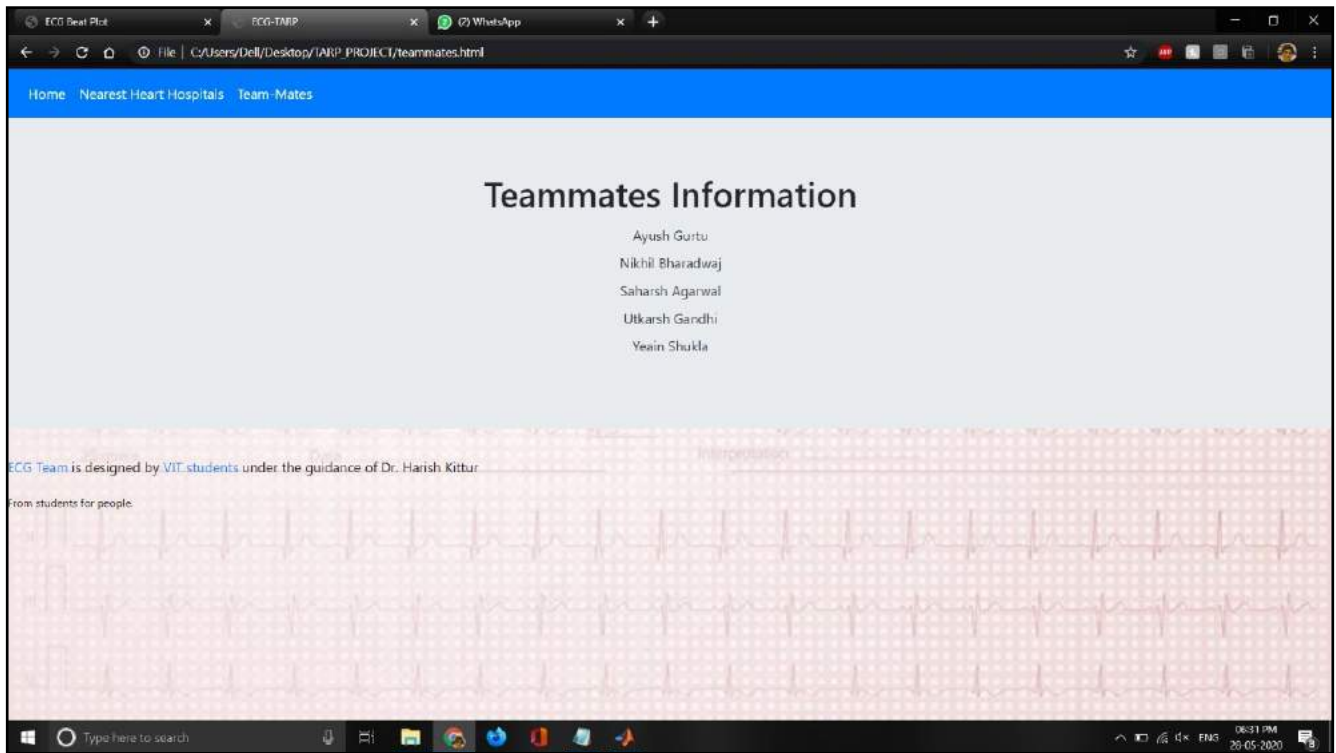
- **Heart attacks:** Blood flow (thus, oxygen) to the heart is partially completely cut off to the heart. Heart attacks are caused by blocked arteries.
- **Heart failure:** This happens when the heart isn't able to pump blood in and out the way it normally does.
- **Coronary heart disease:** CHD occurs when plaque builds up in the two coronary arteries in your heart. It kills the most people of any heart problem.
- **Strokes:** These happen when blood flow from your heart to your brain is impaired or ceases.

And as we and our bodies age, these issues and diseases become more prevalent because of unavoidable factors that are symptoms of growing older. As they relate directly to the heart, these include:

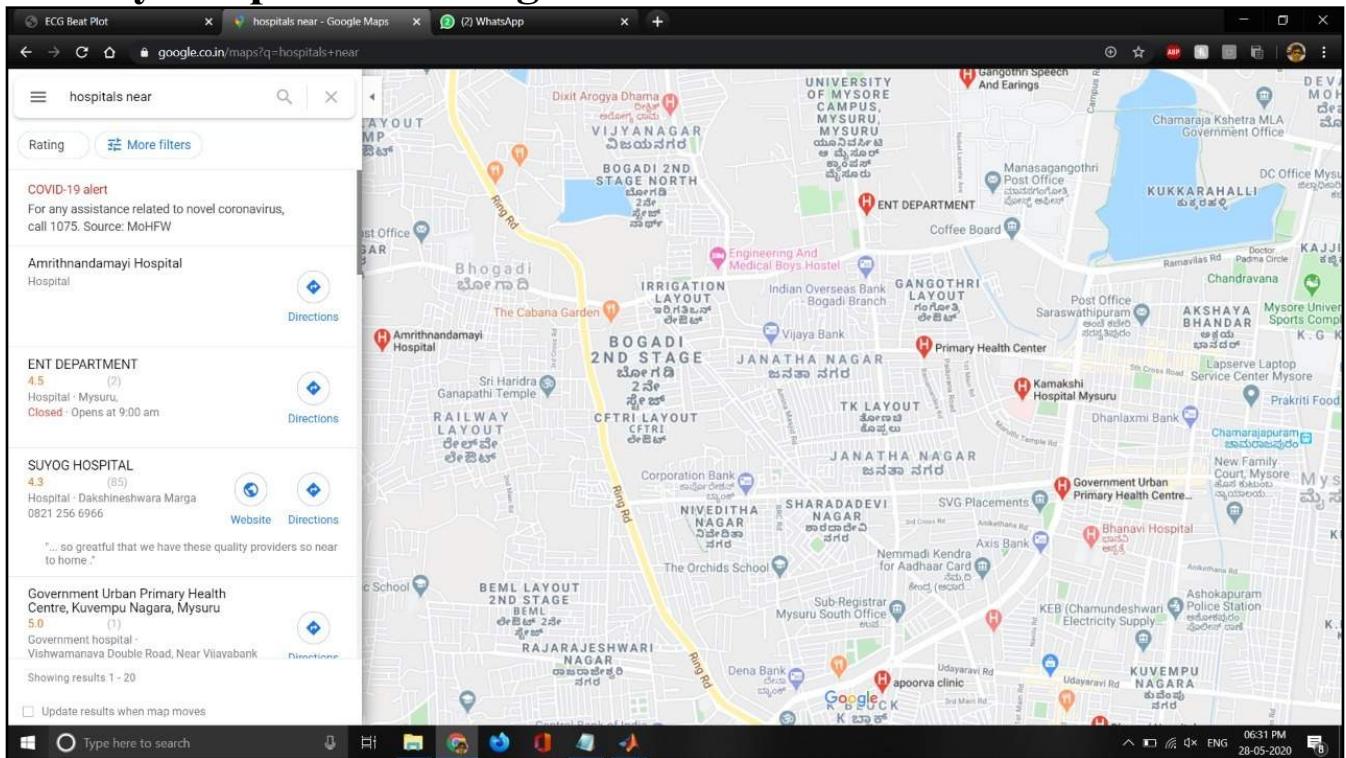
- a reduced heart rate,
- thickening of the heart's walls,
- and an overall weakening in its strength as it relates to pumping blood (the heart is a muscular organ, after all).
- Excessive heart rate.

Results

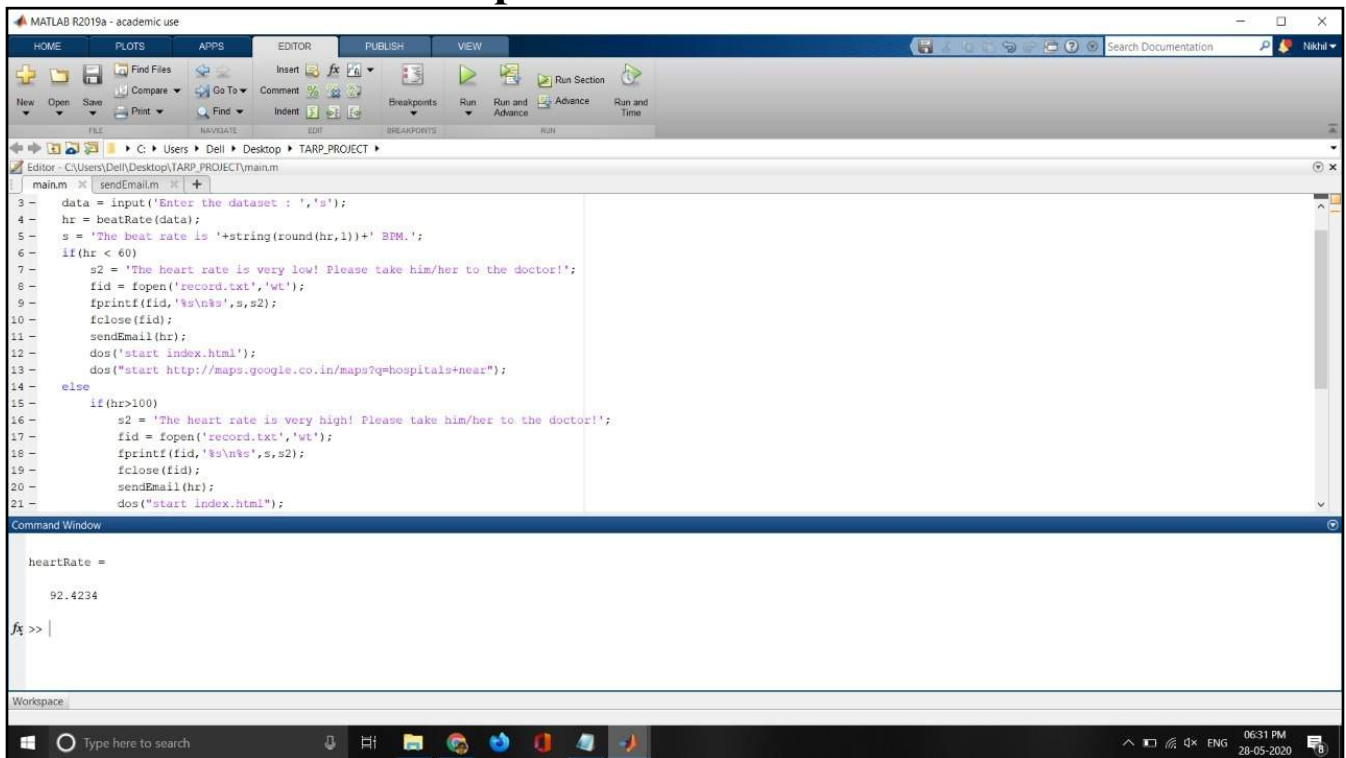
Website UI



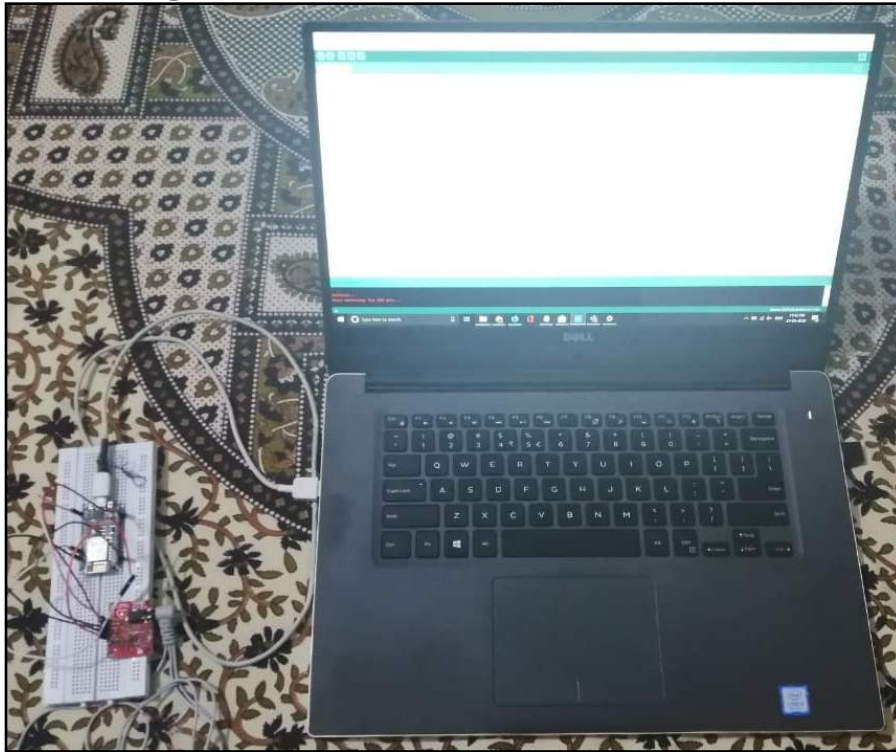
Nearby Hospital Tracking



Heart rate Monitor Output

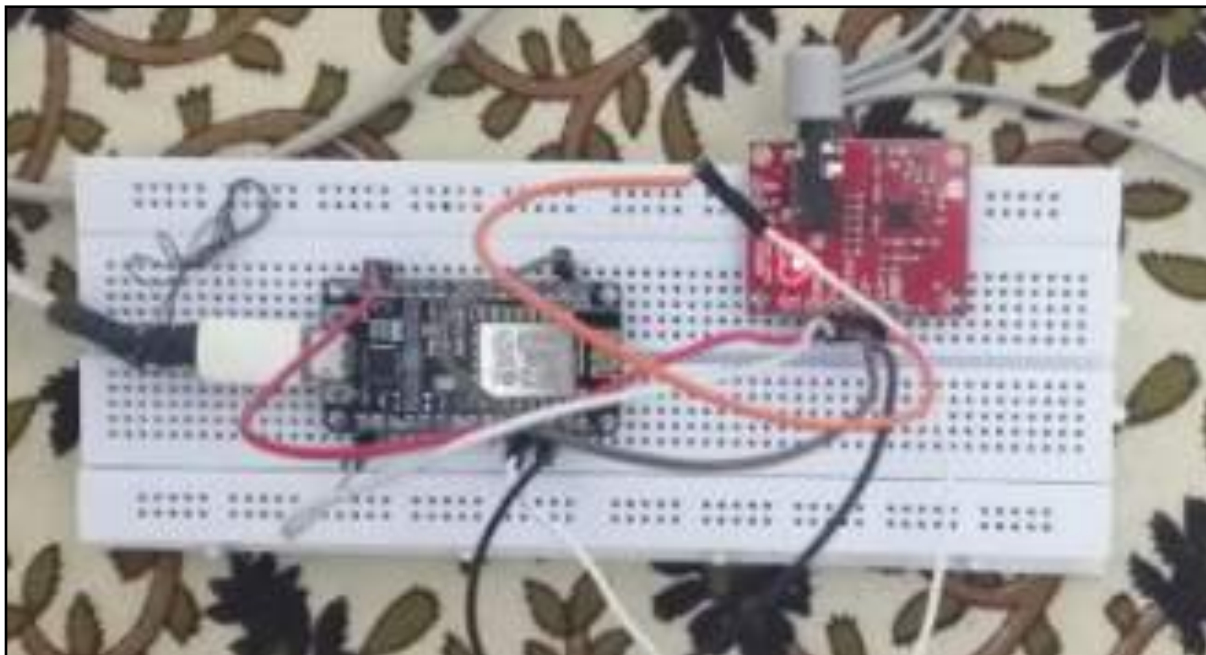


Working Video

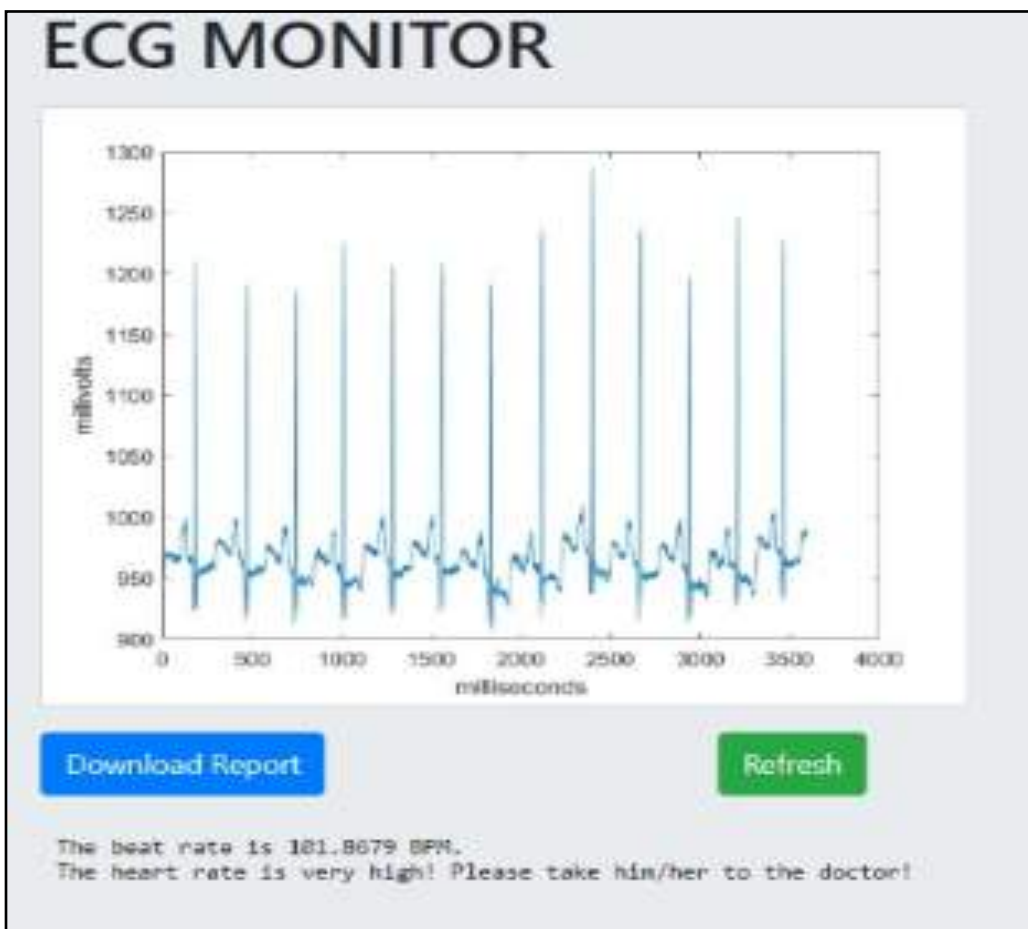
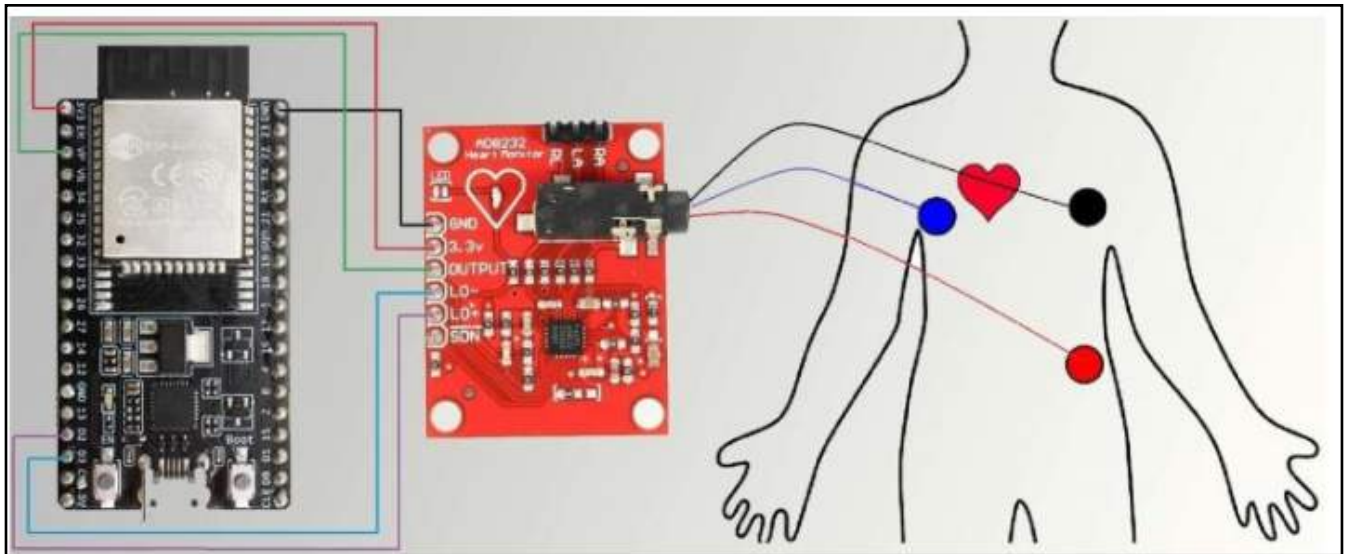


<https://drive.google.com/open?id=1ZXflHBoiMiK43wPSoQXna1uYZqFijBxe>

Final Circuit

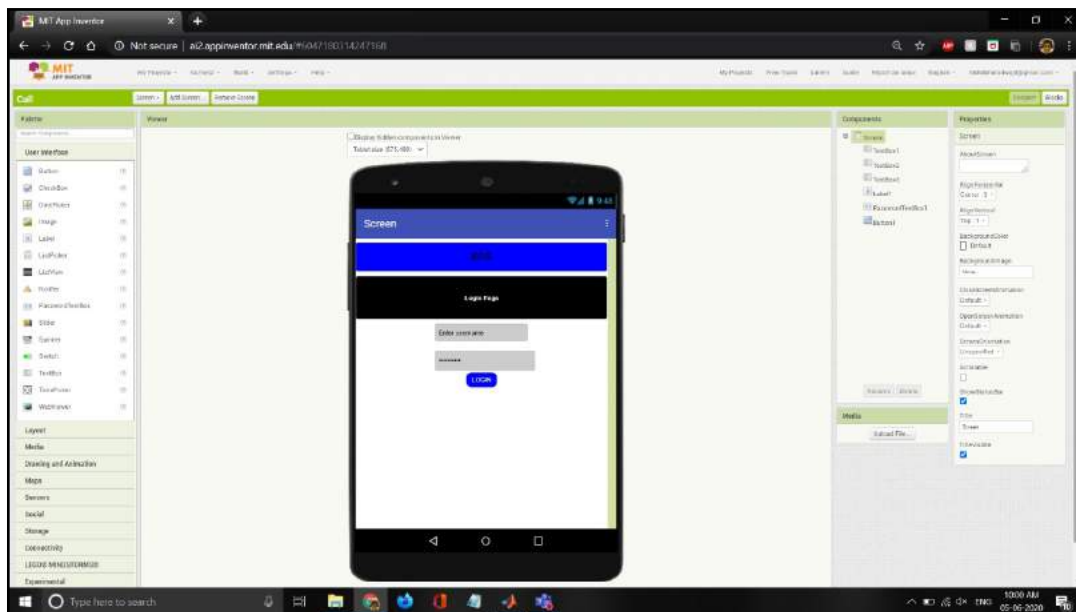


ECG Results

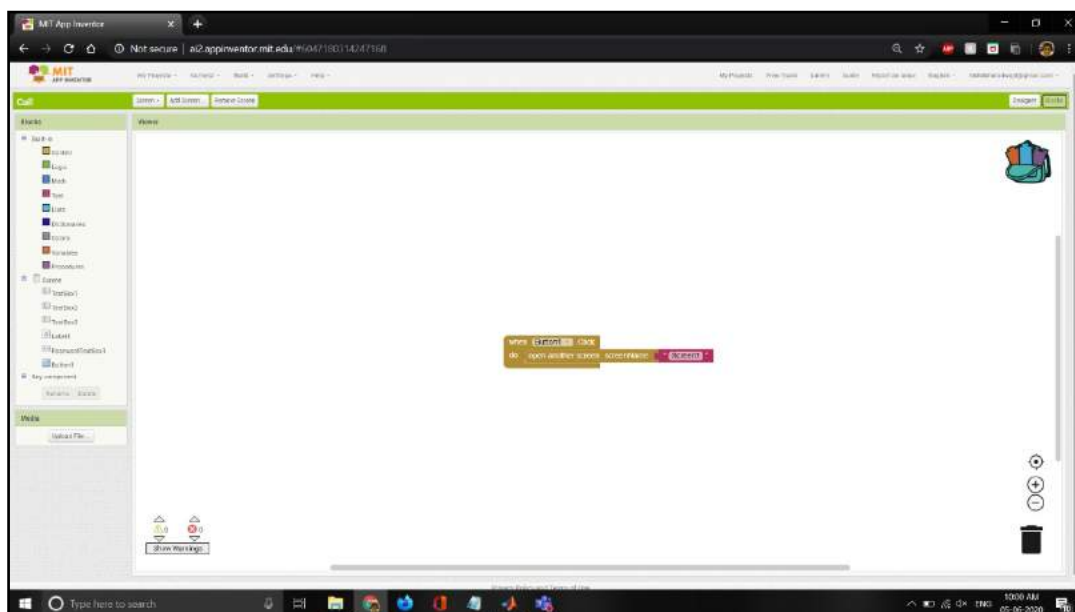


Android App

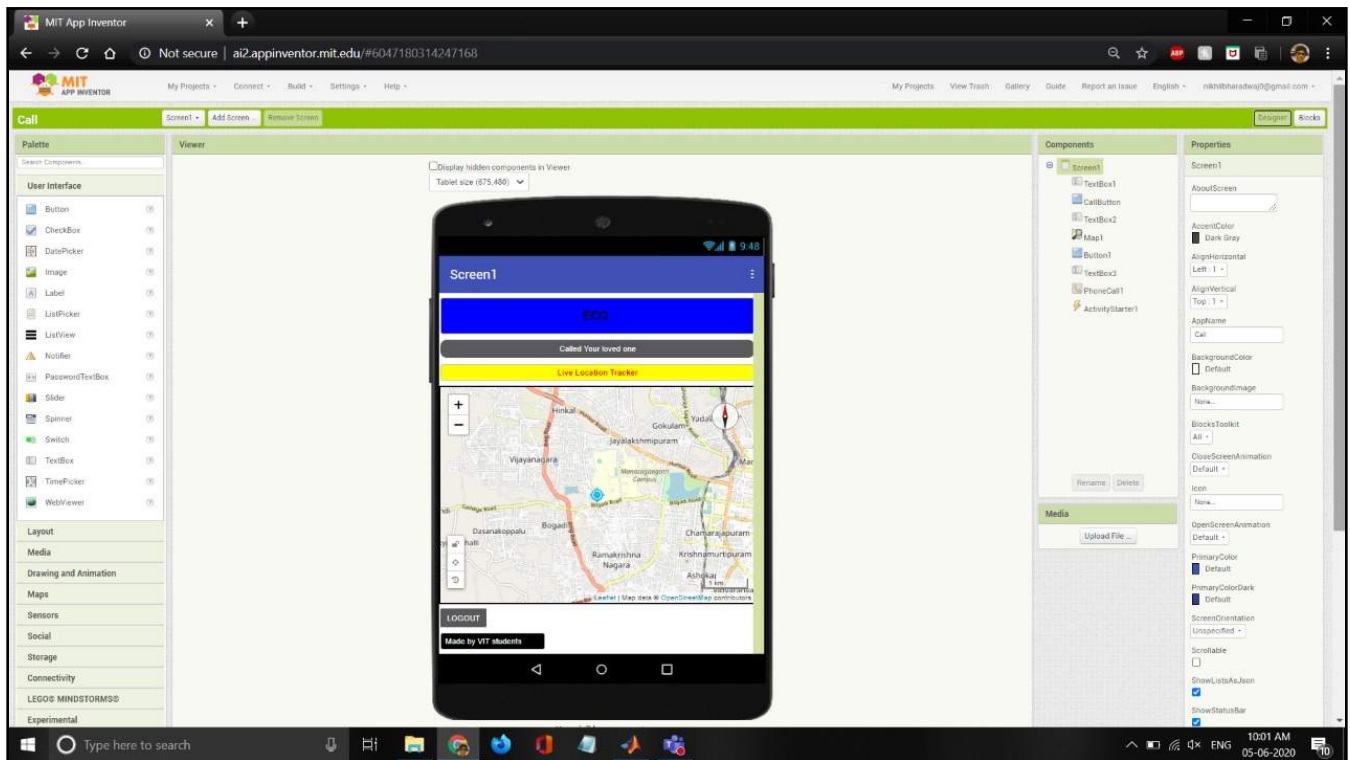
The android app is created using the MIT App Inventor 2 which features a login page wherein, personal details for login id and password can be found in the leaflet provided with the device. The app features a call button where you can call your loved one which is registered with the account and a live tracker wherein one can see where their loved one is at all times.



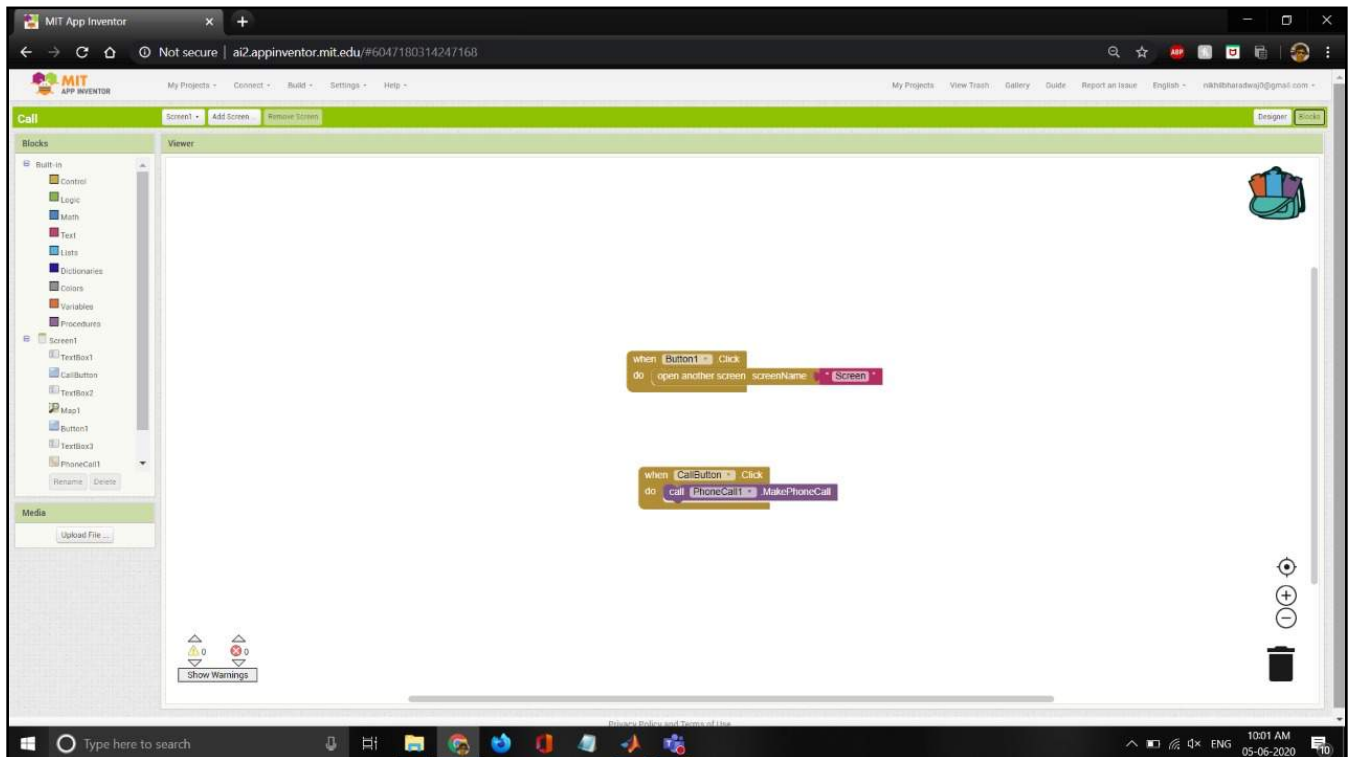
Login Page Design



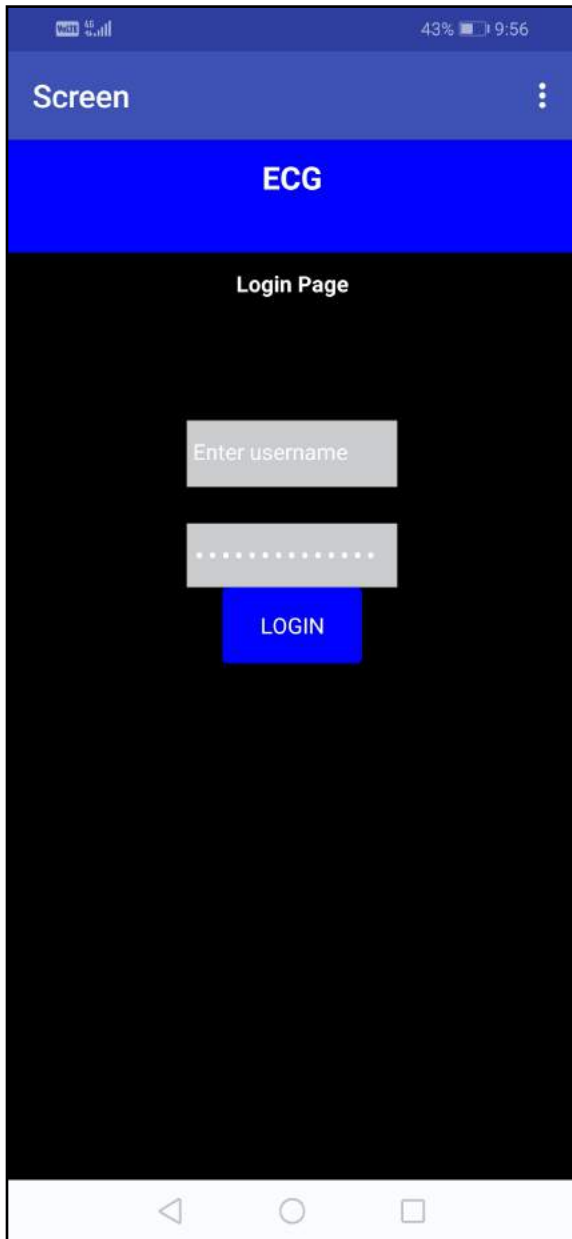
Login Page Block Diagram



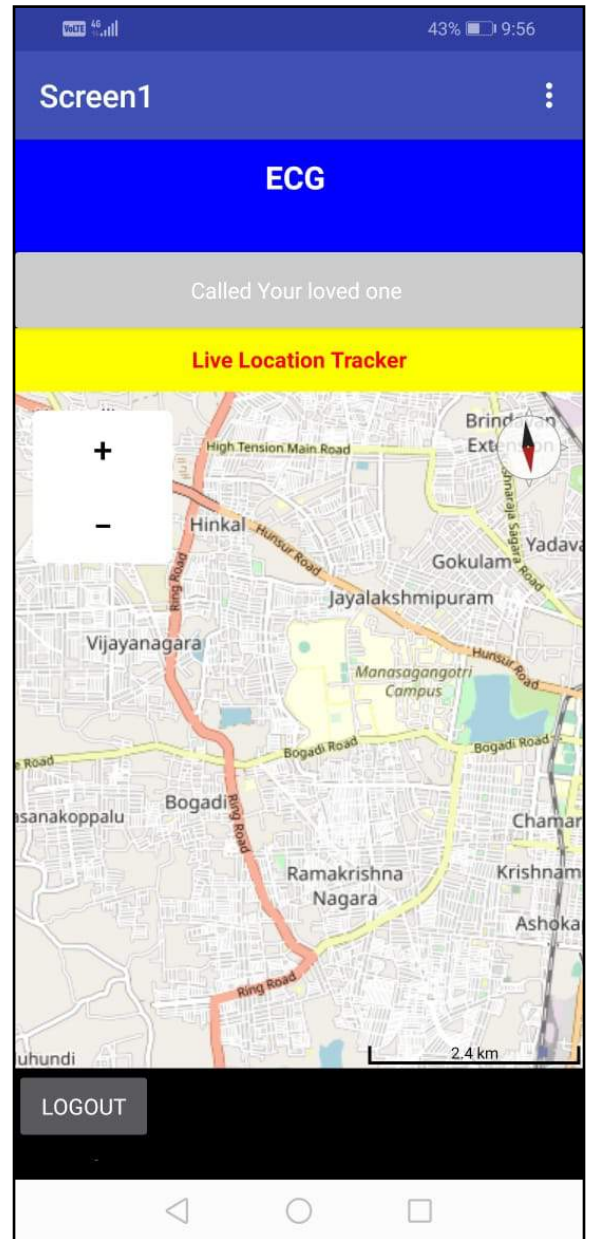
Live Tracker Page Design



Live Tracker Page Block Diagram



User Interface of Login Page



User Interface of Live Tracker Page

Advantages

- ◆ By the end of the test, using the above algorithm we will be able to calculate the Heart Rate and also know if the person is suffering from any kind of heart disease.
- ◆ The sensitivity declines dramatically in the presence of obesity. So, it can also act as an indicator for obesity.
- ◆ It indicates the presence of damaged heart muscles and impaired blood flow.
- ◆ It's a portable and hand held device which is easy to operate.

Conclusion

After implementation of all the circuit components and applying all the algorithms, it can be said that the system developed is a robust system for ECG monitoring.

The system is portable, and the outputs obtained from each part of the system are of satisfyingly high quality. Therefore, the output of the system is reliable. The system is cost-efficient, as only around 2000 rupees was required to develop the system. The system can be used for both real- time monitoring and detailed offline analysis. The system only requires a Laptop and an IC as processing terminals that are now even available in these rural or remote areas.

The availability of receiving alerts through email makes it a life saving gadget for the elderly.

References

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