IoT BASED PATIENT MONITORING SYSTEM

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Declaration

We, hereby declare that this thesis is based on results we have found ourselves.

Materials of work from researchers conducted by others are mentioned in references.

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ABSTRACT

IoT (Internet of things) has become an interesting topic in the field of technological research. It is basically interconnecting of devices with each other over the internet. We typically think of the Internet of things (IoT) in terms of autonomous cars and smart homes, but some of the best applications of IoT technology are in fields that are intensely practical. One such example is health care monitoring system. The main purpose of our project is give the luxury to explore improved services for patients. It can be used to promote basic nursing care in the hospital environment by improving the quality of care and patient safety. Rural area of Bangladesh is lack behind from the proper patient monitoring system. So, remote monitoring and guidance awareness by sharing information in an authenticated manner are the main objectives.

ACKNOWLEDGEMENT

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 01

INTRODUCTION

Because of expanding work cost, medical institutions would constrain to decrease nursing staff for patients. Our project aims to develop new innovations for the use of basic nursing care. In this paper, we introduce a secure IoT-based healthcare monitoring system. To achieve system efficiency simultaneously and robustness of transmission within public IoT-based communication networks, we will utilize robust crypto-primitives to construct two communication mechanisms for ensuring transmission confidentiality. By implementing nursing system will get a new dimension and every patient can be monitored remotely. By this on the basis of derived data if a patient is in critical situation, an immediate instruction can be given to the one who is in charge. It may play a vital role to reduce labor cost, rather will be easy to assess from anywhere anytime and will be helpful to take immediate decision. Thus nursing system will be digitalized. In day to day life, people are affected by various serious and complex diseases like Diabetic Mellitus, Cardio Vascular Diseases, and Hypertension etc which are highly sensitive diseases. So, people are continuously anxious about their health condition. They need to consult with doctors, according with reports and check up all of that. Internet of Things (IoT) is a growing present concept which has an effect of many aspect of human life. Various processes of different concepts including data acquisition, data transmission and data analytics enables IoT based system to support smart solutions especially for health care [1]. In IoT based system, the work progress depends on 3 system which are sensor work, get away and cloud. Firstly, talk about sensor network which is the first step for monitoring patients as well as data collection. Secondly, the gateway system which is a continuous connection networks between sensors and cloud system. The death rate of 55.3 million people dying each year or 1,51,600 people dying each day or 6316 people dying each hour is a big issue for all over the world [2]. So, we are proposing a model where patient can measure heart beat rate and ECG by himself or herself and that report immediately sent to the doctors. Later that, those reports will used to consult with doctors within very short time. It is also reduce valuable time for both patients and doctors. They don't need to wait for the reports because sensors are giving real time data. The model is very effective for rural areas people.

IoT serves through GSM/3G/4G technologies data or patient report is sending to the doctors with time and date. This proposed model can use any type of persons like he or she affected with a disease or not. So, they can check it in regular basis because people pay more attention towards prevention and early recognition of disease [3]. Here, all reports also live video recording will be recorded with real time. IoT devices produce large amount of data and information [3]. These health care services are getting better and less costly by recoding and collecting patients monitoring.

1.1 MOTIVATION

The progression of the advance technology has constantly intrigued us. Moreover, we additionally found that there are not critical examines on computerization technology for hospital IoT based Patient Monitoring System. Along these, we began to search the published paper and advancements around us. In present time, medical science is improving and enhancing day by day. On this creating technique people advancing more noteworthy reinforce logical frill, for example, brilliant belt which find persistent breath and additionally electro dermal movement (EDA) sensors to successively show for physiology indications of seizures during the evening. Patient monitoring system is much accessible, painless and smooth for the patient. Recently grew innovative devices executed in patient's body to reestablish ordinary activities. Sometimes it is quite difficult to know about health condition of patient for doctor and nurse. For this, they cannot give the proper treatment and instant result to the patient. Now it is very important to build up a system which can help doctor and nurse to maintain patient monitoring.

1.2 OVERVIEW

Our system will be beneficial to all age of people especially for the old aged or ICU patient. It will measure the Heartbeat and ECG of the patient and upload the result in the text message, web server and mobile apps. Therefore, we have developed website as well as mobile apps in which people can get access and see the output by searching date and time. Moreover, in case of emergency, nurse or patient‘s relative check out patient’s condition by using LIVE monitor option. Our goal was to build up a system with high accuracy with minimum cost so that anyone can use and afford this.

1.3 OBJECTIVE

Easy to use

It will be a very handy tool as it shows all the data collection and information by using just only the internet. So, it reduces the workloads and stress of the relatives of the patient who work outsides.

Better patient experience

For being connected to the health care system through IoT, doctors can improve the diagnosis accuracy as they are getting all the necessary patient data at hand. In a word, we can say that it allows monitoring patient continuously and remotely.

Provide an accurate detection

By using this system, we can get approximate result based on patient health. Moreover, it will be less error, collect data in less time and more accuracy than any human performances.

Reduce costs

When a patient gets health service at home on a real time basis, there is no need for unnecessary doctor or nursing visit. In particular, this project helps to cut down cost for hospital stays and readmissions.

Alert doctors and relatives

Through IoT, doctors and relatives can do their individual job without any hesitation as they can monitor the patient's health condition from anywhere. Moreover, it will send alerts whenever a particular health parameter goes beyond the ideal limit. Furthermore, by receiving SMS alert doctors and relatives can take necessary action. Lastly, we can say that it saves lives in case of emergency.

Giving a quality life for old aged people:

Most of the people at their old age, like to stay at home with their dear ones rather than visiting or passing time in hospitals. But hue to hectic lifestyle people are suffering from many diseases at their early age and the older people become very weak. Additionally, this project will be beneficial to ICU patient.

Shows the outcome of the treatment:

By accessing patients health data in real time information helps to make decision for the doctor on how the treatment is going on and what should do next. Over all, this project will enable the physicians to utilize the results from data collection and analyze that data in real time.

Non expensive:

This project total cost will be less expensive than any other machines which are used in the hospitals. Moreover, it is compact, lightweight and easy to use.

Bridging the gap between doctor and patient:

Health care is all about the patient so the need of the patient always comes first but it is a matter of fact that most of the patient feel uncomfortable to go to hospital or visit doctor's chamber. In this way, this system creates a communication between patient and doctor by providing the data.

CHAPTER 02

BACKGROUND STUDY AND LITERATURE REVIEW

Now-a-days increasing of technologies health experts is taking the great advantage of these electronic gadgets [4]. IoT (Internet of things) devices are highly used in medical sector. In this paper, the project is about health monitoring system. Especially, for Cardiac patient, High Blood pressure patient, hypertension problem, diabetic patient etc. in rural area because in rural area number of doctors is less than urban area. In rural area, medical equipment is not available except government hospital. So, the number of patients is higher than government hospital. Also, the equipment is expired in many cases. So, if any emergency call needed, this hardware device will immediately send the report to the doctors or intern doctors. Doctors will do their rest of works by their reports.

Of many chronic illnesses, hypertension has become a common major disease that remains the route cause for cardiac/stroke mortality. But in present time, no remote HRV (Heart Rate Variability) analysis systems for hypertension patient available to help the doctors to track down the progression of the patient's condition or critical events in rural area [5]. IoT is nothing but an advanced concept of ICT (Information Communication Technology). [2] Raspberry pi component is more costly than Arduino component device. Technologies are broadly expanded in web based or on line system [6]. Now- a - days collecting real time is vital. When the critical condition, patients are discharging from the hospital, he or she needs to check up in regular basis. That is why IoT based heath monitoring system is best option for rural area.

The Internet of Things digitizes physical assets – sensors, devices, machines, gateways and the network. It connects people to things and things to things in real time. A typical IoT network can grow rapidly, resulting in an experimental increase in the variety, velocity and the overall volume of data. This data opens opportunities for significant value creation and revenue generation. But the real challenge for IoT environments is how to analyze the large volume of information from all sources and take action in real time.

The complexity of IoT combined with the high expectations created by the Internet, Mobile, and 24x7 IT environments has made the need for new analytics approaches and technologies more urgent. Achieving desired business objectives requires the ability to act in real-time to take advantage of opportunities and address problems quickly.

In the pre-IoT era, an issue in a typical supply chain scenario could be addressed in 2-3 day cycles for satisfactory results. But in IoT, time to action is in minutes, seconds, or microseconds – 30 minutes to provision electric service, 30 seconds to act on information from devices, 5 milliseconds to address a security breach. This explosion of data and the high expectations in the IoT environment means the value of data will slip away quickly.

The importance of time-to-action for IoT applications can be seen in a wide array of applications and use cases. Broadly speaking, these applications can be grouped into three categories:

1) Operations and fulfillment are a convenient place to prove out efficiency gains.
2) Customer-focused sales and marketing applications have the potential to increase customer satisfaction and long-term growth.
3) Innovation in new products and services can drive new revenue and business value.

There are also specific use cases within these applications: • Predictive Maintenance • Demand/Supply Optimization • Predictive 1 to 1 Marketing • Outage Management Addressing the critical time-to-action requirement for these use cases and applications in IoT demands an advanced analytics solution that

1) Unifies historical, real-time streaming, predictive, and prescriptive analytics.
2) And provides faster analytics and smarter actions.

2.1 IoT Based Patient Monitoring

According to the WHO, 4.9 million people died from lungs cancer, over weight 2.6 million, 4.4 million for elevated cholesterol, 7.1 million for high blood pressure. Patients who need a regular monitoring by doctors to discuss the state of health condition, IoT based patient monitoring system is useful for them. The main concept of IoT is defined as the integration with electronic devices that connect with doctors or health monitoring persons. IoT the term was first mentioned by Kevin Ashtor in 1998. IoT can be divided in three sections.

1. Internet – Oriented Middle ware.
2. Things Sensors Oriented.
3. Knowledge Oriented Semantics.

First as hardware layer which allow the interconnection by using sensors and technologies. Sensors are used to measure Heart Beat, ECG, and Temperature etc. The main purpose of this IoT is to improve a solution based on ontology with ability to monitor the health status. [4]

2.2 ECG (Electrocardiograph)

ECG or Electrocardiography is a system which can record and measure the electrical activity of the heart over a period of time using electrodes on the skin. Bio monitoring electrodes have passed through a great evolution and progress from 19th century. In 1883, Carlo Matteucci who was a professor of physics at the University of Pisa, first time showed and proposed sensors that watch and monitor the electricity in human body periodically. In 1887, Augustus D.Waller was presented and published the first human electrocardiogram. He was British physiologist. In 1901, Willem Einthoven made re infrastructure of Waller's technology. Here, he used fine quartz coated with silver in a device which is called the string galvanometer. Einthoven won noble prize for formulate and create the electrocardiograph. In present time, bio monitoring electrodes use in ECG which is made of a plastic substrate covered with a silver chloride ionic compound. The Ag/Acl electrode is mostly used for all the application in bio medical electrode system. These electrodes create an electrical potential and ionic activity in living cells. After connecting the human body, these potentials are demonstrate on the body surface. [7]

The heart starts activation at sino-atrical node which is build and produces heart frequency about 70 cycles per minute. This activation generated to the right and left muscle tissues. There is delay which use to allow the ventricles to fill with blood from atrial contraction in the ventricular node.

These activities help to pump blood to the aorta and to the rest of the body. At last, the re polarization happen and the cycle is repeated time after time. When the cycle take place, the trans membrane potential which measure the voltage difference between the internal and external spaces of the cell membrane create a changes at the each stages. Voltages differences are measured by using the surface electrodes. These different peaks P, Q, R, S, T and U are detect in these stages. [8] in figure 1 it's shown,

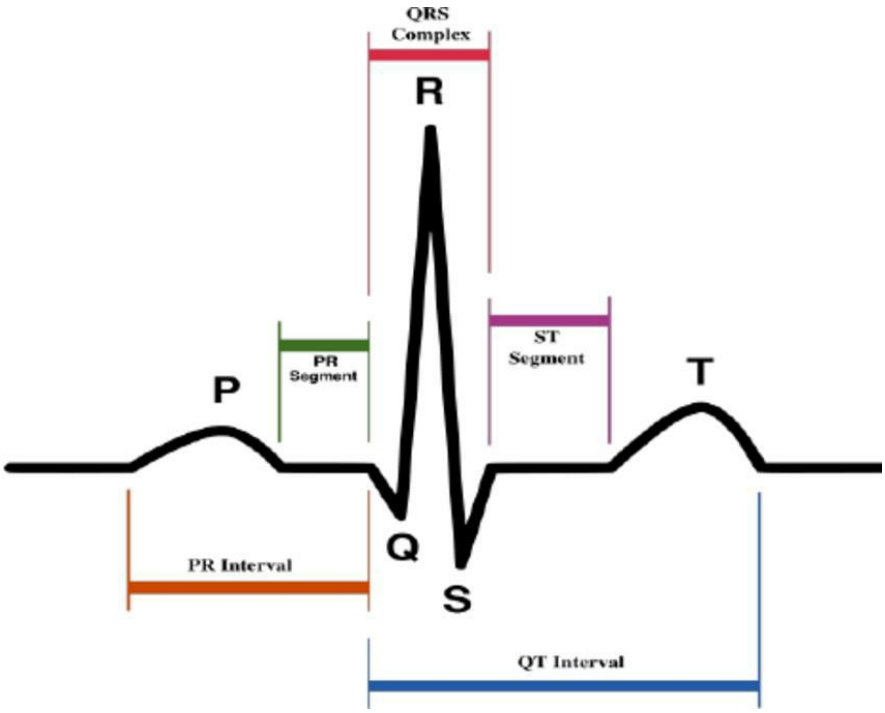


Figure 2.2 Normal sinus rhythm ECG

2.3 ECG sensor generated within the body

The heart has four chambers. The upper two chambers (left/right atria) are section focuses into the heart, while the lower two chambers (left/right ventricles) are shrinkage chambers sending blood through the course. The dissemination is splitted into a "circle" through the lungs (aspiratory) and another "circle" through the body (foundational).

The cardiovascular cycle alludes to an entire pulse from its age to the start of the following beat, containing a few phases of filling and purging of the chambers. The frequency of the cardiac cycle is reflected as heart rate (beats per minute, bpm).

The heart works naturally – it is self-energizing (different muscles in the body require anxious jolts for excitation). The rhythm of compressions of the heart happen unexpectedly, yet are touchy to apprehensive or hormonal impacts, especially to thoughtful (stimulating) and parasympathetic (decelerating) air conditioning activity.

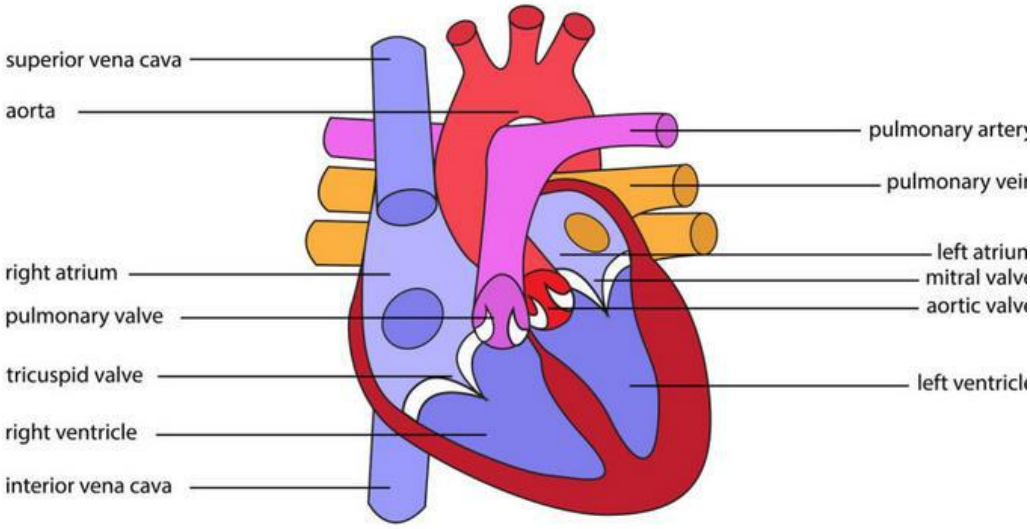


Figure 2.3: Heart Diagram

2.4 ARDUINO

Arduino provides open source electronics prototyping platforms based on flexible, easy to use hardware and software. It is a microcontroller development board based on the Atmel ATmega 328 MCU. The Arduino UNO has 14 digital input or output pins (of which 6 can be used as PWM outputs), 6 analog inputs, 16 mega Hz crystal oscillator, a USB connection, a power jack, ICSP header and a reset button. This Arduino MCU board contains everything needed to support the microcontroller. Simply connected to a computer with a USB connection, power it with an AC to DC adaptor or battery to get started. The Arduino UNO differs from all preceding boards in that it does not serial convertor. The Arduino UNO MCU board can be powered via the USB connection or with an external power supply. The power source is selected automatically.

2.5 Operational Instruction

After power on, one hand finger will touch the H-beat sensor and the LED light will start blinking continuously after 1000 milliseconds. After 20 seconds, the person will get the heart beat value that LED light will blink. It means the operation is progressing on until power off. When the U-H Beat button press the value will directly send on mobile message, android application as well as web page within 3 seconds. For ECG measurement, the ECG sensor attached with chest and push button 'ECG'. The receiver will get the result in web page and android application with time and date within 3 seconds.

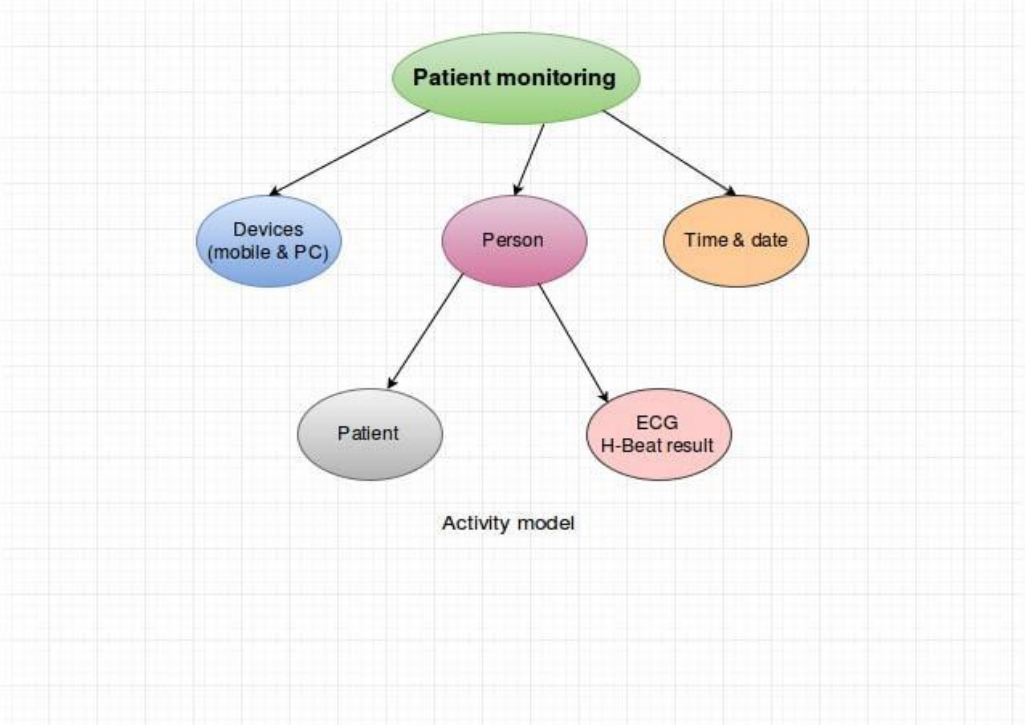


Figure 2.5 Operational Instruction

2.6 Heart Beat

Heart rate known as pulse rate is the number of times a person's beat per minute. Normal heart rate varies from person to person but a normal range for adults is 60 to 100 beats per minute. Also normal heart rate depends on the individual age, body size, heart condition also the person is sitting or moving, medication use and even air temperature. Emotion can

vary heart rate for example getting excited, scared can increase the heart rate. []. According to American Herat Association (AHA) well trained athlete may have a normal heart rate of 40 to 60 beats per minute.

There are 4 steps to measure heart rate:

1. Writs
2. Inside of an elbow
3. Side of the neck
4. Top of the foot

How to measure accurate heart rate: Put two fingers over one of these areas and count the number of beats in60 seconds. Also measure 20 seconds and multiply by three which is easier than first step.
Resting heart rate: When a person is in resting mode, it is the best time to measure heartbeat. According (AHA) for adults and older normal heart rate is between 60 and 100 beats per minute (bpm). But below 60 (bpm) doesn't mean the person has health issue problem. Active people have lower heart rates because their muscles don't need to work as hard to maintain a steady beat. []

Maximum and target heart rate: A person's target heart rate zone is between 50 percent and 85 percent of his or her maximum heart rate. According to (AHA) 30 year old person would be between 50 and 85 percent of his or her max heart rate. [9]

Age	Target HR Zone 50-85%	Average Maximum Heart Rate, 100%
20 years	100-170 beats per minute (bpm)	200 bpm
30 years	95-162 bpm	190 bpm
35 years	93-157 bpm	185 bpm
40 years	90-153 bpm	180 bpm
45 years	88-149 bpm	175 bpm
50 years	85-145 bpm	170 bpm
55 years	83-140 bpm	165 bpm
60 years	80-136 bpm	160 bpm
65 years	78-132 bpm	155 bpm
70 years	75-128 bpm	150 bpm

Table 2.6: Rate of heartbeat per minute

2.7 Communication between Hardware and Software

In this project, communication between hardware and software in serial data communication is used. Serial data communication uses two methods.

1. Synchronous
2. Asynchronous

In where, synchronous method transfers a block of data at a time. Asynchronous method transfers a single byte at a time. It is possible to write software to use either of the methods. The program can be tedious and long that's why special IC chips is made by many manufactures for serial data communication. These chips are commonly referred to as Universal Asynchronous Transmitter / Receiver (UART).

CHAPTER 03

WORKING METHODOLOGY

The system consists of six major embedded electronics.

1. ECG Sensor
2. Heart Beat Sensor
3. IR Sensor
4. GSM Module
5. Arduino UNO.
6. LCD Display.

For power on, 12 volt adapter is using with Arduino and 5 volt adapter attached with GSM module externally. Patient will touch the heart beat sensor, and then the IR sensor's ray will count the beat from blood flow. After counting beat from blood flow we will push the button H-Beat and wait for 20 seconds. The result will upload and the heart beat value will show in LCD display. Similarly using UH push button the receiver will get the value in mobile message, web page and android application. For implement the function of ECG sensor, the sensor will be attached with patient's chest and push the button 'ECG'. In the meanwhile, it will generate the ECG curve. After that, the curve will upload in android application and web page.

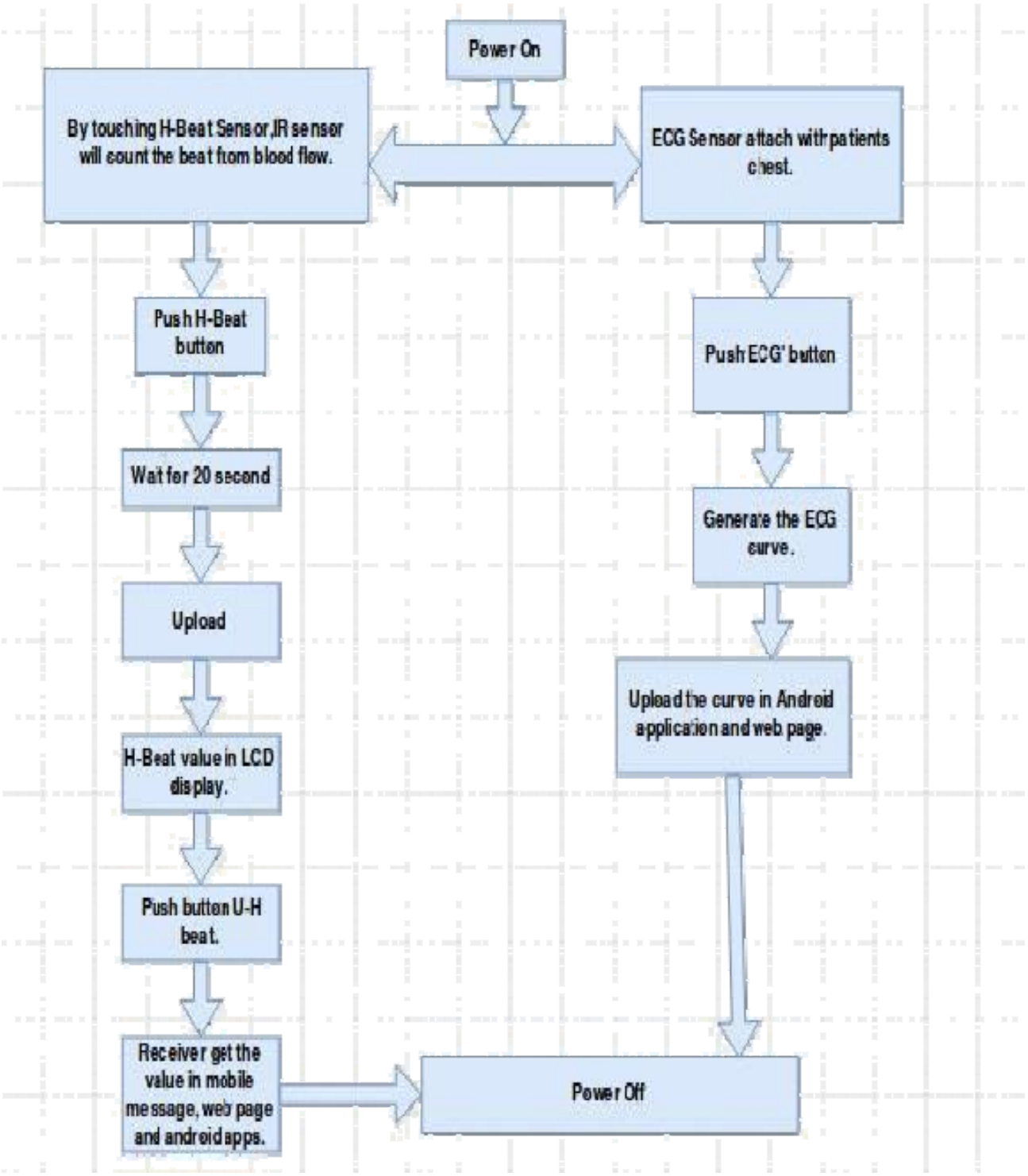


Figure 3.1 Working Flow Diagram

3.1 Workflow Electrical Components Control Unit

Arduino provides open source electronics proto typing platform based on flexible, easy to use hardware and software. Arduino uno is a micro controller develop board on the Atmel ATmega 328 MCU. The Arduino Uno has 14 digit digital input\output (which 6can be used as PWM output) another 6 analog inputs, a 16 MHz crystal oscillator a USB connection, a power jack, an ICSP header and reset button. This Arduino MCU board contains everything needed to support the micro controller. Arduino Uno can be connected to a computer with a USB cable or power it with an AC to DC adapter or battery toget started. It features the Atmega 8 U2 programmed as a USB ti serial converter. Arduino Uno MCU board can be powered via the USB connection or with an external power supply. The power source is selected automatically.

In thus project 2 power adapter are using. One is 12v 1amp and another one is 5v 2amp. From those power sources heart beat sensor is getting 12v. 3.3 v power is driven in ECG sensor if more power is driven in the ECG sensor it will get damage. The GSM module is driven by 5v.

3.2 System Model

Our project is comprised of both hardware and software. In hardware part, heartbeat and ECG sensor are used. Therefore, Arduino integrates with the GSM Module. When the heartbeat and ECG are measured, GSM module helps to upload it in mobile message, Web and APP server. Moreover LCD displays the heartbeat result too.

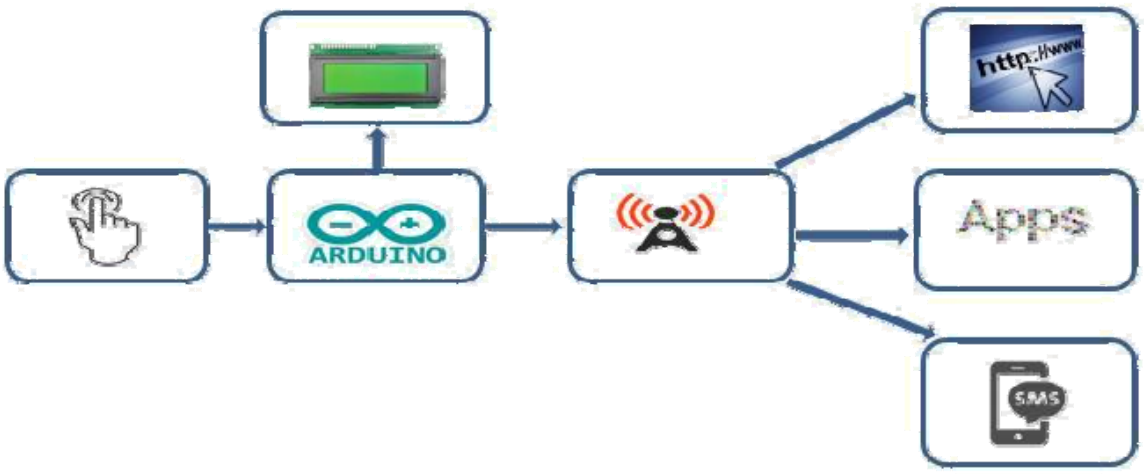


Figure 3.2(a): System model for Heart Beat sensor

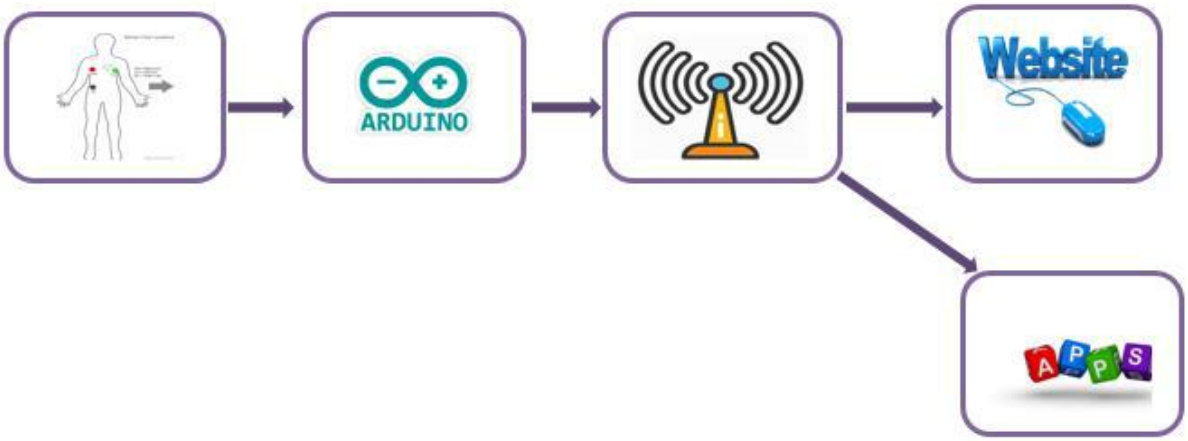


Figure 3.2(b): System model for ECG sensor

3.3 Hardware Implementation

To run the system first we need to connect Arduino with the power supply as Arduino is the main control unit. In input side, we have heartbeat sensor, ECG sensor and some manual buttons. On the other hand, output is shown in the LCD display. Moreover, GSM Module helps to send data in the cloud and when the data gets uploaded, we can check the output by using Laptop or Computer by log in to the server. First of all, a finger is placed in the heartbeat sensor and push button is also pressed so that the system can read data. After that, it shows result in the LCD display. Also, by pressing another push button, it can upload the output in webpage and APP and send text message through GSM module. Similar process is done with the ECG sensor but instead of placing a finger, 3 electro pads are placed in the body and the data reading is taken but LCD display is unable to show the ECG result in its display as the characters are too long. For this case, by pressing push button, data is send through GSM module and shows the ECG curve in the Web page and the APPs. This is all about the block diagram which shows the entire process of hardware.

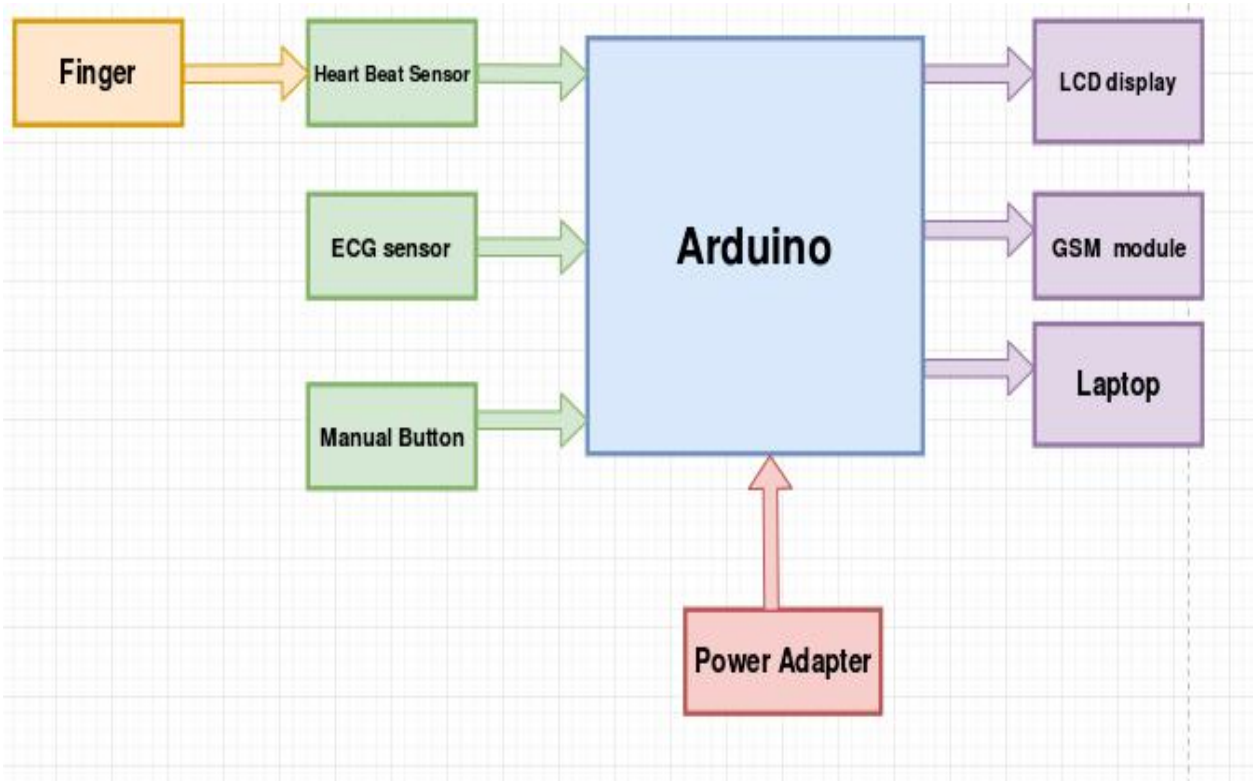


Figure 3.3 Block diagram of Hardware Implementation

3.4 Power Flow of Hardware Implementation

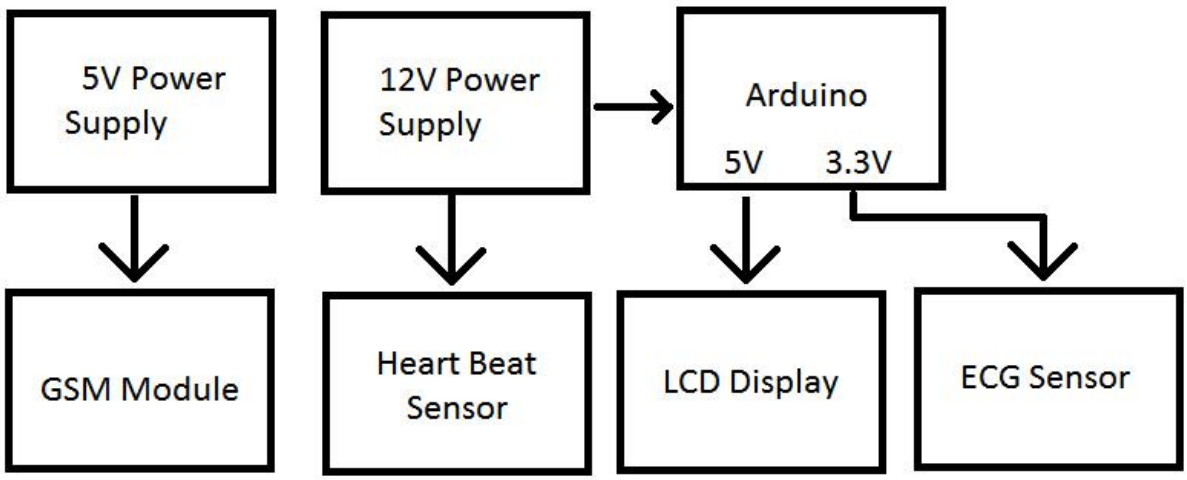


Figure 3.4: Power flow Block Diagram of Hardware Implementation

3.5 Components

To begin with the project, it is very important to know all the information about both hardware specifications. The components we are using are as follows:

1. Arduino UNO
2. SIM 900 GSM MODULE
3. Sensors
   (i) ECG
   (ii) Heartbeat sensor
4. PCB Layout
5. Power adapter
6. LCD Display (20*4)
7. Jumper wires
8. Laptop/ computer
9. LED
10. Push Button

3.5.1 Arduino Uno

Arduino is an open-source physical computing platform based on a simple I/O board and a development environment that implements the Processing/Wiring language. It can be used to develop stand-alone interactive objects or can be connected to software on computer (for example: Flash, Processing, MaxMSP). The open-source IDE can be downloaded for free (currently for Mac OS X, Windows, and Linux. The main features of the Arduino Uno are given below:

- Atmega328 microprocessor controller
- Digital input/output pins from 0 to 13.
- Analog inputs / outputs from 0 to 5.
- Support ISP downloads function.
- Input voltage: No external power supply when connected to the computer or Laptop USB
- External power supply 5V ~ 9V DC voltage input
  Output voltage: 5V / 3.3V DC.

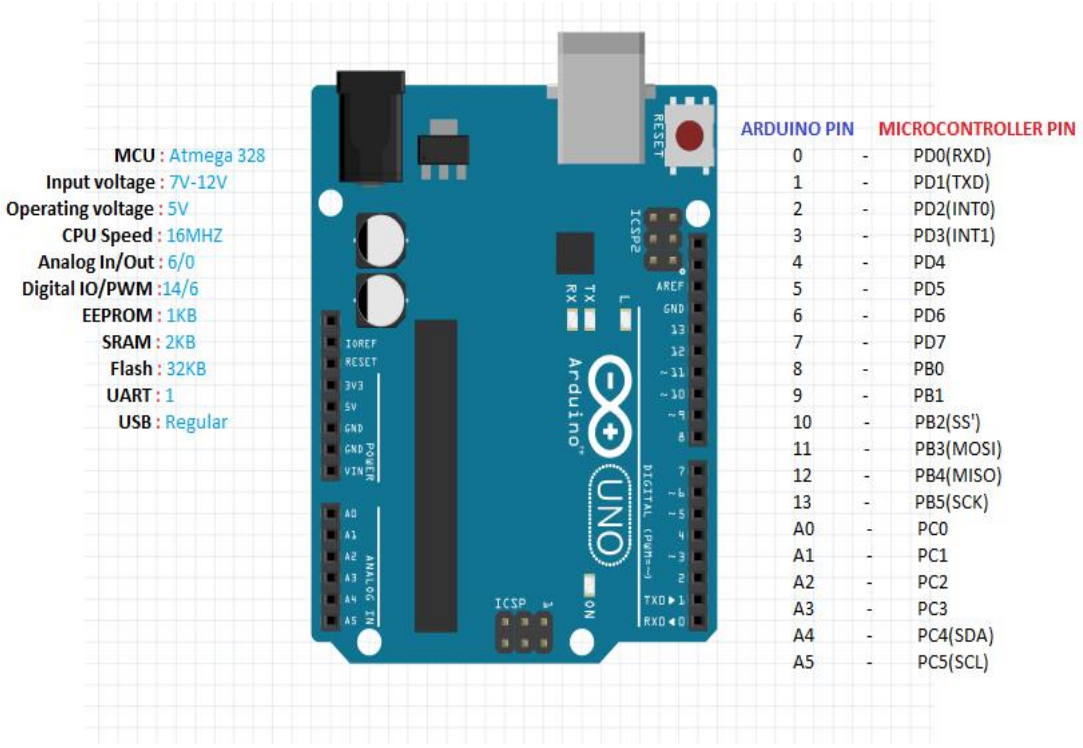


Figure 3.5.1 Arduino UNO

3.5.2 SIM 900 GSM Module

The GPRS Shield provides a way to use the GSM cell phone network to receive data from a remote location. The shield allows achieving this via any of the three methods which are: short Message Service, audio and GPRS Service. The GPRS Shield is compatible with all boards which have the same form factor (and pin out) as a standard Arduino Board. The GPRS Shield can be configured and controlled through UART by simple AT commands. Based on the SIM900 module from SIMCOM, the GPRS Shield is like a cell phone. Besides the communications features, the GPRS Shield has 12 General purpose input output pins, 2 PWMs and an ADC (Analog to Converter).

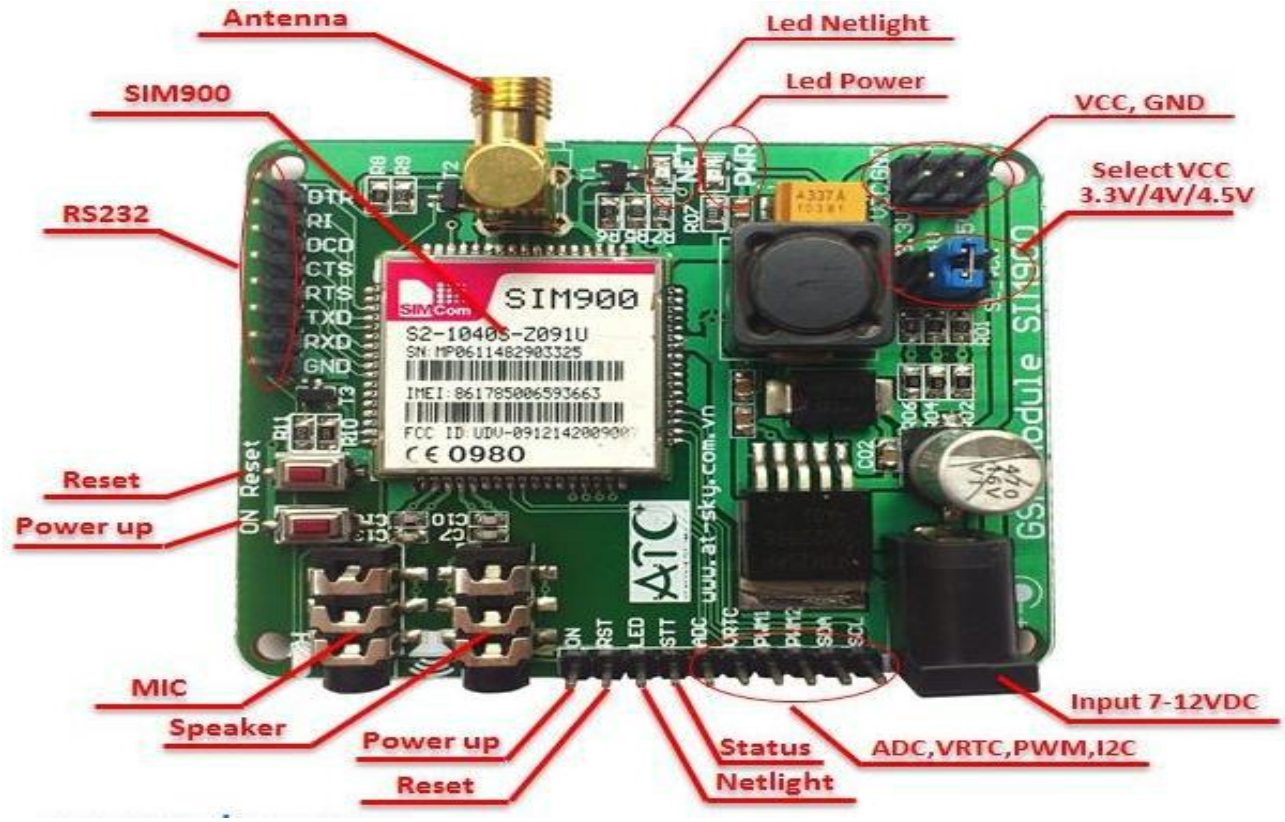


Figure 3.5.2 SIM 900 GSM Modules

3.5.3 ECG Sensor

An ECG Sensor with disposal electrodes attaches directly to the chest to detect every heartbeat. The electrodes of ECG sensor will convert heart beat to electric signal. ECG sensor is very light weight, slim and accurately to measures continuous heart beat and shows data rate of heart beat. The AD8232 is a little chip used to measure the electrical activity of the heart. The electrical activity can be charted as an ECG or Electrocardiogram. Electrocardiography is used to help diagnose various heart conditions.

Features

The AD8232 heart monitor has 9 connection pins in the IC. They are Ground (GD), 3.3 V power supply, output signal, leads of detect (LO -), leads of detect (LO+), shutdown (SDN), Ra (input 1), LA (input 2), RL (input 3). This kit has also 3 cables.

Figure 3.5.3 ECG Sensor

3.5.4 Heartbeat Sensor

The heart beat sensor is a plug and play heart rate sensor for Arduino. It is an electronic device that is used to measure the heart rate i.e. speed of the heartbeat. Heart Rate can be monitored in two ways: one way is to manually check the pulse either at wrists or neck and the other way is to use a Heartbeat Sensor. It sips power with just 4mA current draws at 5V. For this, it is great for mobile application.

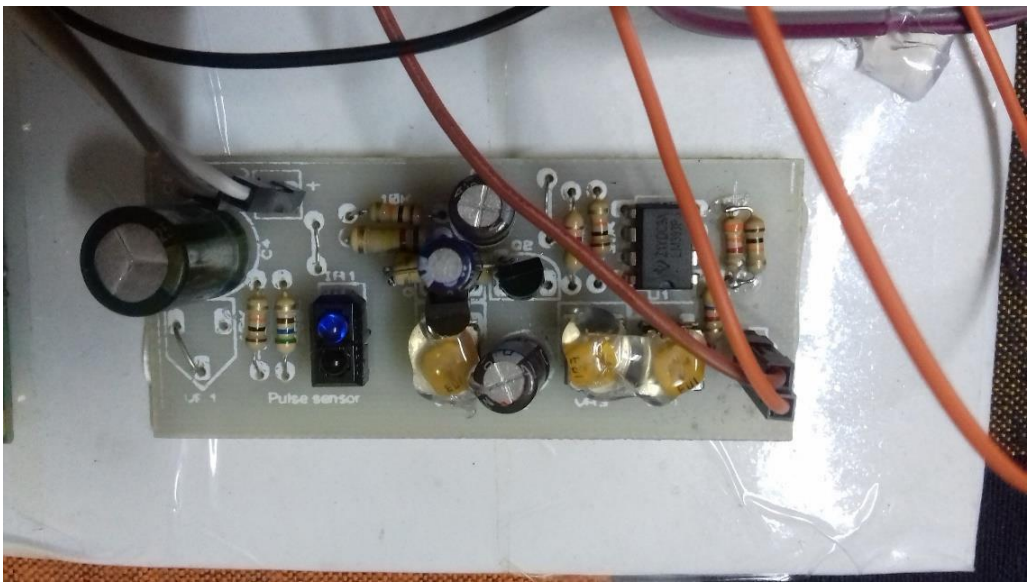


Figure 3.5.4 Heartbeat Sensor

3.5.5 PCB Layout

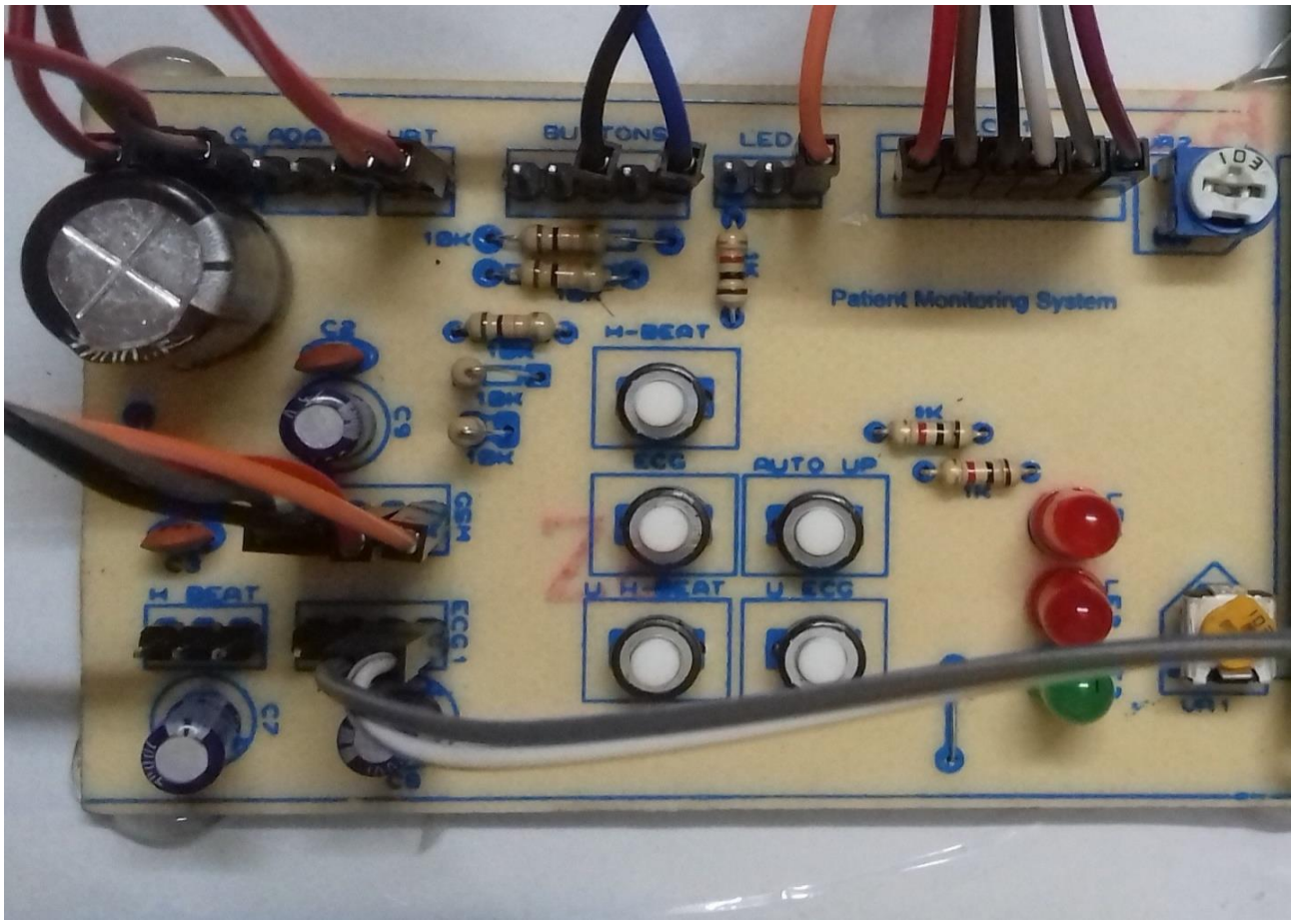
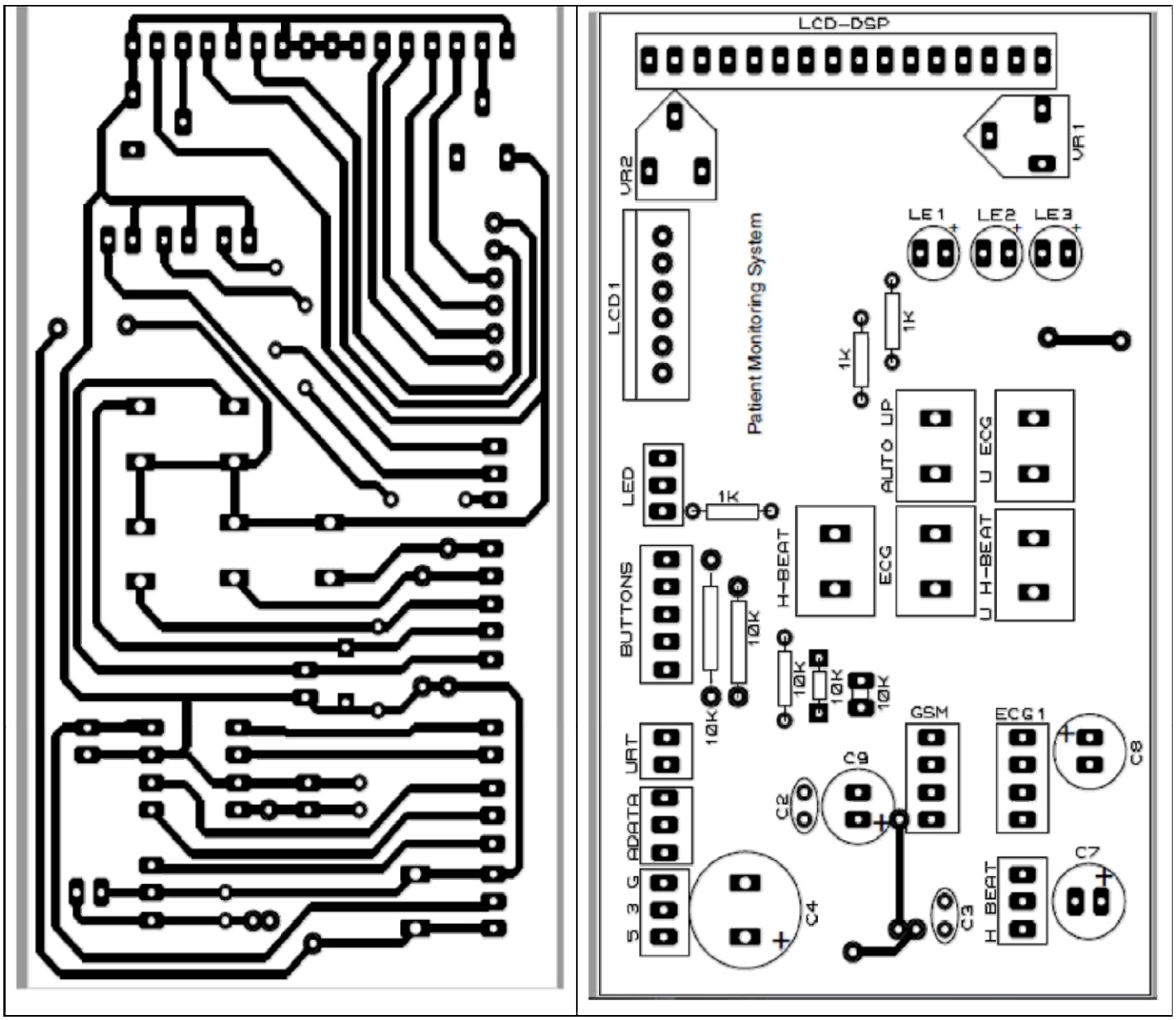


Figure 3.5.5(a) PCB Layout

Printed Circuit Board which is known as a PCB layout is a high-level engineering tool for board design featuring smart manual routing of high-speed and differential signals, shape-based auto router and advanced verification. Breadboards are great for prototyping circuits, but they are not as good for permanent circuit as there has a risk of having weak wire connection. A PCB is like a layer cake in which there has alternating layers of different materials laminated together with heat and adhesive.



Bottom View **Top View**

Figure 3.5.5(b) PCB Bottom & Top View

3.5.6 Power Adapter

In order to run our project we need 2 power adapters which are: 12v 1A and 5V 2A power adapter. To connect with Arduino 12V 1A adapter and to connect with GSM module we are using 5V 2A power adapter.

Figure 3.5.6 Power Adapter

3.5.7 LCD Display

In 20*4 LCD is named because it has 20 columns and 4 rows. It is a very important device in embedded system and used to display information required. It is a character display. Moreover, it has 16 pins including supply power +5V and optional supply power +3V.

Features

- High contrast STN 20x4 character LCD
- White text on blue background
- Single +5.0V supply operation
- LED backlight

- 5x8 dot characters
- HD44780 equivalent controller

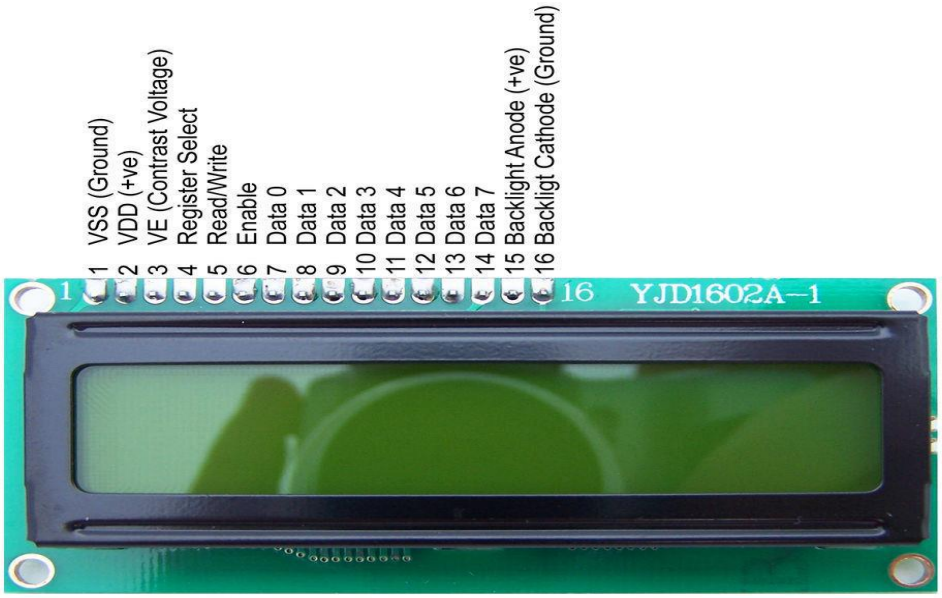


Figure 3.5.7 20*4 LCD Display

3.5.8 Jumper Wire

Jumper wires are used for making connections between items on the PCB and Arduino's header pins. It is required to use them to wire up all the circuits.

Figure 3.5.8 Jumper Wire

3.5.9 Laptop

In order to do coding, monitor data and develop android application we need a laptop.

Figure3.5.9 Laptop

3.5.10 LED

Light emitting diode is a two lead semiconductor light source. It is a P-N junction diode that emits light when activated. When a suitable current is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. The benefits of LED's are low power requirement, high efficiency and long life.

Figure 3.5.10: LED Lights

3.5.11 Push Button

Push button is a kind of switch which is used for controlling a process. Buttons are usually made of plastic or metal. It can connect two points in a circuit when someone presses it. When button is not pressed it is open because there is no connection between the two legs of the push button and reading will be high. When the button is pressed, it is closed and reading will be low because it makes a connection between two legs and connect pin to ground. One point is connected with 12v and another point of the resistor is connecting 10kΩ resistor with the ground.

Figure 3.5.11: Push Button

3.6 Software Implementation

In software implementation, we integrate software part with our hardware part. Our hardware part we have Arduino, ECG sensor, Heart Beat Sensor, GSM Module and LCD display. To implement hardware part, we have to write code part. In our coding part, heart bit pin initialized in pin 7, heart beat button initialized in pin 6, ECG button initialized at pin 2. At the initial stage, value of ECG and Heart Beat is 0. There is a **method** setup which is used for **set up** the LCD's number of columns and rows. In here, button is taking as input. There is a call back method which is used for not interrupt when heart beat is counting for 20 seconds. It is execute in 1 second after by after.

1. **setup** method **Begin**
2. **Input** heartbeat pin, heart beat button, ECG button.
3. **Output** lcd.print("Heath Monitor")
4. **Delay** for **2 seconds**;
5. **callback** used for **not interrupt** when heartbeat count for **20 seconds.**
6. **callback** method **Begin**
7. **n** is the **Timer counter**.
8. **if (**n>100**) then**
9. n = 0 ;
10. n++;
11. **end**

In the **hbeat method**, which is used to set read the heart beat from the hardware. Heart beat count for 20 seconds and here, heat bit pin is high and start to calculate the value. Heart beat value is count here for 60 seconds or 1 minute.

1. **hbeat** method **Begin**
2. lcd.setCursor(0,0) for **set LCD Data Column and Row**
3. **Output** lcd.print ("Preparing");
4. **Output** lcd.print ("Reading");
5. **Output** lcd.print ("Heart Beat");
6.
7. **while** (digitalRead(hbtpin) == HIGH) **then**
8. **Delay** for **4 seconds**
9. **while** (digitalRead(hbtpin) == LOW) **then**
10. n = 0; beat = 0;
11. **while** (digitalRead(hbtpin) == LOW) **then**
12. **n** is the **Timer counter**.
13. **while** (n<=20) **then**
14. **if** (digitalRead(hbtpin) == HIGH) **then**
15. **beat++;**
16. **Delay** for **4 seconds.**
17. **beat =** 20 seconds;
18. **beat = beat * 3** used for 60 seconds count of the heat beat.
19. **end**

After that, in **send hbeat method** start to upload the heartbeat.. “AT+CMGF=1\r” command line is used for set GSM modem in text mode. It is a readable text. “AT + CMGS =” command is used for write the mobile number where the SMS will show from the GSM module.

1. **sendhbeat** method **Begin**
2. lcd.setCursor(0, 0) for **set LCD Data Column and Row**
3. **Output** SIM900.println("H Beat");
4. SIM900.print("AT+CMGF=1\r");
5. **When** SIM900.print("AT+CMGF=1\r") **then**
6. **Delay** for **1 seconds**
7. **When** SIM900.println("AT + CMGS = \"+8801795943468\"");
8. **Delay** for **1 seconds**
9. **end**

In **up Heartbeat method**, AT+SAPBR=3, 1, command is used set the connection with GPRS and connect the APN of the website. "AT+HTTPINIT" command initializes the HTTP services to the server. "AT+HTTPACTION=0" command line for use enter button and “AT+HTTPREAD” command line is used for read the data from the page. AT+HTTPPARA AT command sets up HTTP parameters for the HTTP call.

1. **uphbeat** method **Begin**
2. lcd.setCursor(0, 0) for **set LCD Data Column and Row**
3. **Output** lcd.print("Uploading..");
4. **Output** SIM900.print(beat);
5. **When** SIM900.println("AT+SAPBR=3,1,\"CONTYPE\",\"GPRS\"") **then**
6. **Delay for 1 seconds.**
7. **When** SIM900.println("AT+SAPBR=2,1") for **integrate gateway ip**
8. **Delay** for **1 seconds.**
9. **When** SIM900.println("AT+HTTPINIT") for **integrate HTTP**
10. **Delay** for **1 seconds**
11. **When** SIM900.println("AT+HTTPPARA=\"CID\",1");
12. **Delay** for **1 seconds.**
13. **When** SIM900.print("AT+HTTPPARA) for **interrogate URL**
14. **Delay** for **1 seconds**
15. **delay(1000);**
16. **When** SIM900.println("AT+HTTPACTION=0")
17. **Delay** for **1 seconds**
18. **When** SIM900.println("AT+HTTPREAD") for **Page Data Read**
19. **Delay** for **3 seconds**
20. **end**

For **up ECG method** is also same command line as the heart beat method. Here, ECG count is used for check ECG rate in 50. If this ecg count is smaller than 50, than ecg count send analog data to the web server to show the ECG curve.

```
1. Upecg method Begin.
2. Output lcd.print("Uploading..");
3. Output SIM900.print(ecg);
4. While (ecgcnt<50) then
5.         ecgcount = 0;
6.         ecgcnt ++;
7. ecg = analogRead(A0) for Analog Data Read
8. Output lcd.print("Uploaded  ");
9.     end
```

Loop method is used for up and convert the analog ECG data to Digital Data. If the data is greater than 80 then up the ECG less than 80 than show the ERROR.

```
1. loop method Begin.
2.Output lcd.print("Reading");
3. checg=0;
4.   while (checg<100) then
5.    if (digitalRead(A0) == LOW) then
6.              checg++;
7. digitalRead(A0) used for ECG data Analog to Digital conversion
8.    if (checg>80) then
```

```
1.          upecg();
2.       else (checg<=80) then
3.    Output lcd.print("ERROR");
4.    Output lcd.print(" ");
5.     end
```

3.7 Website Implementation

Over 10 years after its presentation, REST has turned out to be a standout amongst the most critical advances for Web applications. REST remains for Representational State Transfer, which is a compositional style for arranged hypermedia applications. Its significance is probably going to keep developing rapidly as all advances move towards an API introduction. Each significant improvement dialect now incorporates structures for building RESTful Web administrations. [ ] To implement our website, we integrate our hardware with service call to show in the website. It show the real time value in the website. We created a web front with a device interface. PHP/ Java script language is used for create the website. PHP used to call the server and get the data from server. When heart beat is measured in heart beat sensor, it uploaded into the server and showed real value into the website according to date and time. It also generates the ECG curve graphically in the website according to the time and date. Chart.js is a powerful data visualization library. It is used to create the graphical line into the website. Web service is used to show ECG graphically by calling data from the server and generate it from the Arduino code. In other part, one can also make a live monitoring of the patient by using login username and password. https://www.ivideon.com is a cloud based video surveillance monitoring system. It has also a mobile applications in the Google play store that one can monitor by using own smart phone.

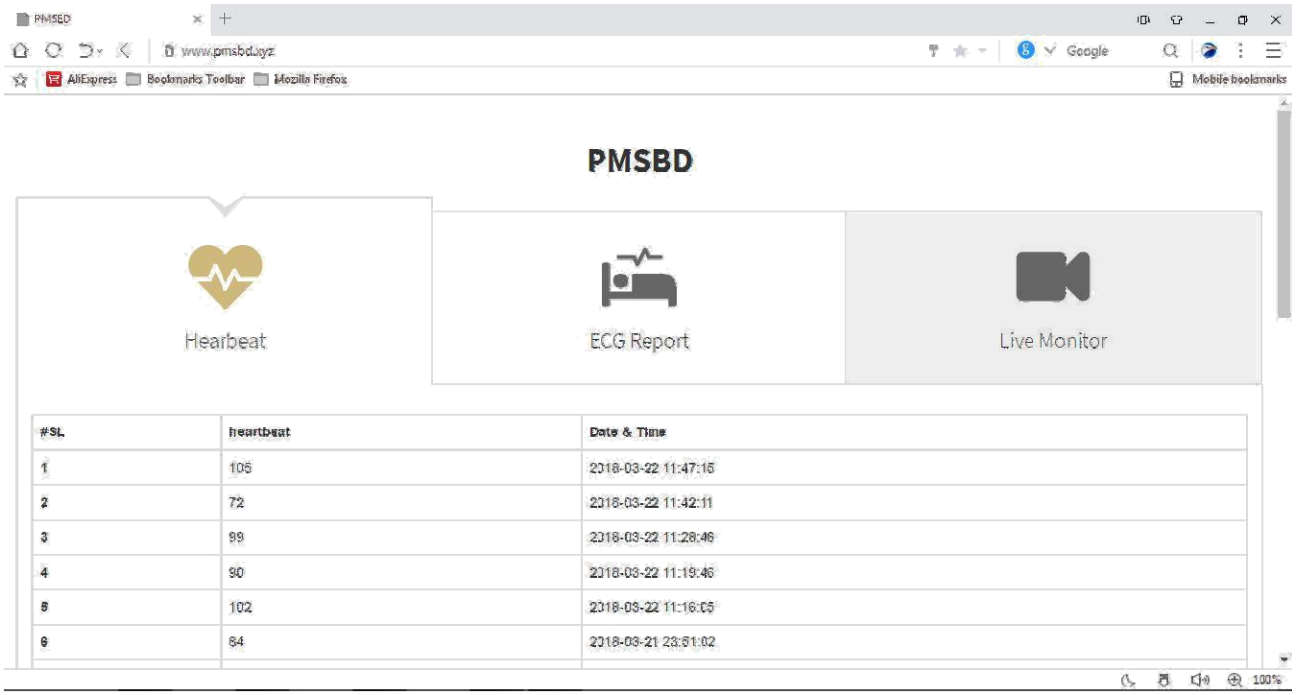


Figure 3.7.1 Website Interface

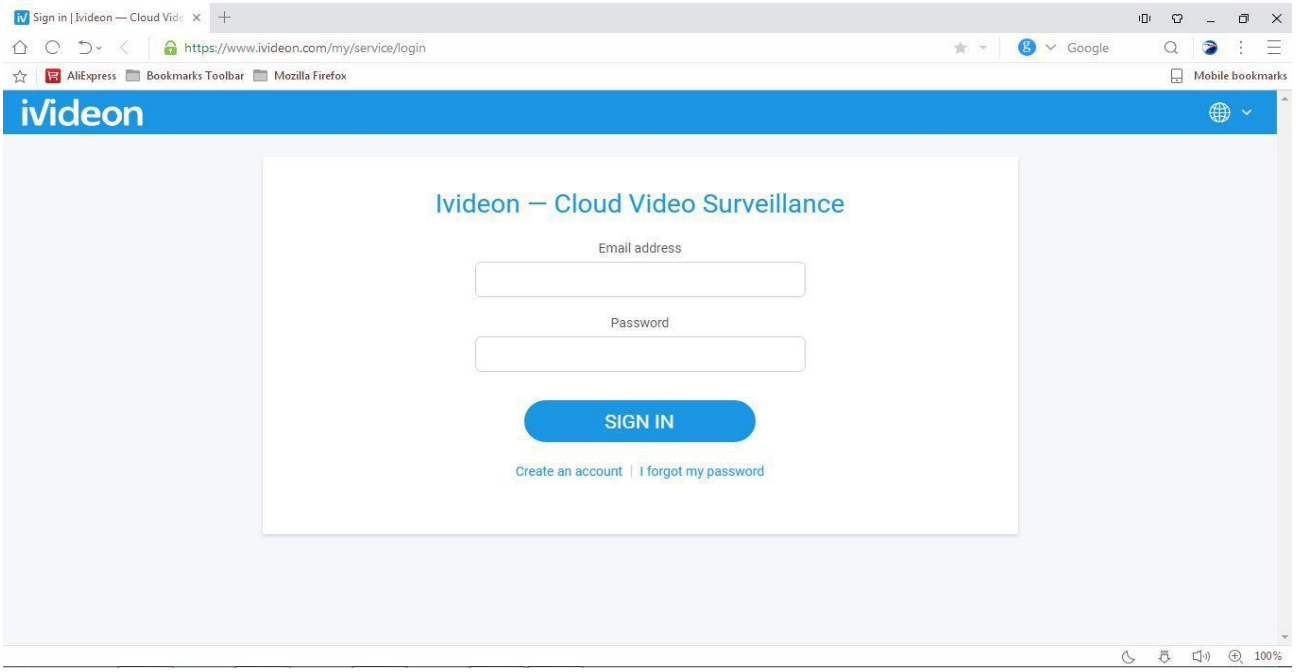


Figure 3.7.2 Live Monitoring Cloud Website Interface

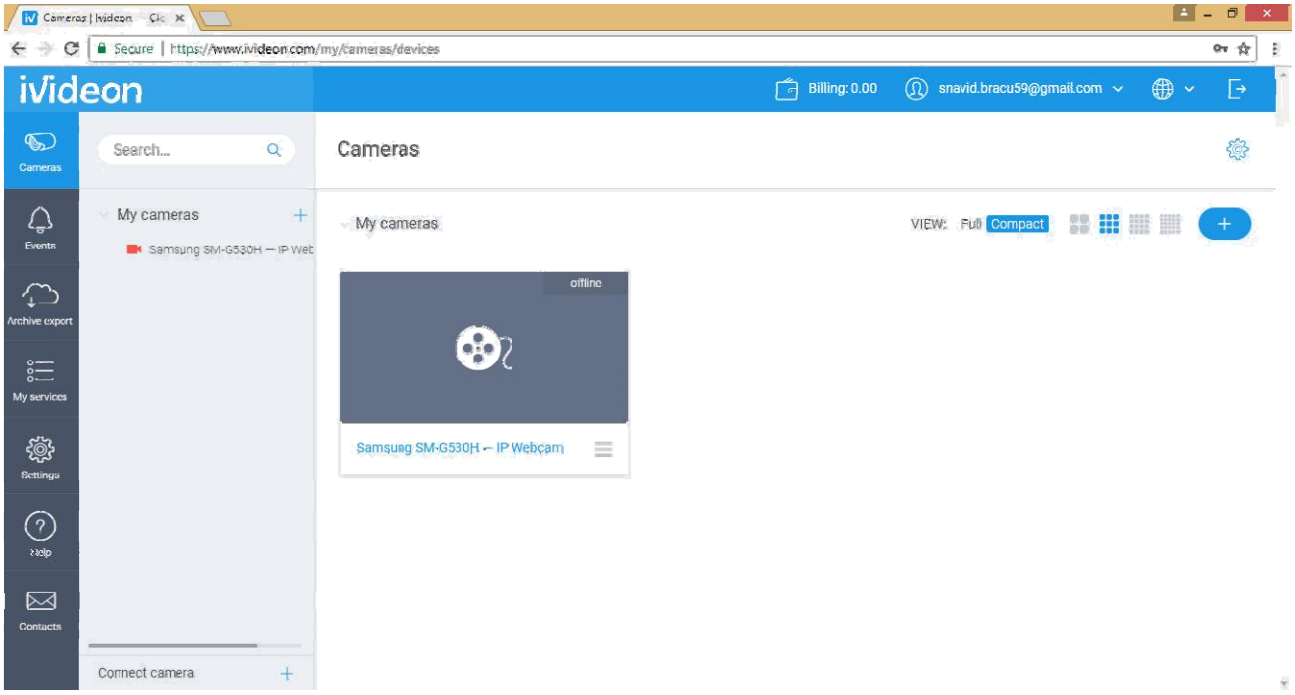


Figure: 3.7.3 After Log in into Website

3.8 Android Application Implementation

For easy and better access of our project's result, we also developed an application. To accomplish this outcome, we have likewise made a portable application. For the versatile application we have picked android stage. As of being open source and most generally received compact Operating System, Android has dependably been the best decision for us. Developing the Linux people group with in excess of 300 equipment, programming gear, Android has immediately transformed into the snappiest creating compact working framework. As our essential focused on gathering of individuals are from creating nations. Along these lines, it was another motivation to pick Android versatile application. As it offers more adaptability and effectively prepared to go client base, Android is the best suit for our project.

TECHNICAL SPECIFICATIONS

- JDK JRE 8.0
- Min SDK version 15 (API support level 14 and above)
- Target SDK version 24
- Android Studio
- Windows, Linux or Mac Operating System
- Android level permission:

1. Bluetooth
2. SMS

Android application gets the relevant data from website server and by this it shows the result to the android application.

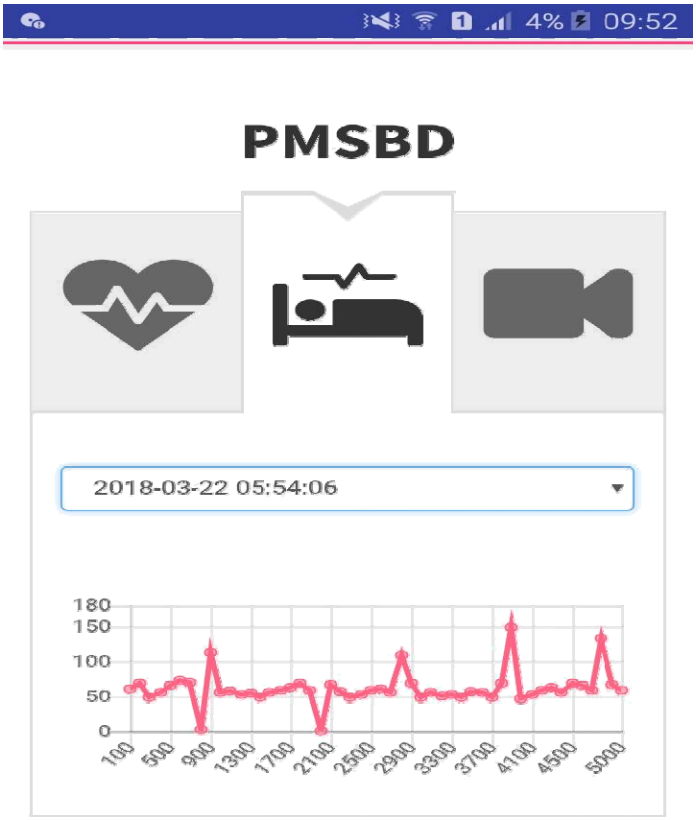


Figure 3.8 Mobile Application Interface

Chapter 4

CONNECTION SETUP

The whole circuit will work successfully if the entire components connected successfully. There are many individual components which performing different individual tasks. Connection scenario of individual part with each other and all over the circuit description is given below

4.1 CONNECTION

4.1.1 ECG Sensor

Chip AD8232 which is placed in ECG sensor is a kind of low noise amplifier. In every IC there has some obstacle noise but the advantage of this chip is the obstacle is too low. In ECG sensor there are 3 probes and the reasons for having 3 probes is to create differential amplifier so that it can eliminate noise. In ECG sensor kit 3.3V pin and ground pin is connected with PCB board.

4.1.2 Heartbeat Sensor

For heart beat sensor, BJT550 is used for amplification. In this BJT, CE method has been followed. Resistor with 120kΩ is placed so that the BJT can remain on by default. On the contrary, to turn on the BJT there is a minimum requirement of voltage that is why a variable resistor is also placed below the 120kΩ resistor. To amplify the previous BJT, another BJT has been used and this new BJT will do amplification and filtration. Capacitor (100µf) is added to the input side so that the noise can be bypassed through the previous BJT. So this is working like a low pass filter. Additionally, an Op amp is used to work like a comparator circuit. The final output is going to the Arduino pin between 3.3kΩ and 4.7kΩ resistor.

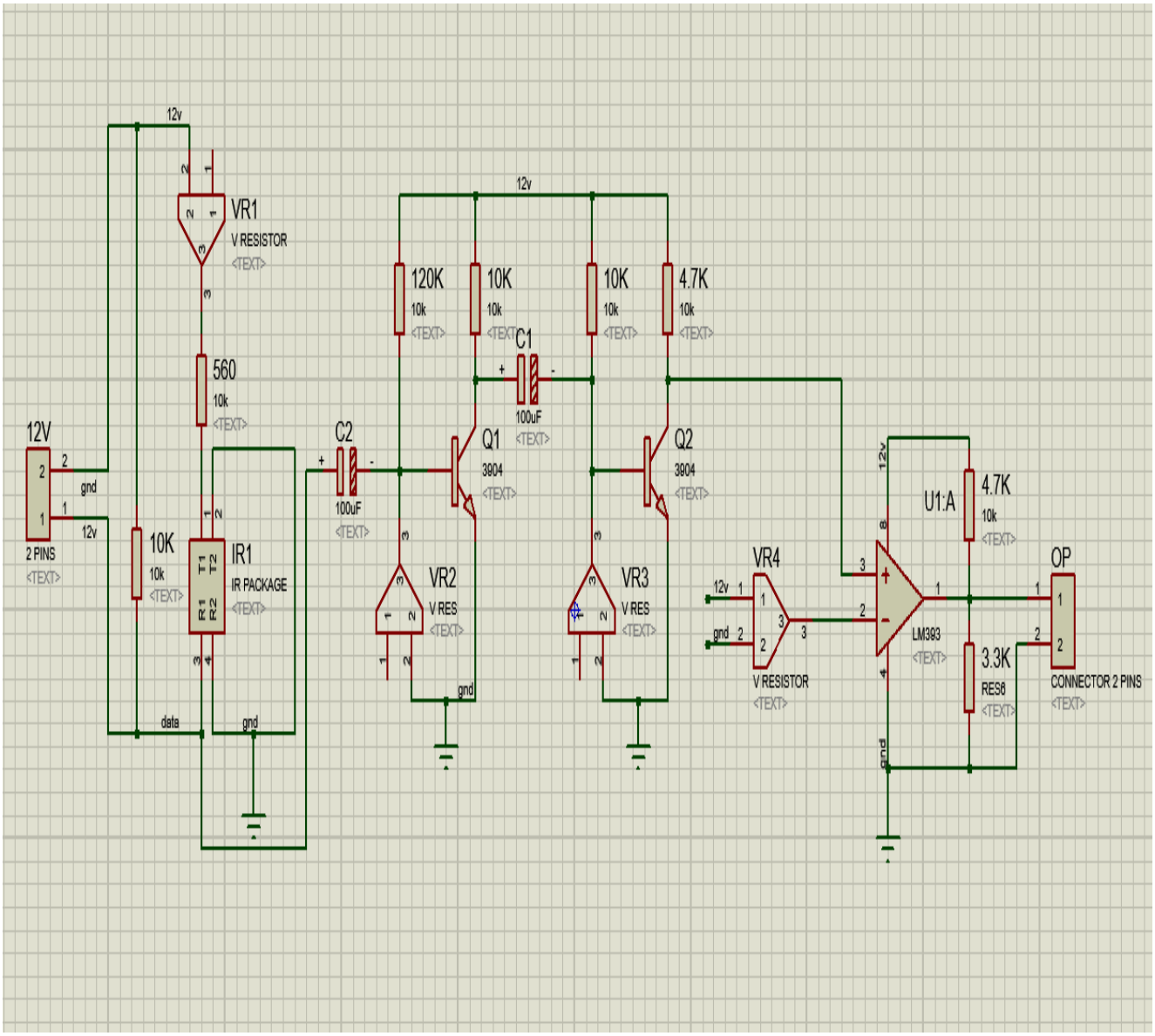


Figure 4.1.2 Heartbeat sensor diagram

4.1.3 LCD Display

There are 16 pins in 20*4 LCD display. The Pins description of 20*4 LCD display is given below:

Serial No	Pin No	Pin Name	Type of Pin
1.	Pin 1	Ground	Source Pin
2.	Pin 2	Vcc	Source Pin
3.	Pin 3	Vo/VEE	Control Pin
4.	Pin 4	Register Select	Control Pin
5.	Pin 5	Read/ Write	Control Pin
6.	Pin 6	Enable	Control Pin
7.	Pin 7	Data Bits(0-7)	Data/Command
8.	Pin 15	LED positive	LED Pin
9.	Pin 16	LED negative	LED Pin

Table 4.1.3: LCD PIN Configuration

As Pin 1 and Pin 2 are the source pin so, Pin 1 is grounded and Pin 2 is given 5V connection with PCB. Moreover, Pin 3 to Pin 6 is control pin so these pins are wired with Arduino. In Pin 7, there are 8 data or command pin. Although having 8 data pins we can work with 4 data bits. For this, we are grounding D0-D3 data bits and the rest data bits are wired with Arduino. Lastly, Pin 15 and Pin 16 are the LED pins in which LED Negative pin is grounded and Led positive pin is connected with variable resistor by applying 5V source in the PCB.

4.1.4 PCB Design

i. There are 6 pins for LCD display: 4 Data pin (D4-D7), Rs pin and En pin. Two variable resistors are also present in the PCB which helps to control brightness and contrast in the LCD display.

ii. For the LED's, there are 3 pins along with 3 resistors.

iii. 5 buttons are used in the PCB and for each of the button one 10kΩ resistor is required. These 5 buttons are: to measure heartbeat and ECG, to upload ECG and heartbeat reading and the remaining one is for auto upload.

iv. There are 5V, 3V and ground pin in the PCB and these 3 pins are wired with Arduino.

v. 4 pins connector is used for the connection of GSM module and they are 5V, ground pin, Rx (Receiver) and Tx (Transmission) pin. With the 5V and ground pin 1 (100 µf) capacitor is placed.

vi. For Arduino, ECG and GSM Module ports 3 (100 µf) capacitor is used in order to get smooth power supply. Moreover, it has 3 analog data pins in the board.

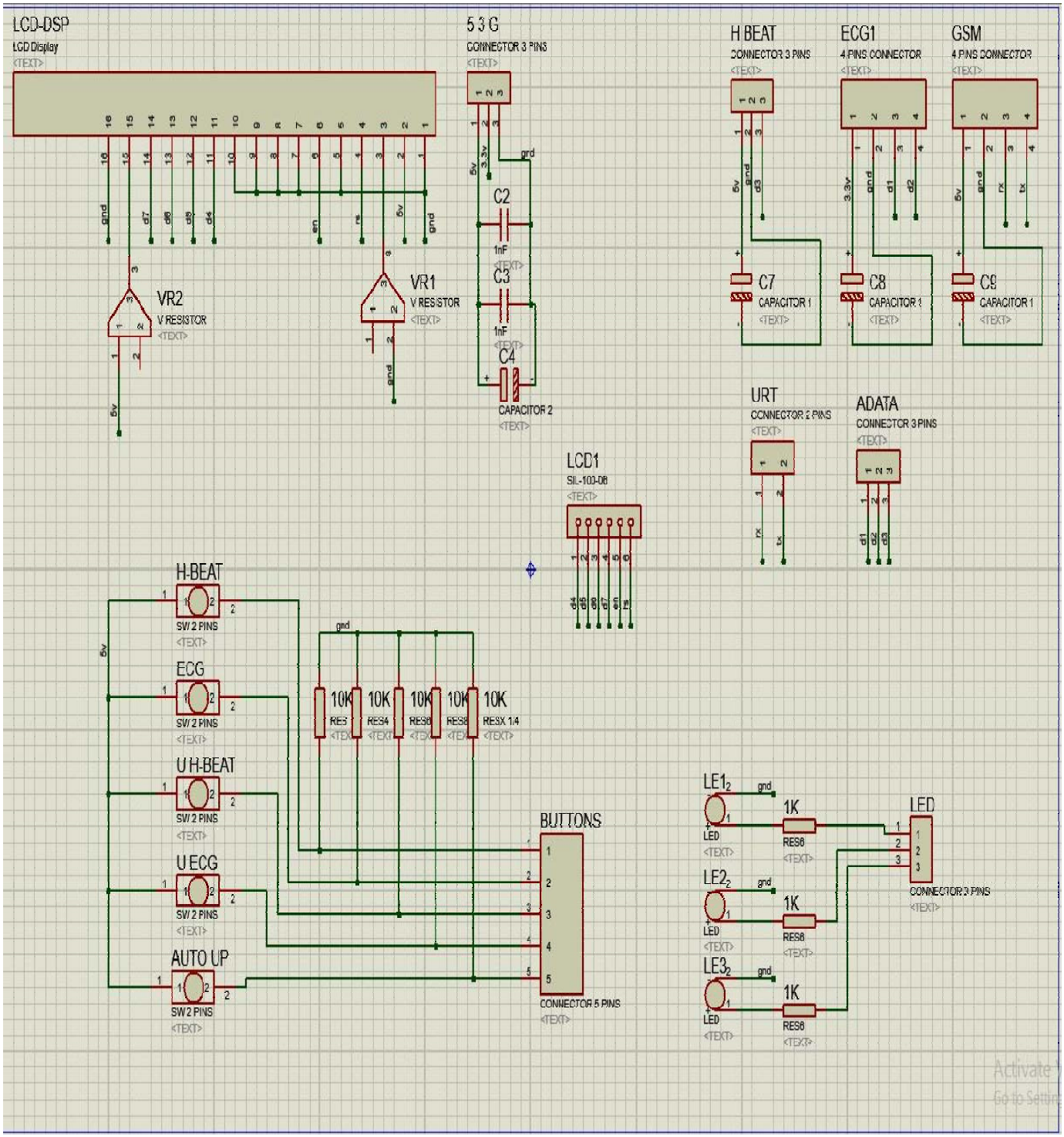


Figure 4.1.4 PCB Board Schematic diagram

ARDUINO CONNECTION WITH ALL THE COMPONENTS

4.2.1 Arduino connection with Heart Beat Sensor:

Arduino's 7 number pin is connected with heart beat sensor sub circuit. Heart beat sensor has 3 input. One is connected with arduino, second one is connected with 12 volt (PCB Board) and last one is grounded.

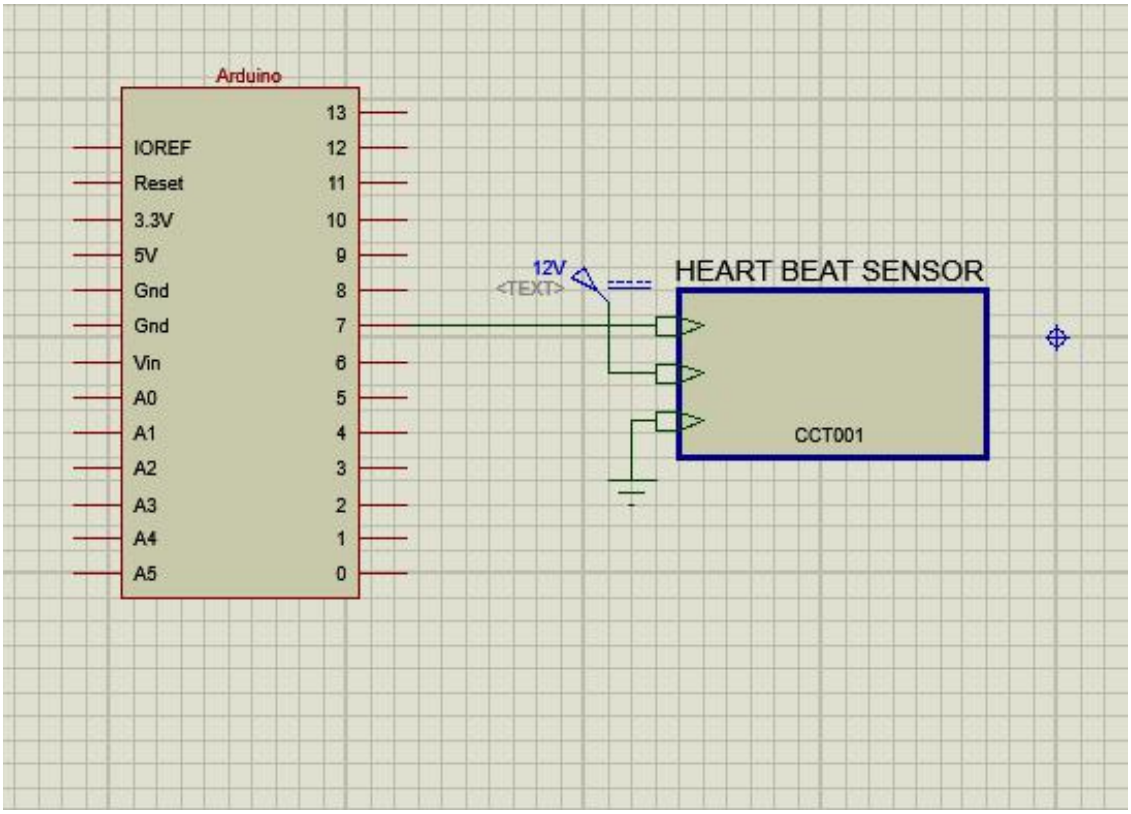


Figure 4.2.1 Arduino connection with heart beat sensor

4.2.2 Arduino connection with ECG sensor

ECG sensor has also 3 inputs. First one is connected with A0 pin of arduino (pin number 5). Another input is connected with 3.3 volt of arduino (pin number 10). Last one is grounded.

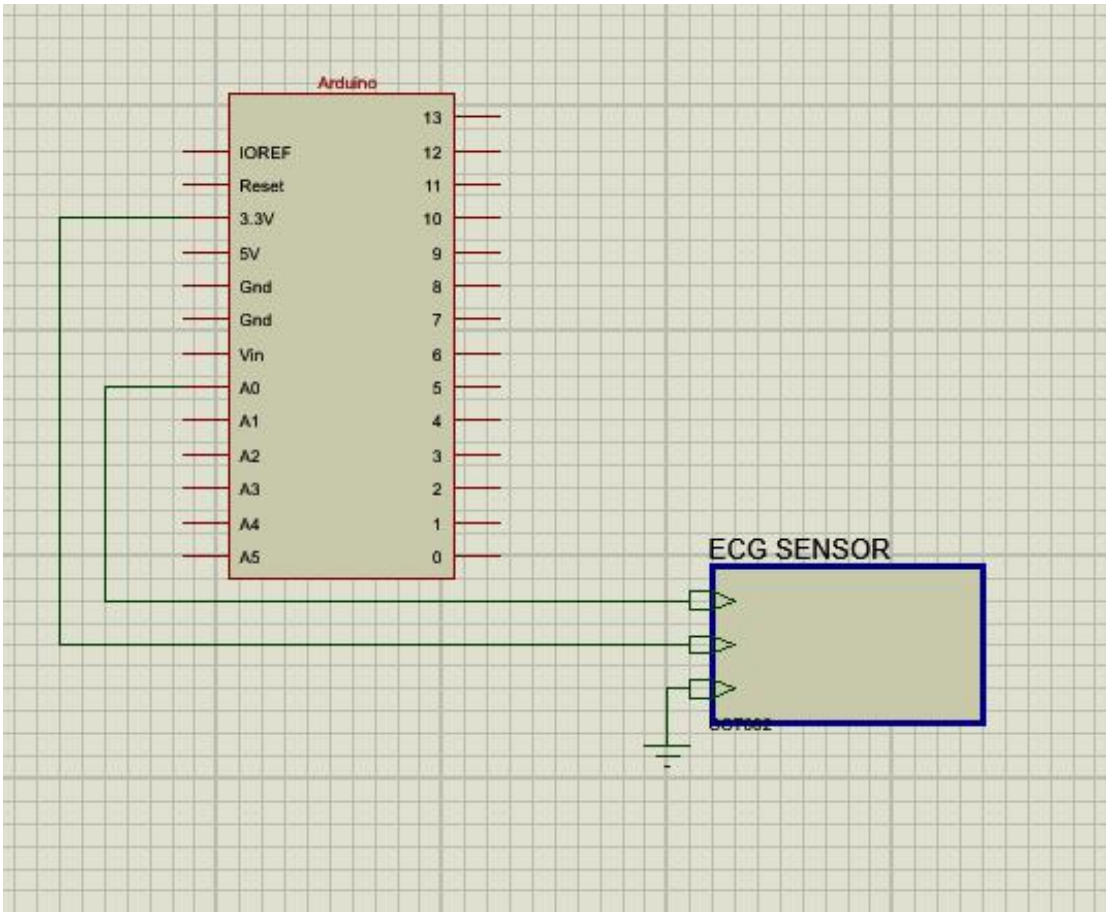


Figure 4.2.2 Arduino connection with ECG sensor

4.2.3 Arduino connection with GSM Module

GSM module has 4 inputs of sub circuit. First one is connected with pin number 3 of arduino, second one is connected with pin number 2 of arduino and third input is connected with PCB board which is connected with 5 volt and fourth one is grounded.

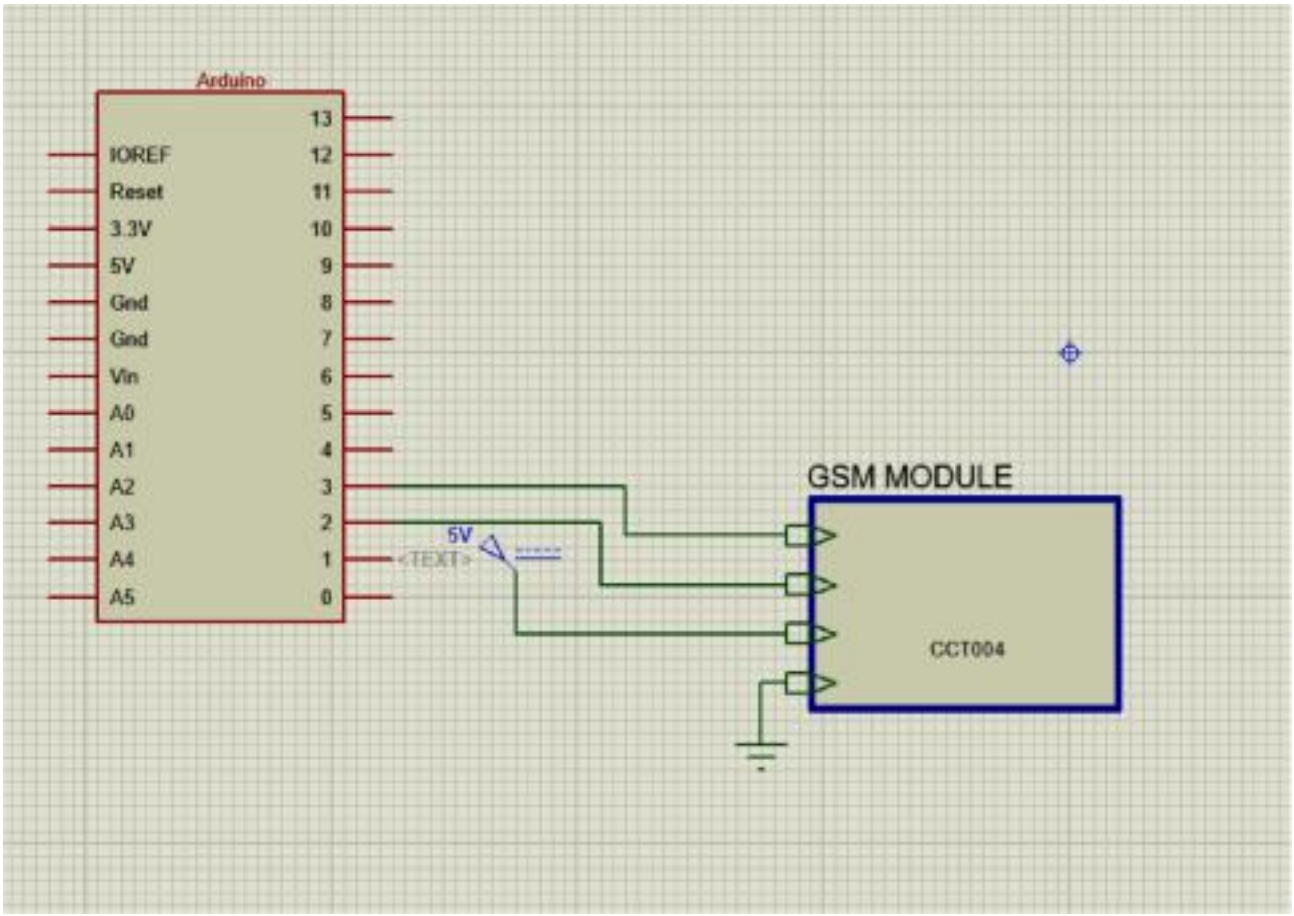


Figure 4.2.3 Arduino connection with GSM Module

4.2.4 Arduino connection with LCD display

First of all, LCD display has 14 pin. Pin of LCD 14,13,12,11 pin are connected with 13, 12, 11, 10 pin of arduino. LCD display pin number 10, 9, 8, 7, 5, 1 are directly connected with ground. Pin number 3 of LCD has connected with a variable register RV1 and this pin is connected also ground. Pin number 4, 6 of LCD connected with pin 8, 9 number pin of arduino. Last of all, pin number 2 of LCD is connected with 5 volt which is connected with PCB.

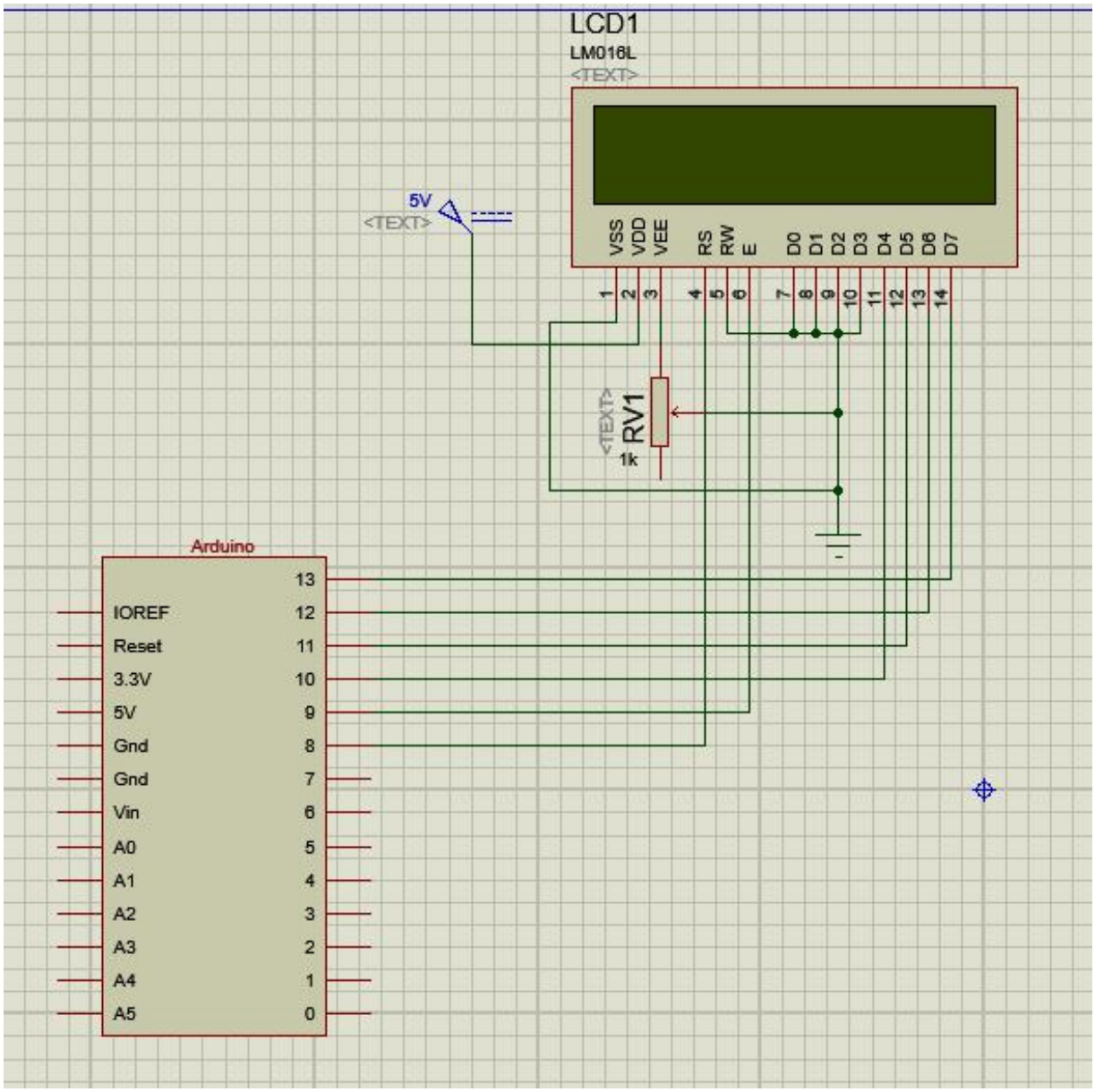


Figure 4.2.4 Arduino connection with LCD display

4.2.5. Arduino connection with button

In this project, we are using 5 push buttons. Among 5 of them, 3 push buttons are connected with 3 registers in series. All 3 registers value is 10K. Here, R1, R2, R3 are connected with pin number 6, 5, 4 of arduino. All 3 push buttons are grounded.

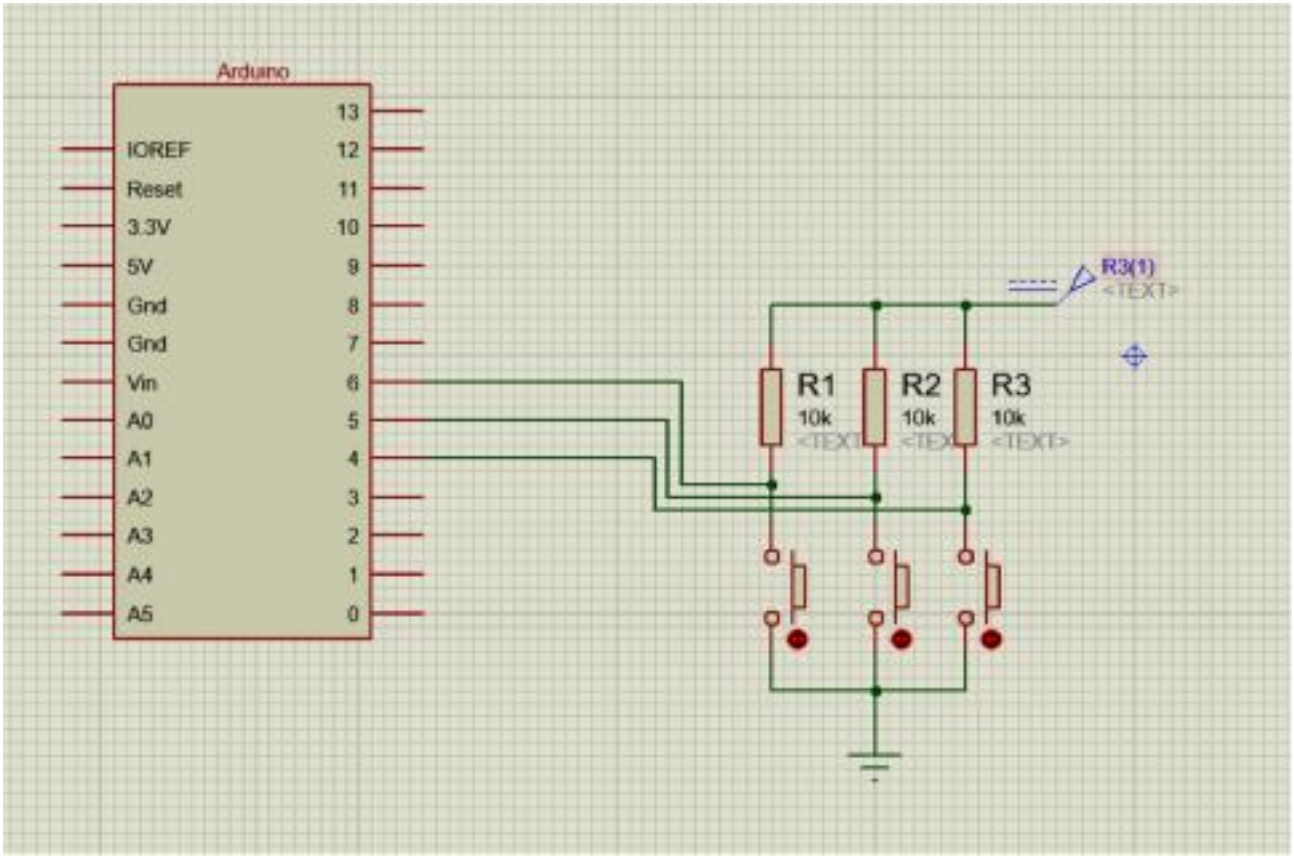


Figure 4.2.5 Arduino with push button

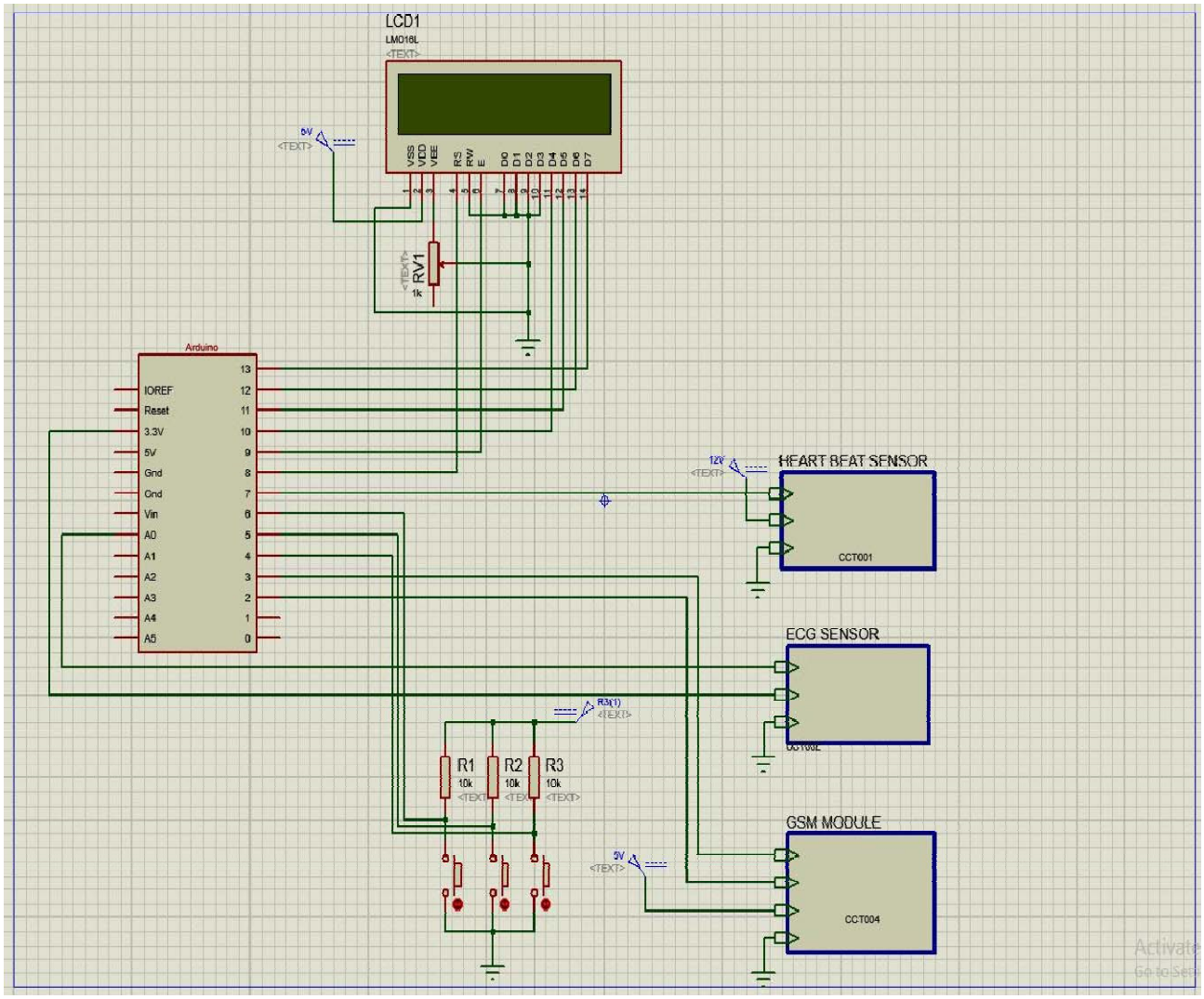


Figure 4.2.6 Arduino connection with all the components

CHAPTER 05

RESULT AND DATA ANALYSIS

After connecting and programming all the components with each other, we have performed the experiment. According to the proposed system, we have designed prototype Iot based Patient monitoring System. Arduino, GSM module and all the sensors are connected with lots of wires.

The whole project setup is given below.

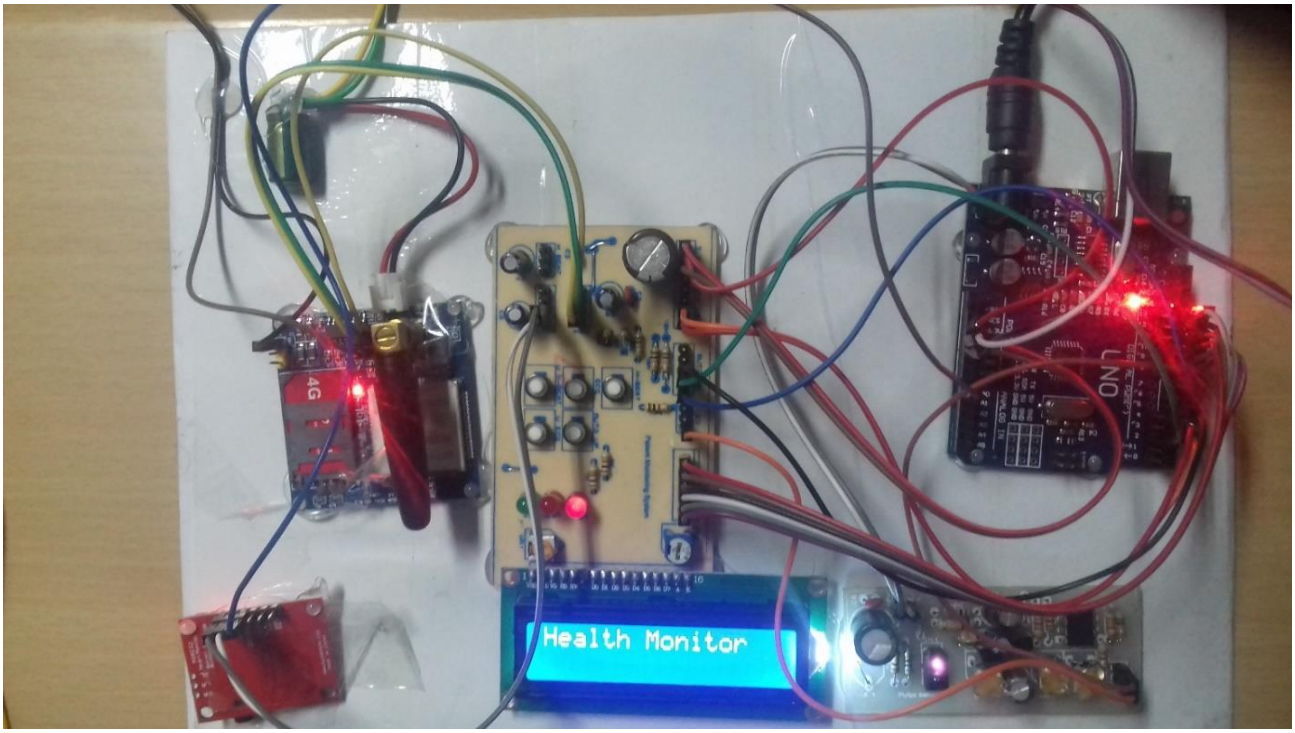


Figure 5.1 Top view of whole system

5.1 Heartbeat Result Analysis

To verify whether the heartbeat sensor is working or not, we compare the heartbeat result with an automatic blood pressure machine's heartbeat output. To proceed with this thought, we have checked the data which is taken from 5 various people having specific age limit. The data is given below with specific date and time.

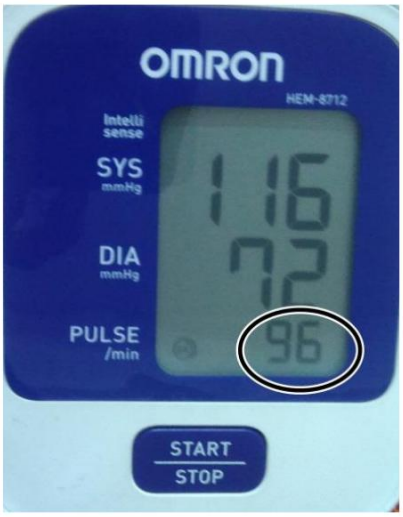
Age	Sex	Heartbeat output from BP machine	Heartbeat output from our system
12-22	Female		
Date & Time		22 March 2018	22 March 2018
		11:12	11:18

Table: 5.1(a): Heartbeat result analysis

Age	Sex	Heartbeat output from BP machine	Heartbeat output from our system
23-33	Female		
Date &Time		22 March 2018	22 March 2018
		11:18	11:20

Table 5.1(b) Heartbeat result analysis

Age	Sex	Heartbeat output from BP machine	Heartbeat output from our system
34-44	Male		
Date &Time		22 March 2018	22 March 2018
		11:21	11:29

Table5.1(c) Heartbeat result analysis

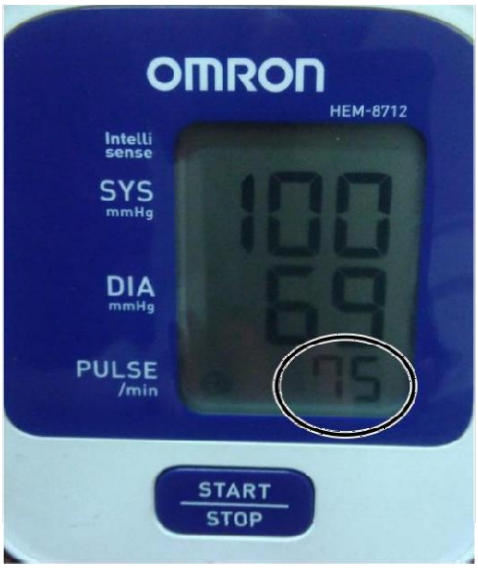
Age	Sex	Heartbeat output from BP machine	Heartbeat output from our system
45-55	Female		
Date &Time		22 March 2018	22 March 2018
		11:40	11:42

Table 5.1(d) Heartbeat result analysis

Age	Sex	Heartbeat output from BP machine	Heartbeat output from our system
56-66	Male		
Date & Time		21 March 2018	21 March 2018
		11:43	11:47

Table 5.1(e) Heartbeat result analysis

5.2 Heart Beat Result in Mobile Message

From the previous tables of heart beat results, now in this figure, the same results are shown by mobile message with time and date

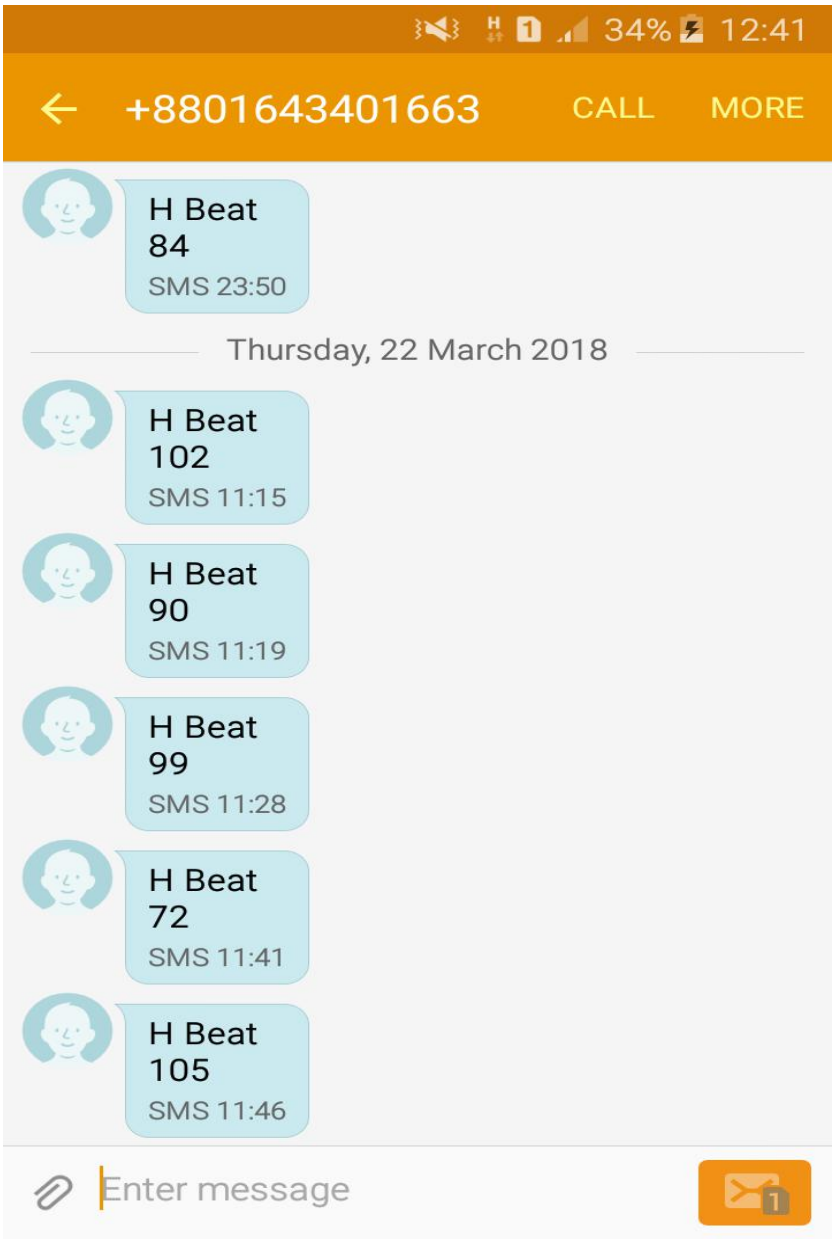
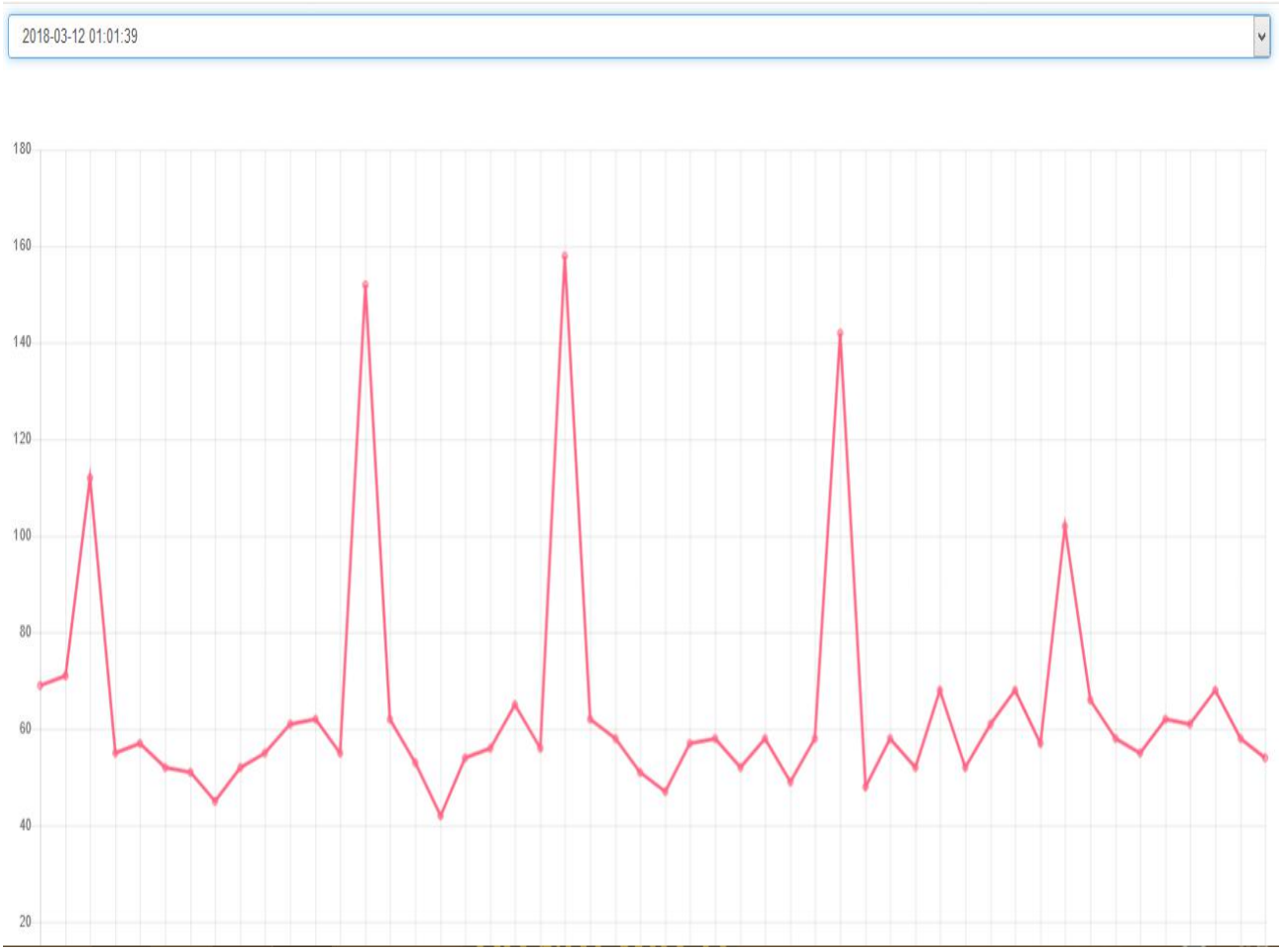


Figure 5.2 Heartbeat Result in Mobile Message

5.3 ECG Report Analysis

At first in our ECG sensor we have 3 electrodes placed in the patient's chest. The red color electrode is placed in the right side chest where the heart beat is producing. And the green colour electrode place in left side chest and last one yellow electrode place in below green colour electrode. Then we have to press ECG push button. The value will generate curve and upload in mobile application and website.

Here we are presenting some ECG results:



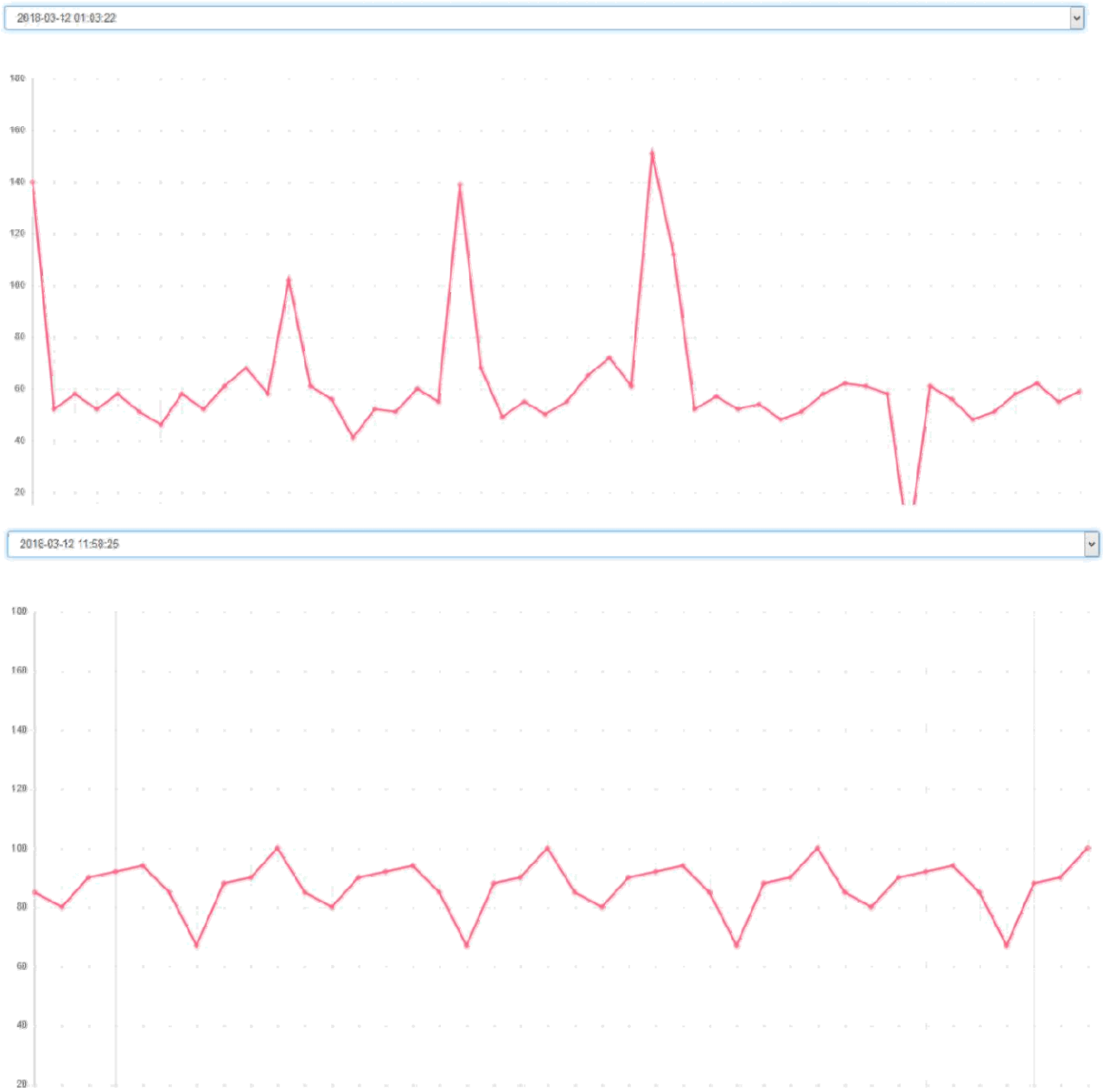
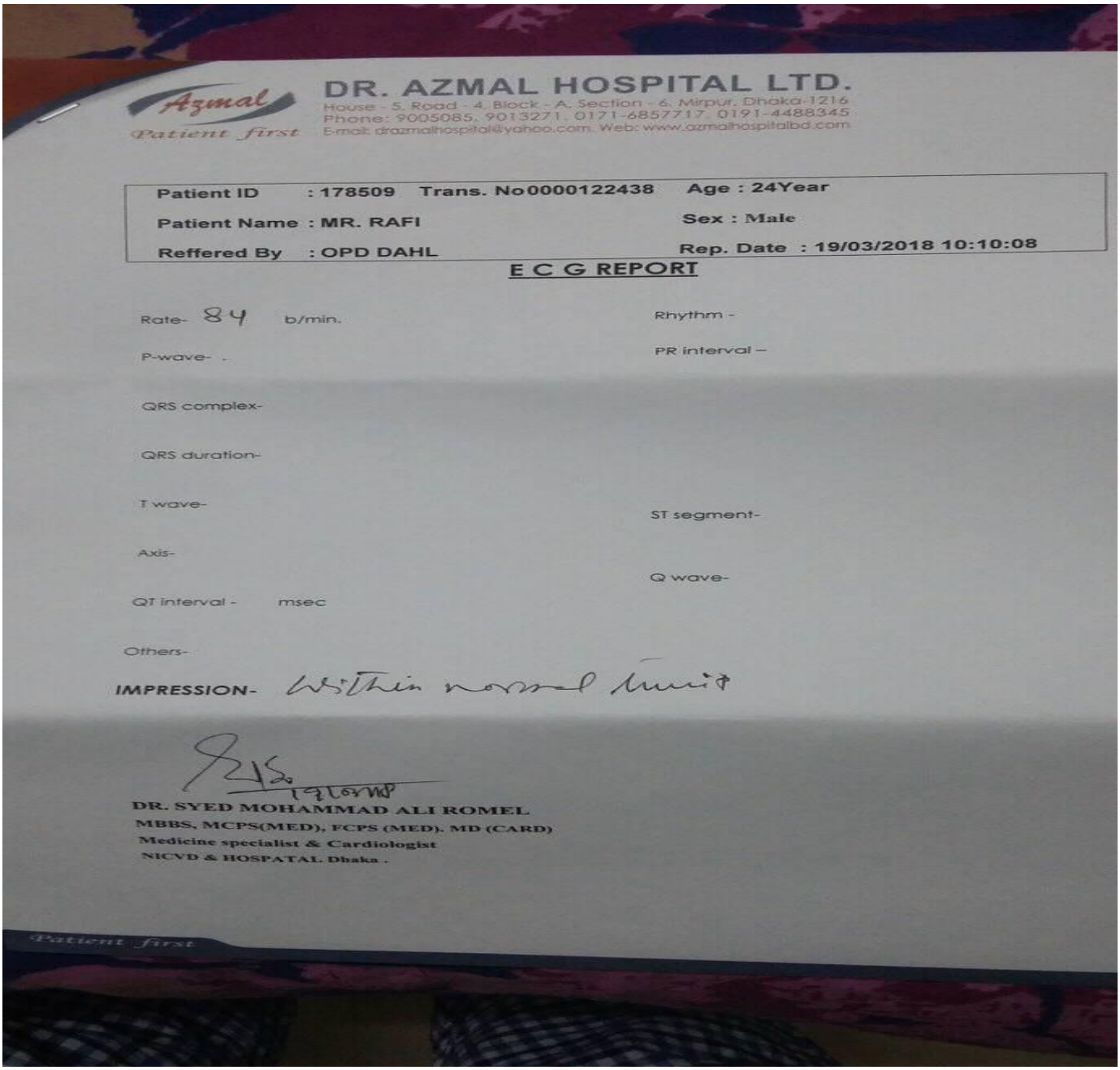


Figure 5.3 ECG Results

5.4 Doctor reference with ECG report



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Patient ID : 178509 Trans. No 0000122438 Age : 24Year
Patient Name : MR. RAFI Sex : Male
Reffered By : OPD DAHL Rep. Date : 19/03/2018 10:10:08

E C G REPORT

Rate- 84 b/min. Rhythm -
P-wave- . PR interval –
QRS complex-
QRS duration-
T wave- ST segment-
Axis-
Q wave-
QT interval - msec
Others-
IMPRESSION- Within normal limit

DR. SYED MOHAMMAD ALI ROMEL
MBBS, MCPS(MED), FCPS (MED), MD (CARD)
Medicine specialist & Cardiologist
NICVD & HOSPATAL. Dhaka .

Figure 5.4 (a) Doctor Reference

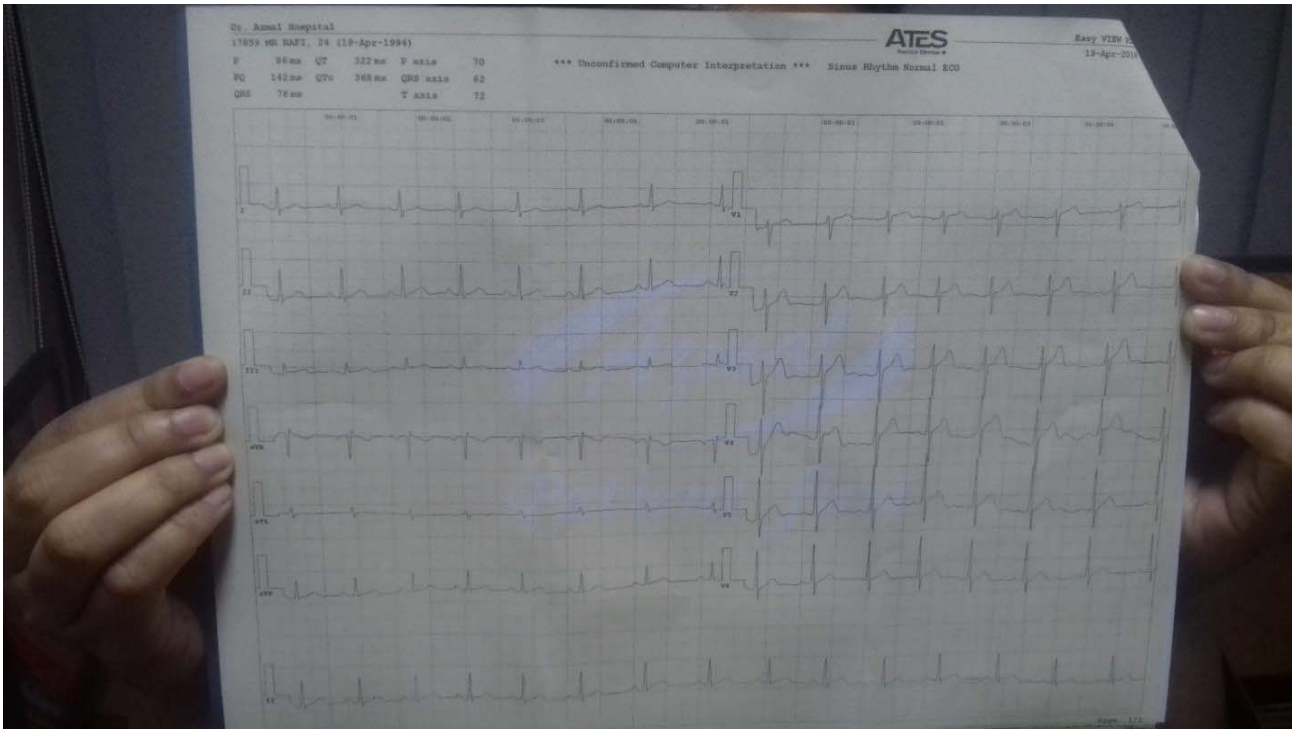

Figure 5.4 (b) ECG Report

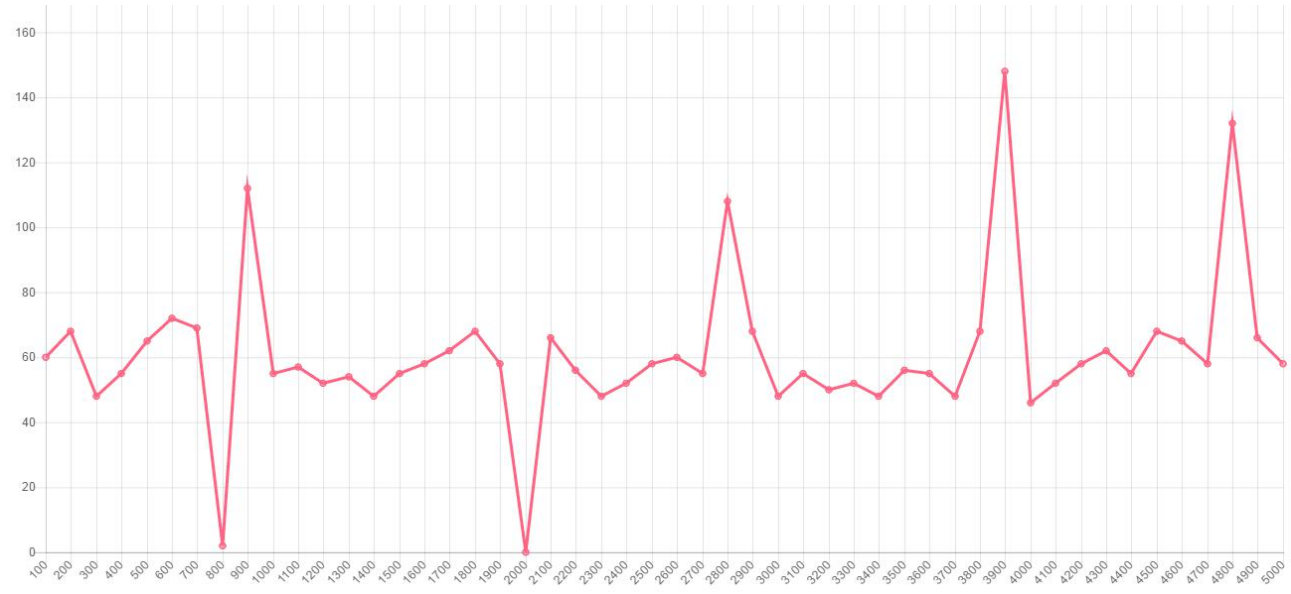

Figure 5.4 (c) Website ECG Report

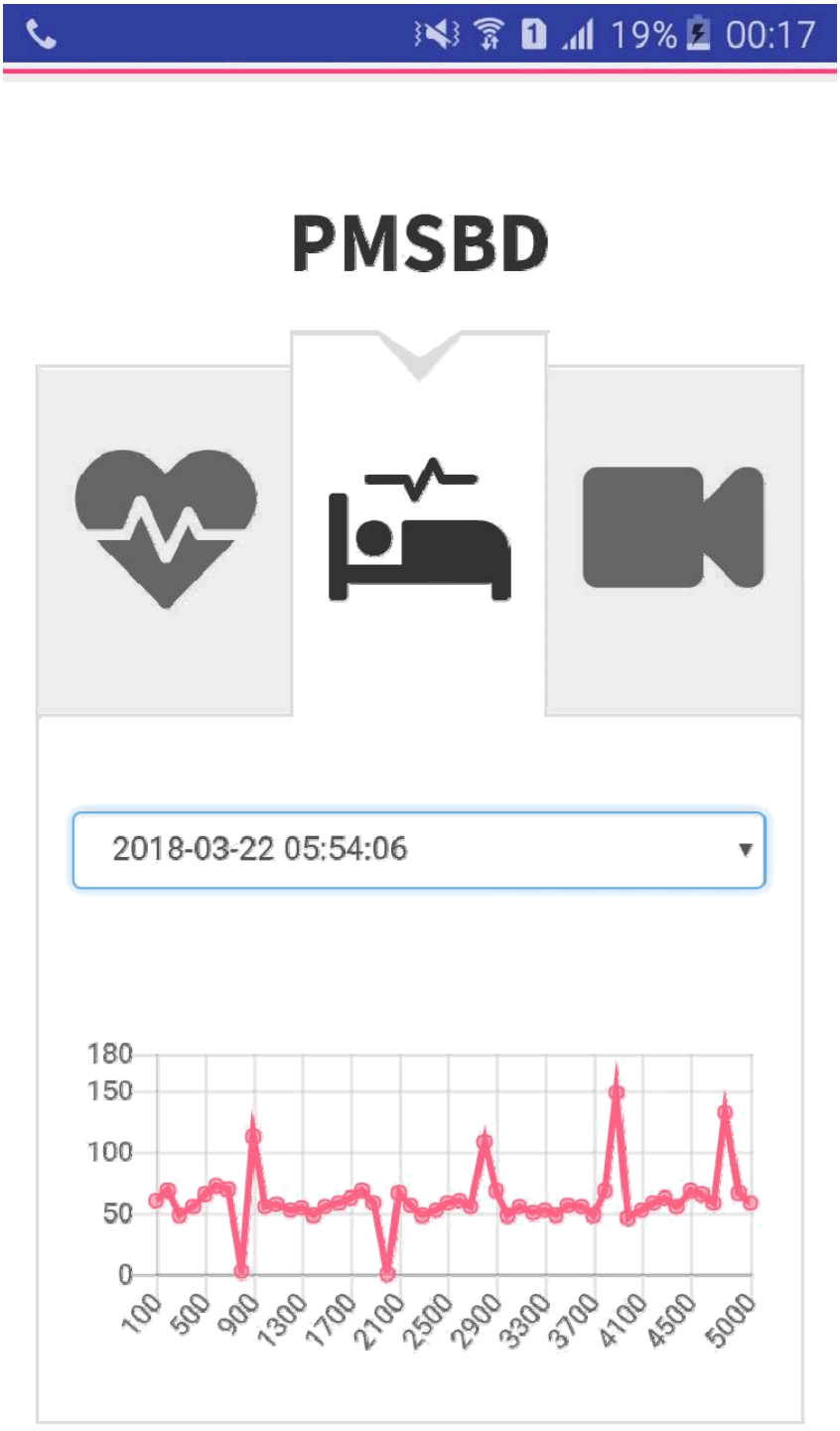

Figure 5.4 (d) Mobile Application ECG Report

5.5 Live Monitoring

In our thesis project, we have also added live monitoring system of the patient in order to monitor anytime from anywhere. For this, we need to use two android mobile phones. One can stream live by using IP Webcam application which is available in google play store. Then, another person can watch the video from the https://www.ivideon.com/ by create an account there.

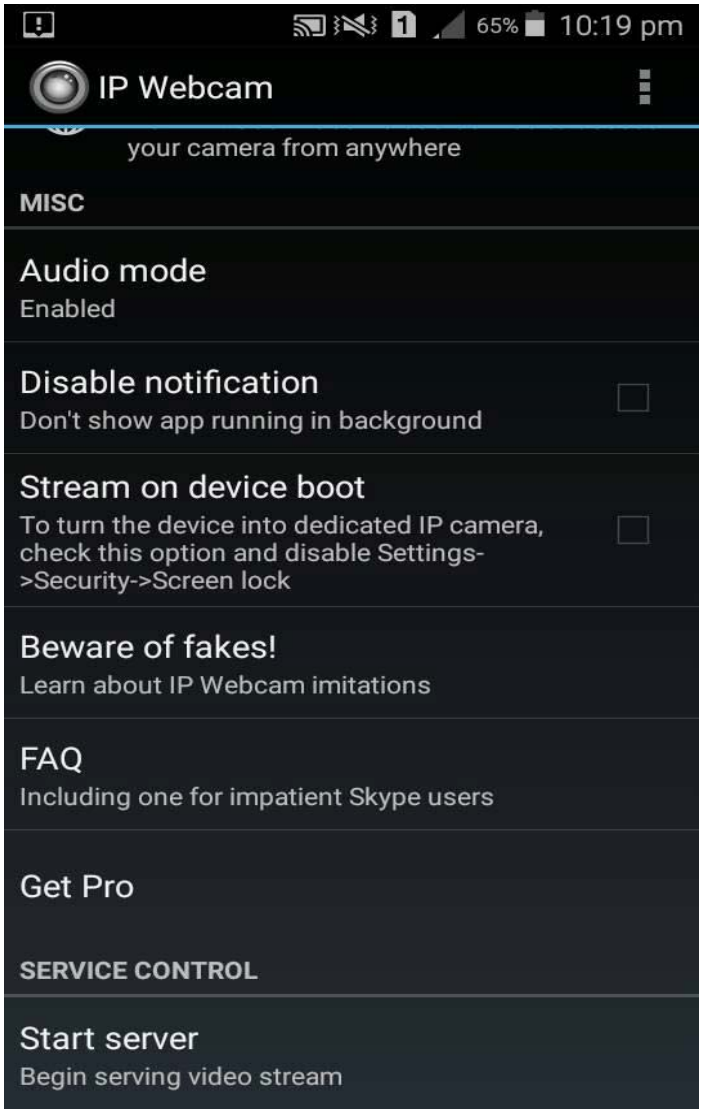

Figure 5.5 (a) IP Webcam Screenshot

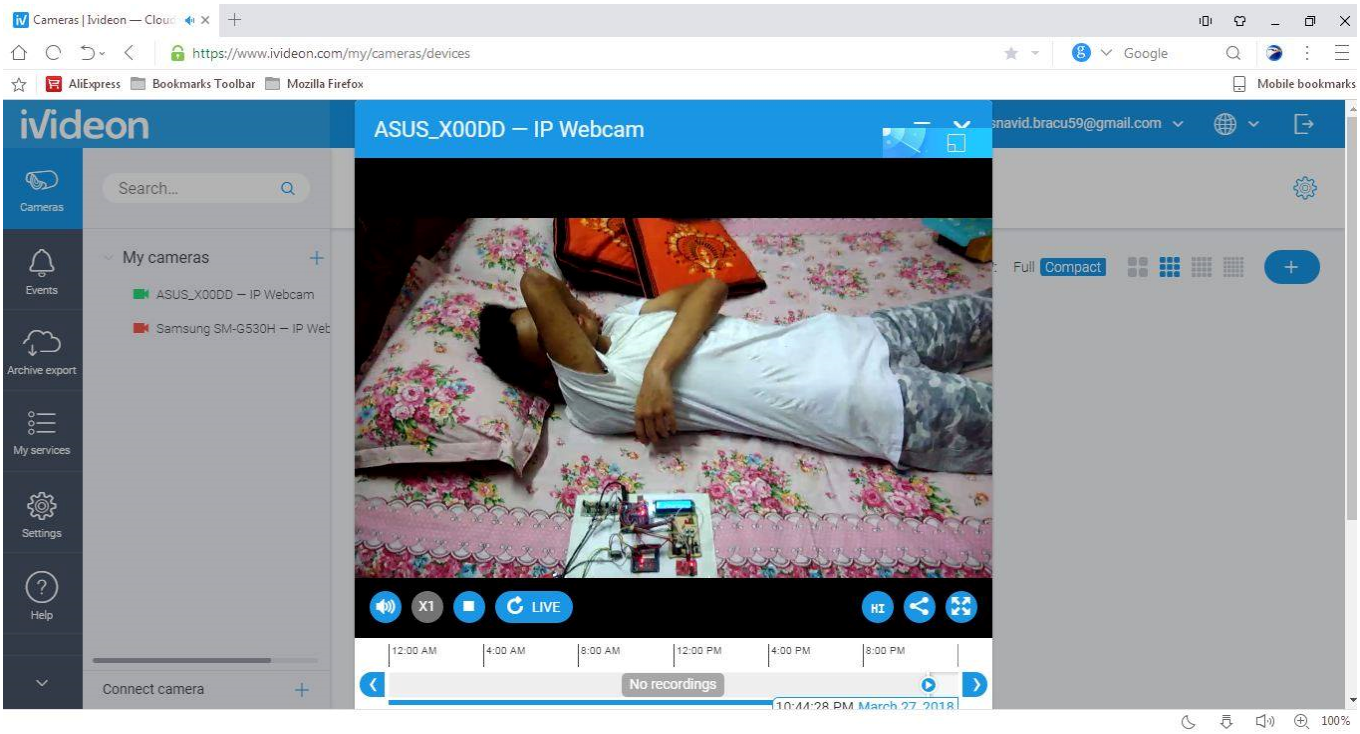

Figure 5.5 (b) Live Monitoring Screenshot

5.6 Cost Analysis

In our country like Bangladesh, many new health equipment are found in the hospital. Moreover, most of the best hospital brings health equipment like ECG machine, Laser machine, MRI machine from outside of the country. Therefore, hospital authorities have to pay a large number of cost for bringing the equipment so that they can give the best service to their patient.

But we glad that, it took very much cheap price to build our project. Our every component is very cheap and the quality is also good. So, everyone can afford it without having any financial headache.

To build out project, we have used Arduino Uno, GSM module, Heartbeat/Pulse sensor, ECG sensor, PCB, LCD display and other components like resistor, capacitor, voltage regulator and connectors

Components	Unit Price
1.Arduino Uno	490/=
2.SIM 900 GSM Module	2,176/=
3.Heartbeat sensor	2,300/=
4 ECG sensor	600/=
5.PCB	700/=
6.LCD display	810/=
7.Others	204
Total	**7,280**

Table 5.5 Cost analysis table

Chapter 6

CONCLUSION

6.1 Conclusion

In general IoT based health care platform which connects with smart sensors attach with human body for health monitoring for daily checkup. In this paper we discussed about IoT based patient monitoring system. The system technologies being used by smart phones or gadgets in present time where we also mentioned about advantages, challenges and opportunities. Due to the importance of observing medical patient, continuous remote monitoring is necessary. Our project work is giving the opportunity to monitor patient continuously by using the web and apps service along with live monitor and mobile message service. This paper also compared the early aged medical system between present time health monitoring. The present time represents the time reducing, reduce health care cost especially for rural area people.

6.2 Future Plan

In our proposed system we monitor the patient condition especially for the ICU or cardiac patients but in the future we will upgrade both hardware and software part. In hardware part, we will measure temperature of the patient so for this we will need temperature sensor. Also we will monitor the whole ward room or patient room from far places by Wi-Fi module .Therefore, person fall detection feature will be added which would be beneficial to older people Moreover, blood pressure sensor will be given.

In software segment we will upgrade the Website as well as the Apps. We will build a user friendly feature in the website which will show the patient name, date and time description in the ECG segment automatically. Similarly, Apps will be upgraded and uploaded in the Play store. Therefore, people will get the opportunity to download the Apps from Google Play Store and install it in their Mobile phone.

Due to the importance of observing medical state of patients who are suffering from acute diseases, especially cardiovascular diseases, a continuous remote patient monitoring is essential. Internet of Things is able to provide tools to build comprehensive services.

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