IoT based
Smart Health Monitoring

A BTP Report

By

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INDIAN INSTITUTE OF INFORMATION

TECHNOLOGY SRICITY

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2nd Semester Report

INDIAN INSTITUTE OF INFORMATION TECHNOLOGY SRICITY

CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the BTP entitled **"SMART HEALTH MONITORING"** in the partial fulfilment of the requirements for the award of the degree of B. Tech and submitted in the Indian Institute of Information Technology SriCity, is an authentic record of my own work carried out during the time period from January 2021 to May 2021 under the supervision of Prof. Dr Paul Braineard, Indian Institute of Information Technology SriCity, India.

The matter presented in this report has not been submitted by me for the award of any other degree of this or any other institute.

Balakrishna Nair

Signature of the student with date

(N. Balakrishna Nair)
(17-12-2021)

- -

This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

Signature of BTP Supervisor with date

(Prof. Dr Paul Braineard)
(17-12-2021)

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S. Manikanta

Signature of the student with date

(S. Manikanta)
(17-12-2021)

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(17-12-2021)

ABSTRACT

In the current pandemic situation a good real-time health monitoring system that lets the hospitals be updated on the vital conditions of their patients such as the Pulserate, BodyTemperature, etc., is a prime necessity and this system can be implemented to improve the analysis and better help the frontline soldiers (Doctors and Medical staff) to analyse the data efficiently.

A Real-time health monitoring system is proposed to collect data from various sensors and update them on the website to notify/remotely monitor by both the hospital management, appointed doctor and the guardian, the patient. This system will reduce the need for additional manpower at COVID wards (current example) and lets the hospital efficiently maintain a record of the obtained patient data. The Internet of Things serves as a catalyst for healthcare and plays a prominent role in a wide range of healthcare applications.

Keywords- Pulse Rate, Temperature, COVID-19, Database, Website,

Contents

Literature Survey

A number of researchers have proposed various models for IoT in Healthcare and the prediction of various types of diseases using various techniques. This part focuses on the work done in the same area.

1. Smart medicine and physical health system using IoT

Details: P.Elanthiraiyan and Dr S.Babu International journal march 2015. LINK

The Author studied the resources optimizations and how to monitor the data using IoT related to health care. As electronic health records become commonplace, and the rapid uptake of mobile and handheld devices puts powerful. Proposed system an Ontology based automating design methodology for smart medicine and physical health system using IoT.

2. Gaussian Processes for Personalized e-Health Monitoring With Wearable Sensor

Details: David Clifton IEEE Transactions, et.al. Jan 2012 LINK

The Author told Advances in wearable sensing and communications infrastructure have allowed the widespread development of prototype medical devices for patient monitoring. This paper adopts a principled, probabilistic approach to vital-
sign monitoring of patients, set within a Gaussian process frame-
work

3. Health-Status Monitoring Through Analysis of Behavioral Patterns

Details: Tracy S. Barger, Donald E. Brown, and Majd Alwan LINK

In this paper, the author made a smart house facility using a sensor network to monitor and track the movements of the patient in hoke and a prototype of the same is also being tested. The primary objective of their work is to check if their system is capable of outsmarting behavioural patterns and have discussed the same in their work.

IoT based Smart Health Monitoring System

Introduction

The present-day modern technology and industrialization of everything are still hindered in some vital aspects such as human resource management. Though there have been numerous improvements and revolutions in the fields of early detection and treatment of previously incurable diseases, the medical sector still lacks the proper management of human resources and in the current pandemic situation, numerous lives are being put to risk due to the lack of sufficient doctors and/or constant monitoring of the patients by nurses and assistants.

Currently, in this pandemic situation, many hospitals are severely impacted with a high percentage of medical admissions to hospitals with conditions that can be reasonably managed at home in many circumstances. So a good real-time monitoring system that lets the hospital be updated on the vital conditions of their patients is a prime necessity.

Objective

In this project, we aim to develop an IoT based patient's vital monitoring in real-time and an emergency alerting "Smart health Monitoring" system. Visualizing the data of the patient's vitality helps the guardian and doctor to monitor the patient's health at any time and anywhere. It helps the hospital to maintain patient records efficiently.

IoT for SmartHealth Monitoring

Internet of Things has definitely become the next big thing in the technological world with many devices connecting to the internet which enables us to communicate and interact with the devices remotely without the need to be physically present just by using a mobile application or in some cases automating their functionalities too. Medical sciences are one of the fields which will have a giant leap if they are intertwined with IoT enhancement. The general way that most hospitals follow to conduct a healthcare checkup includes the extremely lengthy process of filling application forms, making appointments, taking tests in different hospitals, and waiting for long hours to get to meet the doctor.

This can be revolutionized by using IoT technology where the patient can take these readings beforehand and the data can be sent directly through an app to the doctor for evaluation and analysis. This could also be very useful to send the data from far away too in some cases where the patient can't be physically present.

This way we can also reduce the costs that are incurred on production and improve the efficiency of the system. The present day sensors have improved significantly from the ones in the past where they could all fit in one's palm. This gives the possibility of these sensors being implemented into wearable devices and can be used for non-medical applications such as using it as a fitness measuring device.

Many modern health industries use technology such as fitness tracker or wearable devices where it is equipped with various sensors to monitor people's health such as heart rate sensor, blood pressure sensor and glucose sensor. This technology allows people to easily monitor their health without the need to use sophisticated medical devices to check their heart rate or blood pressure.

These wearable devices also can be connected to the internet via Bluetooth or Wi-Fi where this data can be stored or synchronised to an online website or smartphone application. This connection is known as Internet of Things where devices are connected to the internet and can be monitored through the internet. Patients and doctors will be given unique passwords or addresses that allow them access to the cloud server. By using this password, the privacy and security of the patient's data will be secured from the unwanted and unauthorized access of other individuals.

Applications of Smart Health Monitoring system :

- A patient who is prone to heart attacks or may have suffered one before. The vitals may be monitored to predict and alert in emergencies.
- For people at an advanced age and bedridden at home.
- Athletes during training. To know which training regimes will produce better results.

Sensors and Microcontrollers Used :

Arduino uno microcontrollers :

- Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs.
- We use an Arduino board as our microcontroller .
- Arduino uno controls the sensors and acquires data from them.
- We measure parameters such as Body temperature, pulse rate.
- Arduino sends data to Raspberry pi

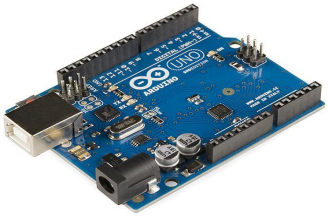


Figure : Arduino Uno

LM35 Temperature sensor :

- The LM35 device is used to observe body temperature. The working of this sensor is based on its Analog output voltage which changes in accordance to the body temperature. The temperature readings are calibrated in Celsius (Centigrade).
- The sensitivity of LM35 is10 mV/°C i.e., for every 1 degree rise in temperature, the sensor measures 10mV. E.g. 270 mV means 27°C.
- It is a 3-terminal linear sensor which has a measuring range of -55 °C to 150°C. The accuracy of LM35 is comparatively high to that of Thermistor output

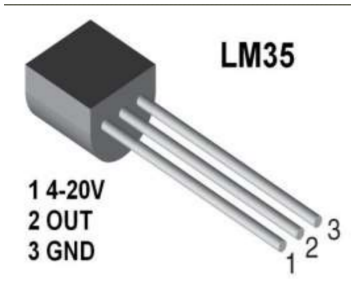


Figure : LM35

Pulse sensor :

- The pulse sensor that we have preferred to use is the generic pulse rate amped which is available in all markets.
- This pulse sensor has an easy to connect and function principle and gives precise readings with just a touch.
- It consolidates a basic optical heart rate sensor with enhancement and noise cancelation hardware making it quick and simple to get perfect heartbeat readings.
- There are three primary lines namely the VCC, ground and DATA lines.

Figure : Pulse sensor

Raspberry Pi : The gateway IoT platform.

- OS : 2019-07-10-raspbian-buster-full - 7GB in size
- SD card is used as hard drive for Raspberry pi - 16GB
- We use Raspberry pi to send and receive data from our website via a cloud platform Thingspeak.
- Before that a 2-Way communication between Raspberry Pi and Arduino uno is established, to send acquired and calculated sensor data from Arduino to Raspberry Pi.

Figure : Raspberry PI

LCD module :

- It has 2 Rows and 16 Characters.
- It is cheap in cost, programmable based, low energy consumption and no restrictions to display characters. It has 16 pin configurations
- It is operated between 4.7V to 5.3V and current capacity is 1mA without backlight. It carries alphanumeric characters and numbers. It is a flat panel display used to view the output results

Figure : LCD Module

ESP8266 :

- ESP8266 offers a self-standing Wi-Fi networking with TCP/IP protocol stack which can give Wi-Fi connection to Arduino.
- ESP8266 when connected on-board it has storage and processing capabilities hence can be easily connected to the sensors based on the application.
- The main reason to use ESP8266 as Wireless Module is due to its compact size and high performance.
- ESP8266 NodeMcu module that we have is not functioning and was not able to replace it with a new one, since it's not available in the area where we live. So, we replaced it with Raspberry Pi which has its own inbuilt WiFi.

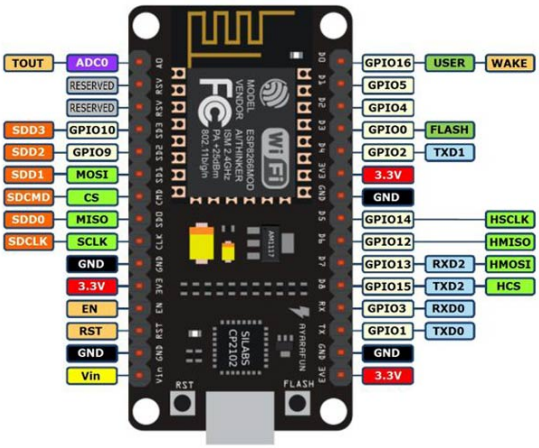


Figure : ESP8266 NodeMCU

Methodology

The following is the Flowchart of the project, which describes the whole process of how patients' data (readings) is collected, stored and available for monitoring. There are 2 main stages in a smart health monitoring system namely,

1)Sensor module - consists of sensors and microcontroller

2) Web user interface - a website to monitor each patient's vital signs individually.

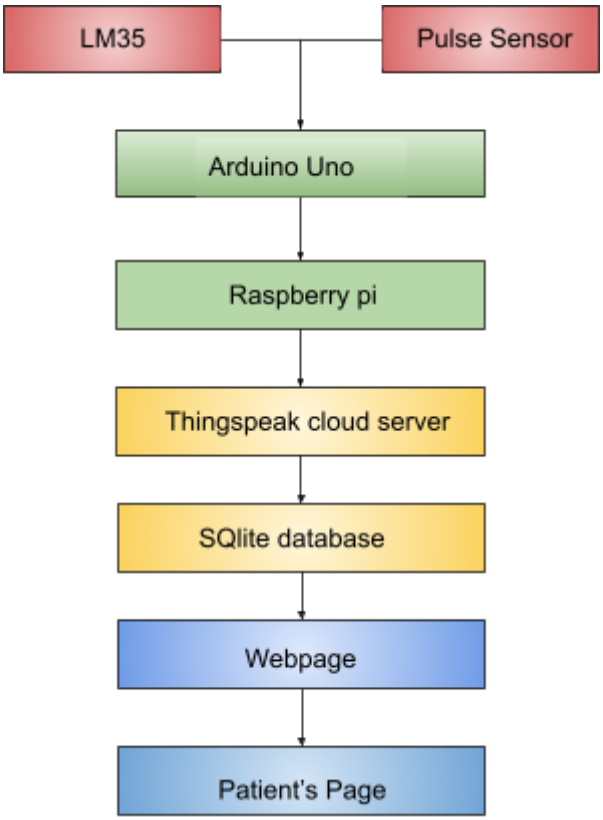


Figure : Flowchart

If we look at the block diagram (Fig.1), sensors such as temperature sensor and pulse sensor are interfaced to the Arduino. Arduino Uno acquires data from the sensors and collected data is sent over to the cloud server for monitoring through a website.

The following is the block diagram for the **Web user interface** for viewing patients data.

The process is as follows :

- After the patients login/signup in the website, they need to provide their information and.
- From that information the latest updated info will be displayed to them in the home page above the readings and their graphs.

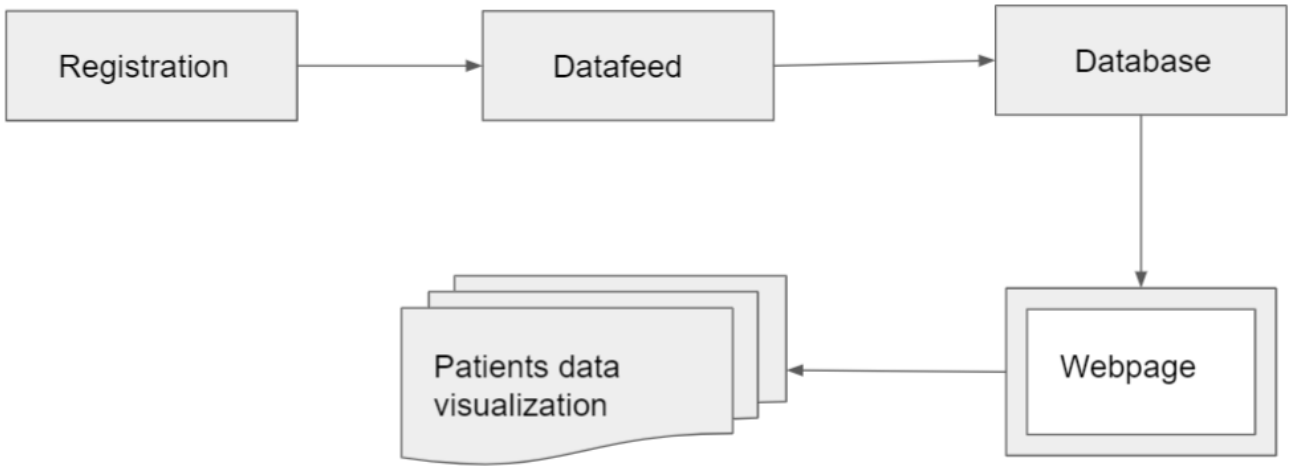
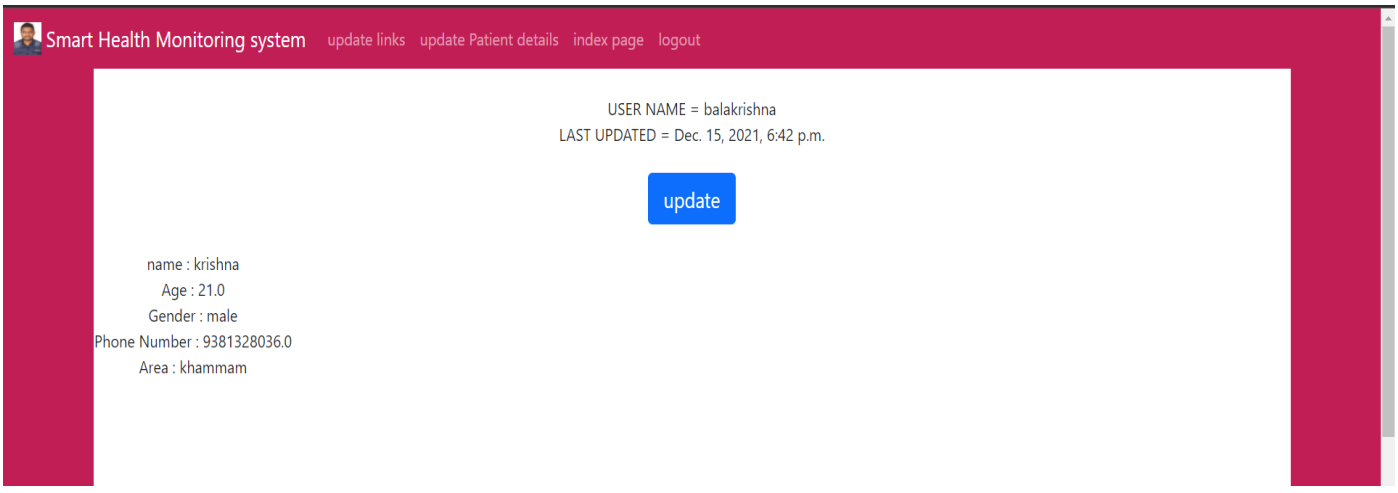


Figure : User Registration Process

Registration step:

- Each patient is registered first to have a separate space to show his /her data.
- Name, Age, Gender, Area and Phone number of the patient are required for registration.
- The data is sent and started in SQlite Database.



Data feeding step:

- Inorder to show their vital sign readings, firstly they need to go in to the update links section after they login , and provide thingspeak's channel ID and API key.
- Patients vital data such as body temperature and Pulse rate are fed and visualized.
- Arduino is used as the microcontroller that collects data from sensors and feeds that data to the Raspberry pi, from there the data is fed to thingspeak through api keys.
- Recent readings of the patient are shown in the table and visualized graphically.
- Each patient's data is sent and stored in the Database according to their login details.

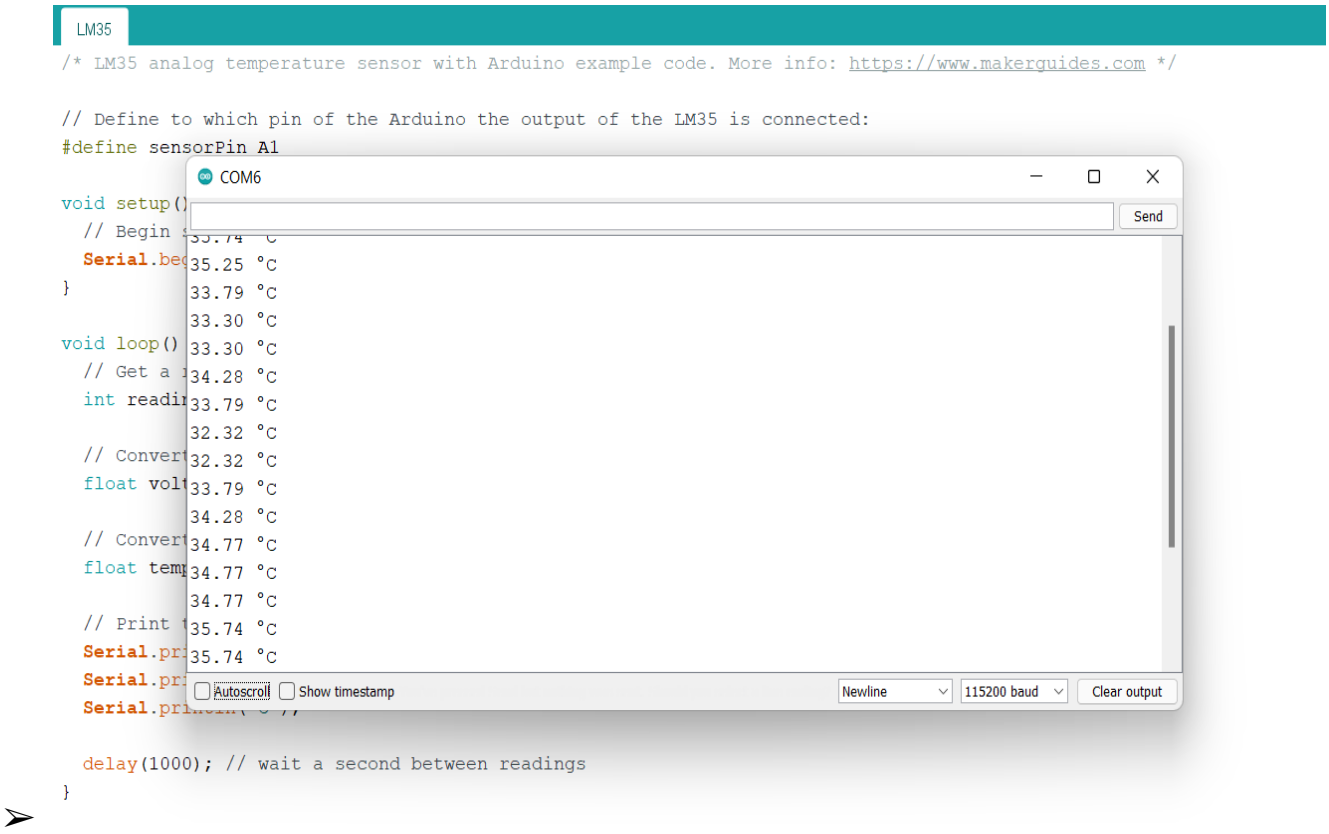
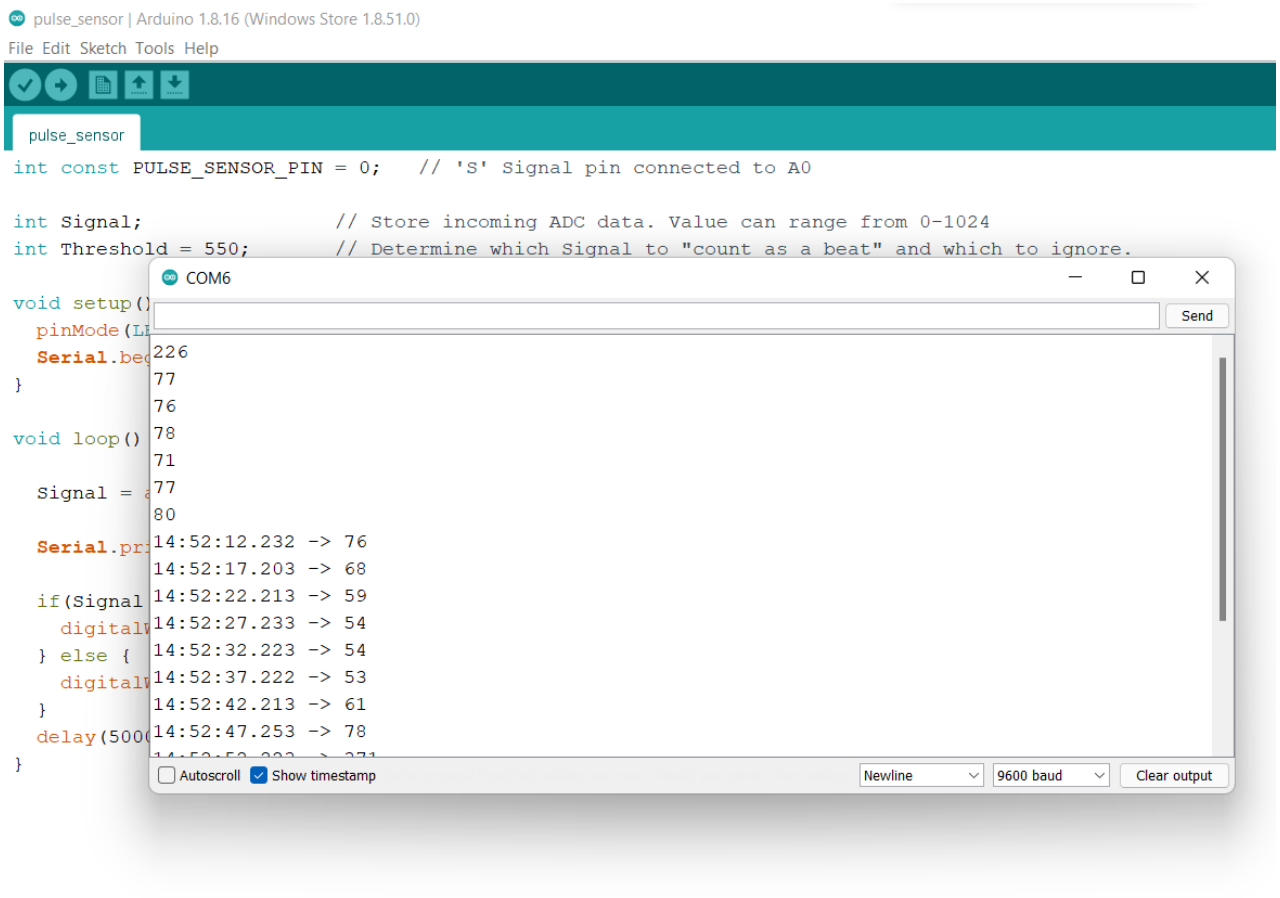


Figure : Temperature (LM35) readings



➢

Figure : Pulse Sensor readings

- <u>Data Flow Diagram</u> :

➢ 

➔ Now onto the website, there are 2 pages in the website, those are:

1)Index page and 2) Patient's page (Home page)

1) **Index Page**:

The Index page of the website consists of these sections: a)NavBar - Login, sign up

b) About the Project section, c)Precautions, d)Contact details

Precautions: In this section, we have mentioned some useful precautions to be followed on a day to day basis to stay healthy.

(Following Images are screenshots directly taken from the website we built as a web user interface for monitoring patients vital parameters)

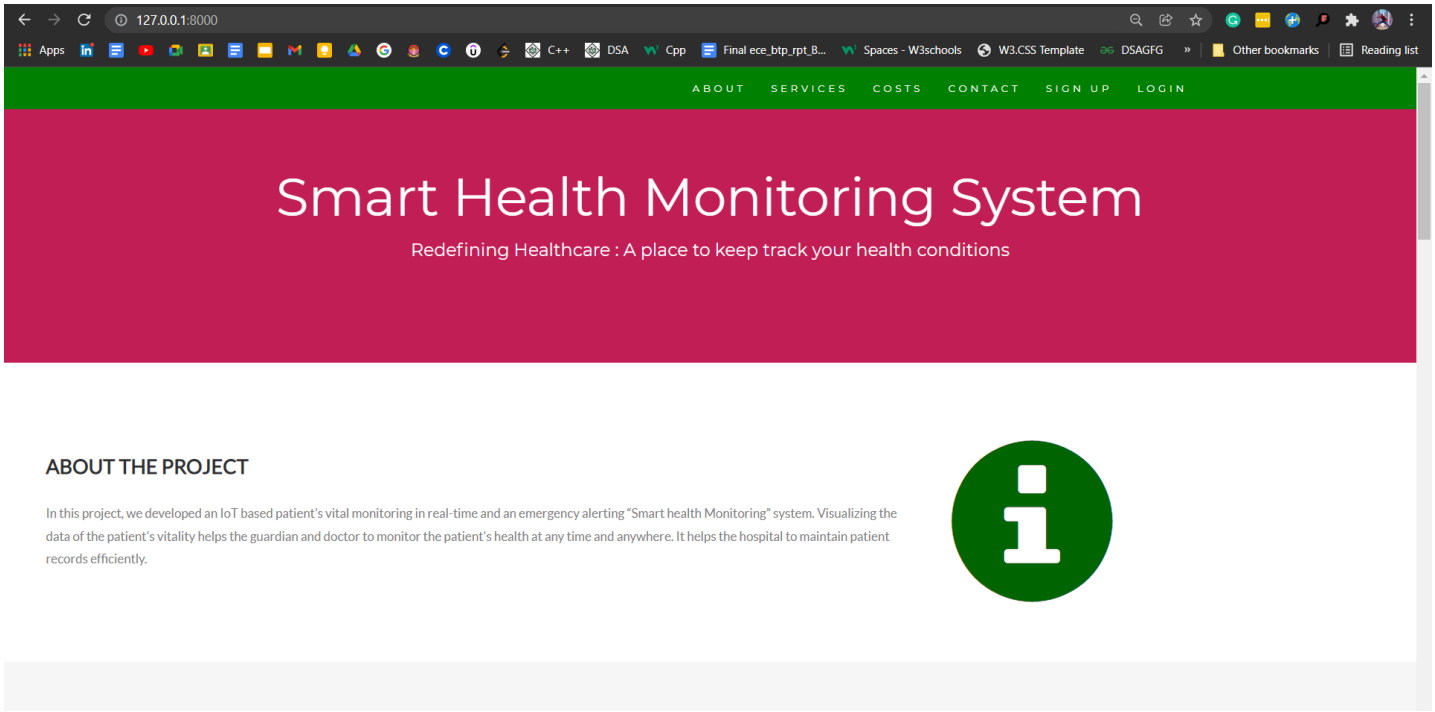


Figure : Landing Page

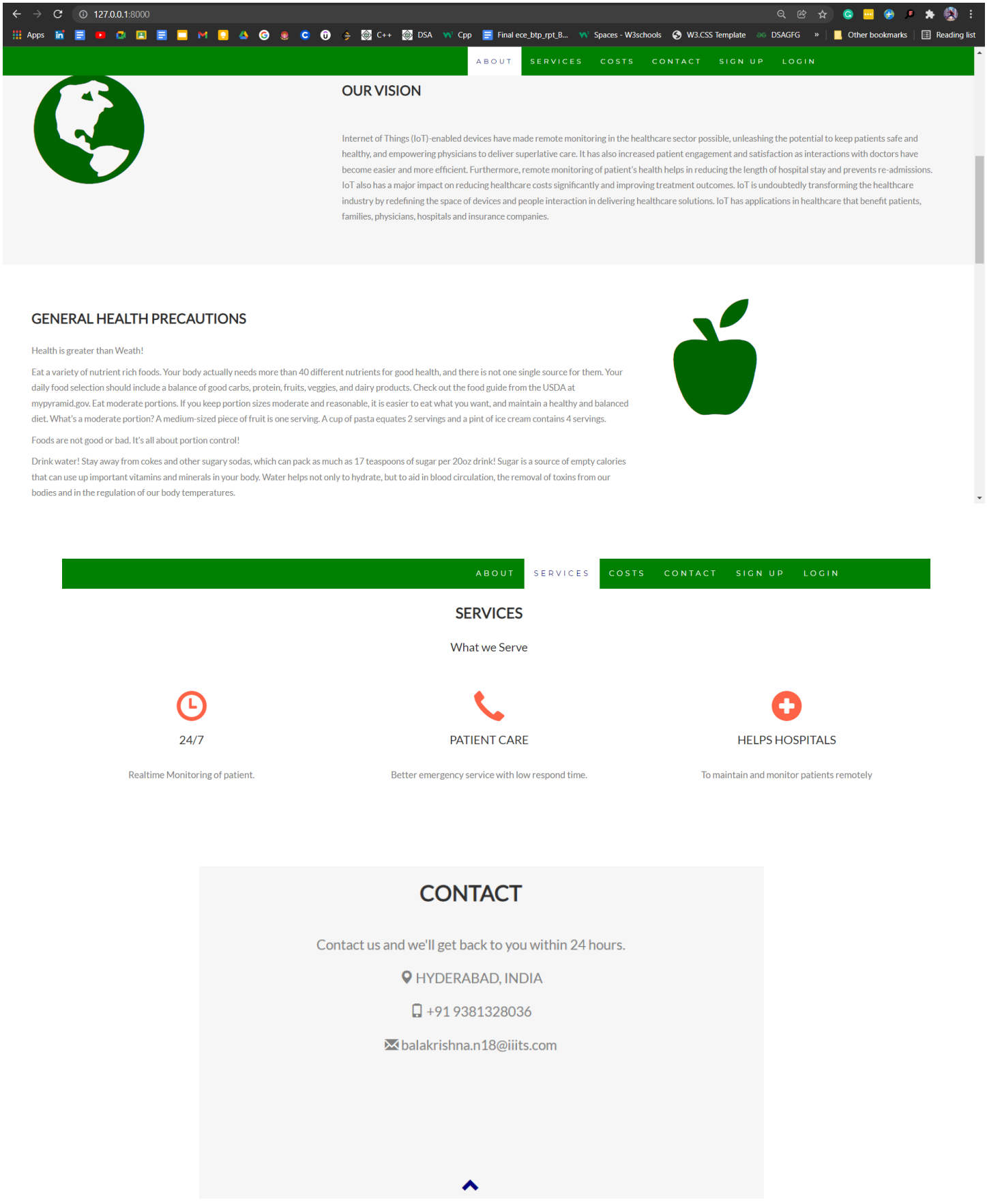
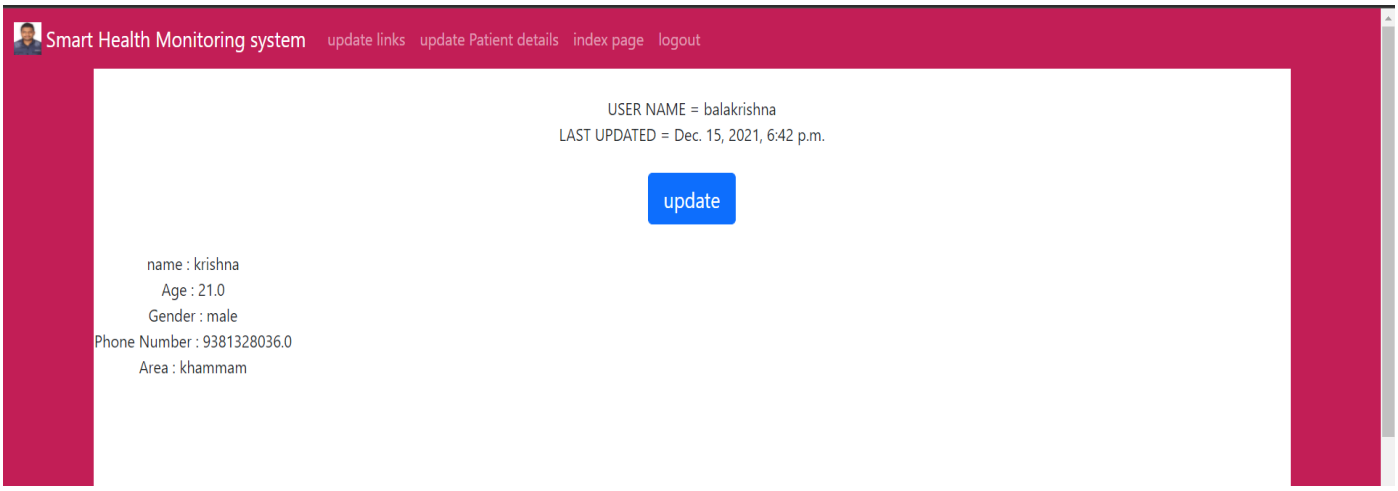


Figure : Landing Page sections

2) **Patient's page**:

In the patients. Once we login as a patient, we can see the profile of the patient with the name, age, gender and image of the patient. The patient's name is considered as child and sensor names as sub child. IIn this way data is fed.

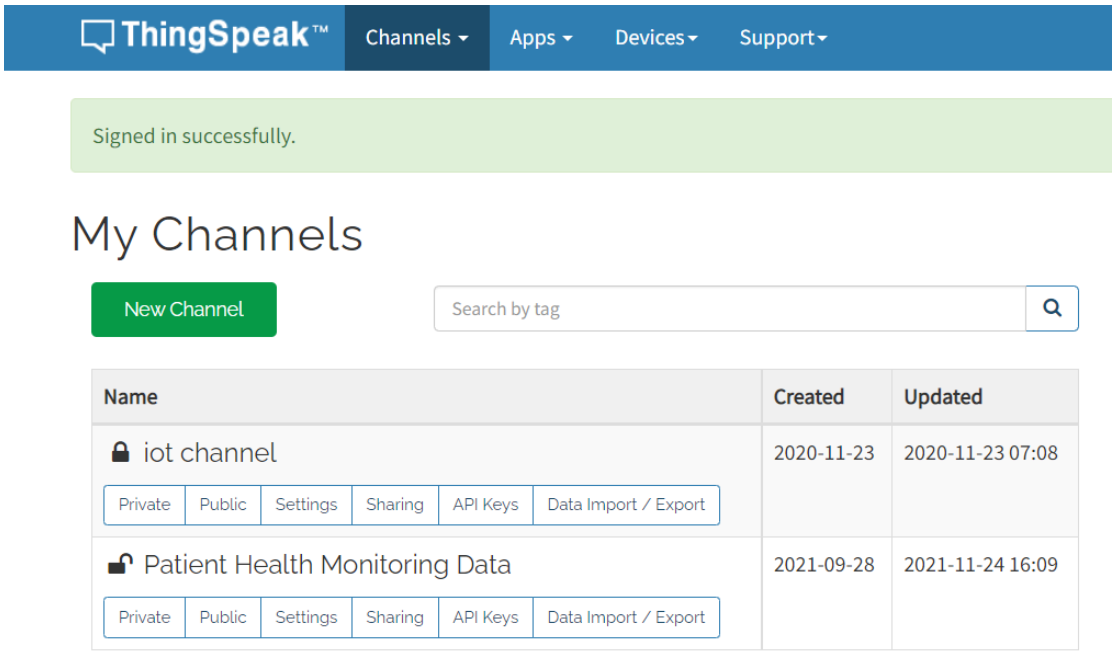
The patient's profile is followed by the patient's vital parameters like Body temperature and Pulse rate, and graphs are plotted in a graph with vital sign readings to visualize the information.

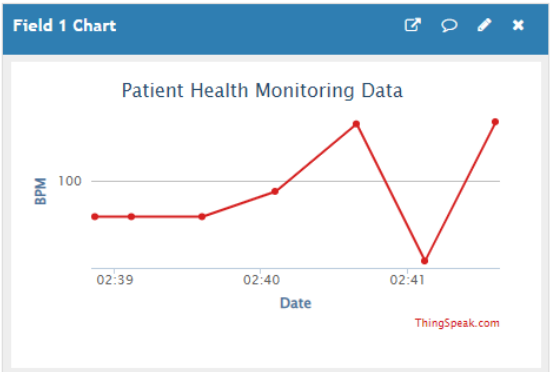


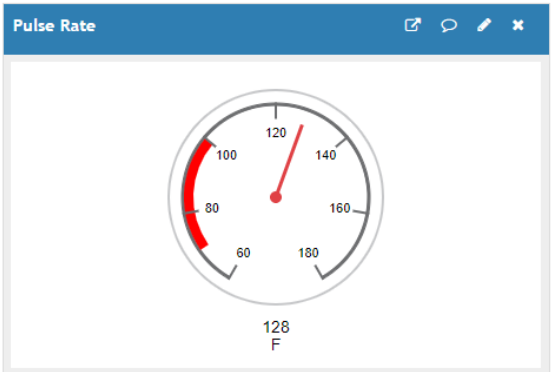
Tools and Technologies Used :

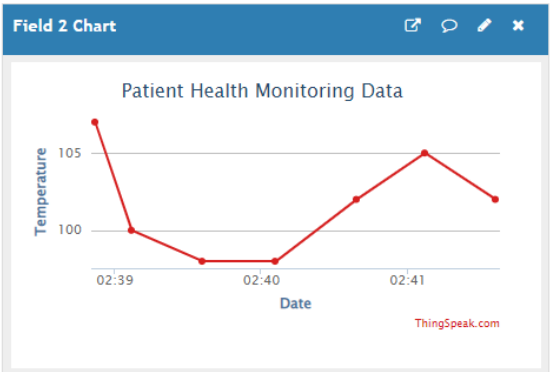
ThingSpeak : Thingspeak acts as a bridge between our device kit and the website.

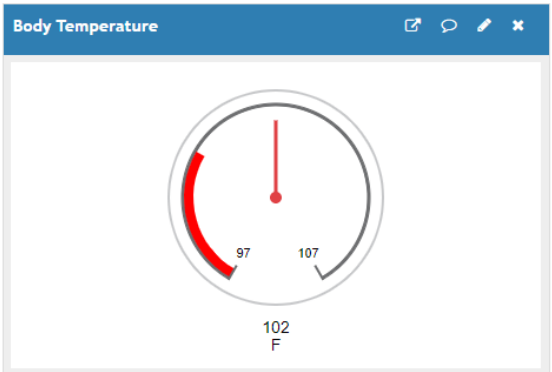
- Thingspeak is an open-source IoT platform that can be used to analyse, store and visualize the data received from the Internet of things applications and APIs.
- Thingspeak is website oriented which makes it easy to use.
- Thingspeak also supports a variety of apps(Matlab, android apps)
- This makes Thingspeak an ideal platform to monitor data in real-time and store it securely
- To write and read data we have to use “write a channel feed” and “read a channel feed” links which are filled by patients themselves in the Update links section in the website after they signup and login.











Thingspeak for Mobile :

There are many applications on the android Playstore that can easily access thingspeak, if we provide channel ID, and sharing API key, thereby easily accessing/monitoring patient's reading through smartphone on the go from anywhere and at any time.

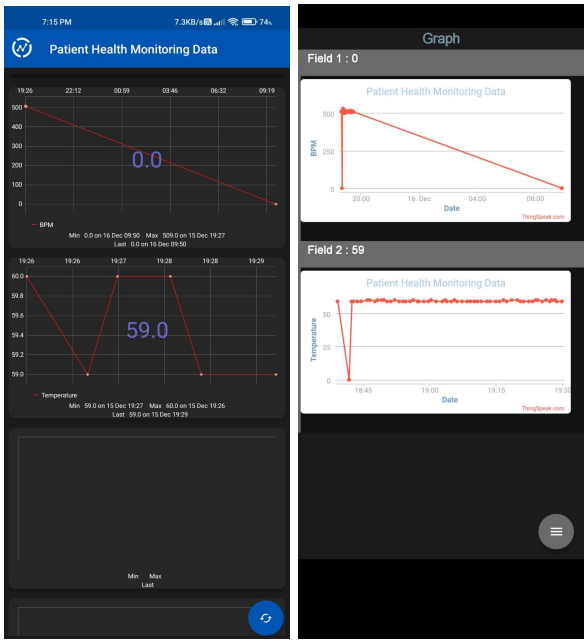


Figure : Screenshots taken from third party applications in playstore, compatible with thingspeak.

ngrok :

- We used ngrok to temporarily grant access to someone by issuing them with a randomly generated URL.
- ngrok runs a small client process on your machine which creates a private connection tunnel to the cloud service. Your localhost development server is mapped to an ngrok.io sub-domain, which a remote user can then access.
- The connection tunnel established by ngrok is secure and can only transmit data to the localhost port you have open. Anyone could access the web app while the tunnel (system is on) is open. (Source)

VNC viewer :

- VNC stands for Virtual Network Computing. It is a cross-platform screen sharing system that was created to remotely control another computer (Here it is Raspberry pi).
- This means that a computer's screen, keyboard, and mouse can be used from a distance by a remote user from a secondary device as though they were sitting right in front of it.
- VNC works on a client/server model. A server component is installed on the remote computer (the one you want to control), and a VNC viewer, or client, is installed on the device you want to control from. When the server and viewer are connected, the server transmits a copy of the remote computer's screen to the viewer. (source)

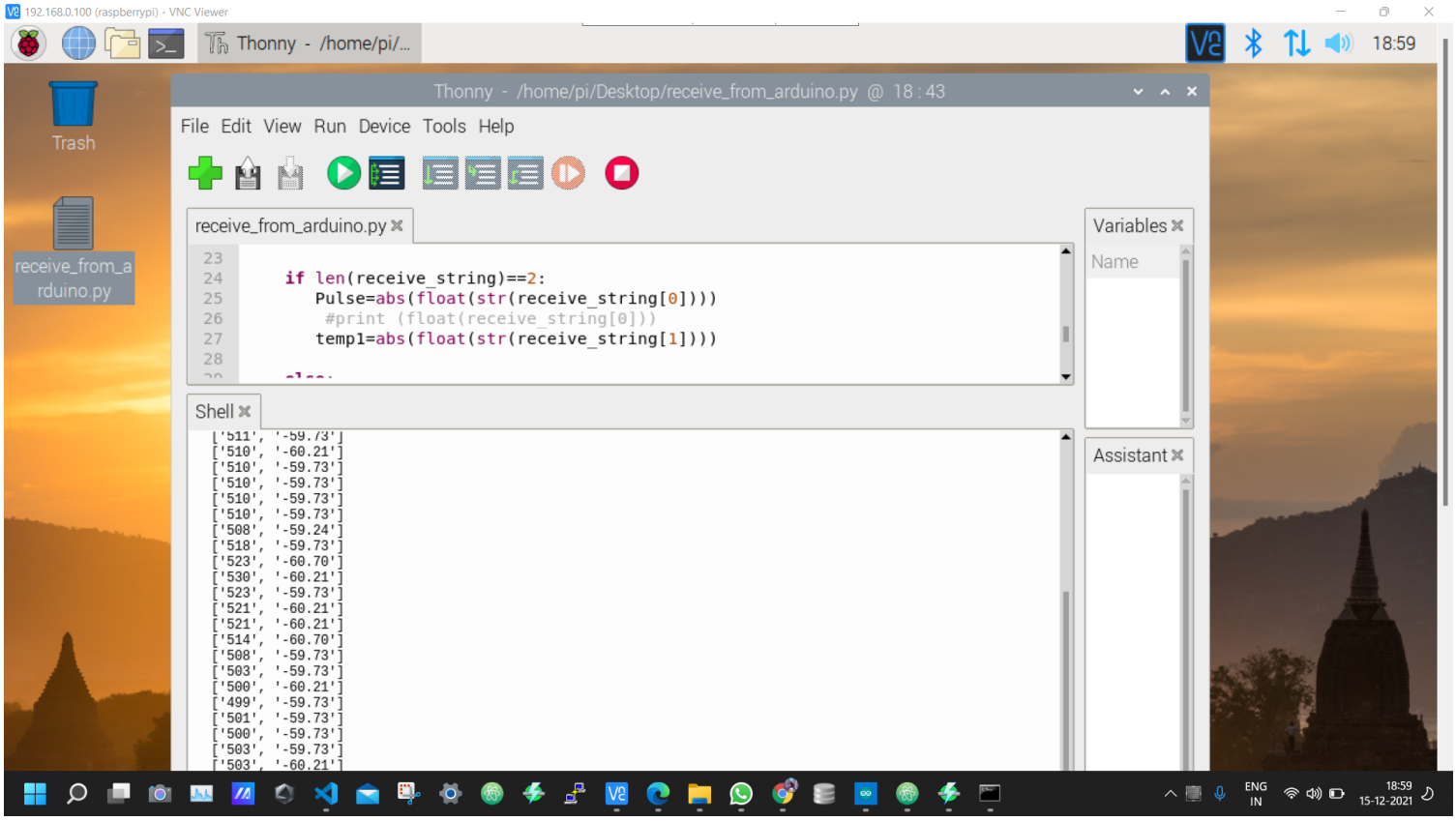


Figure : Raspberry Pi's display is shared on the system connected to the same network.

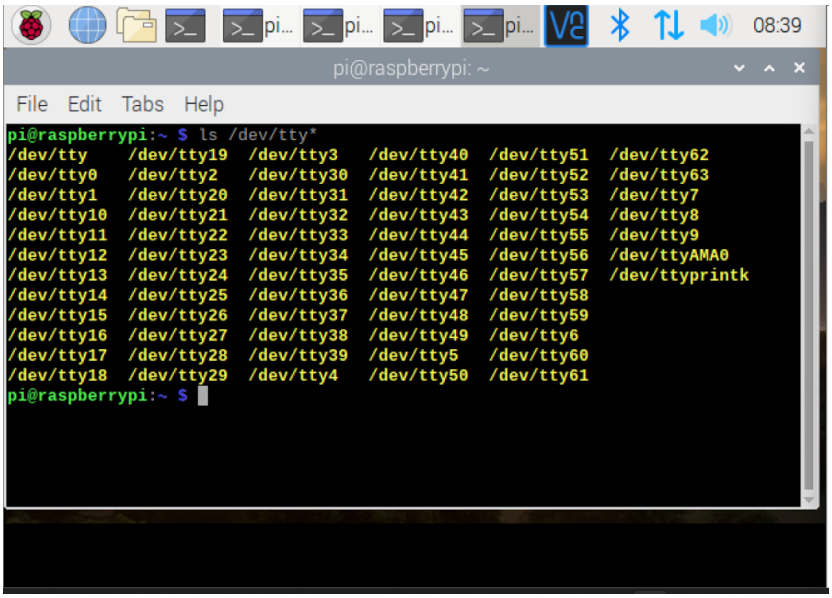
2-Way communication :

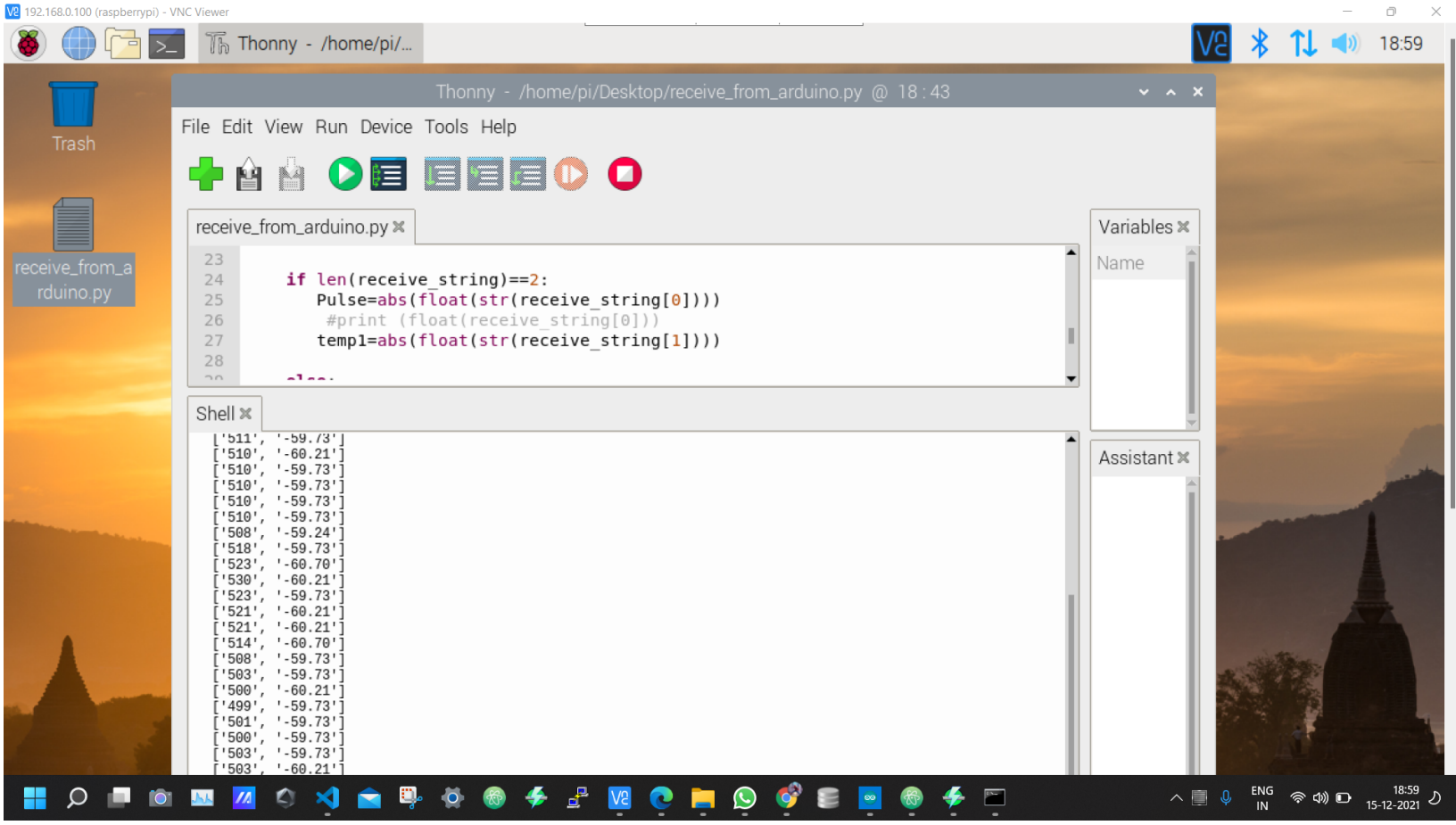
Communication between Arduino and Raspberry pi is a 2-Way communication.

Arduino dumped with the Sensor code sketch along with modified code is connected to Raspberry Pi through a unique port found using the terminal.

A python code in Raspberry pi is made to run inorder to receive data and type convert Data into string format and stored in ordered way in accordance from which sensor the Data is from.

Then this data is directly sent to thingspeak IoT cloud server using hardcoded links of The channel, API key, channel ID. (Guide)




192.168.0.100 (raspberrypi) - VNC Viewer
Thonny - /home/pi/...
18:59
Trash
receive_from_arduino.py
Thonny - /home/pi/Desktop/receive_from_arduino.py @ 18 : 43
File Edit View Run Device Tools Help
receive_from_arduino.py
23
24 if len(receive_string)==2:
25 Pulse=abs(float(str(receive_string[0])))
26 #print (float(receive_string[0]))
27 temp1=abs(float(str(receive_string[1])))
28
Variables
Name
Shell
['511', '-59.73']
['510', '-60.21']
['510', '-59.73']
['510', '-59.73']
['510', '-59.73']
['510', '-59.73']
['508', '-59.24']
['518', '-59.73']
['523', '-60.70']
['530', '-60.21']
['523', '-59.73']
['521', '-60.21']
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['514', '-60.70']
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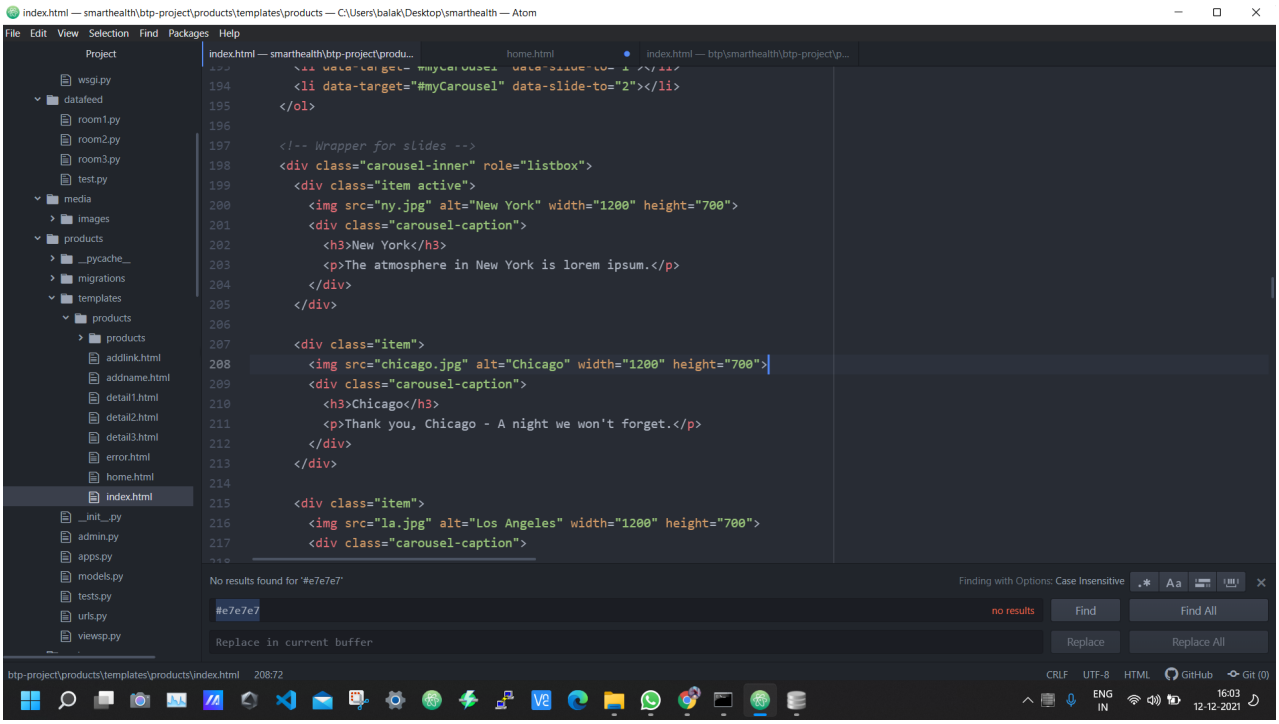
['499', '-59.73']
['501', '-59.73']
['500', '-59.73']
['503', '-59.73']
['503', '-60.21']
Assistant
ENG
IN
18:59
15-12-2021

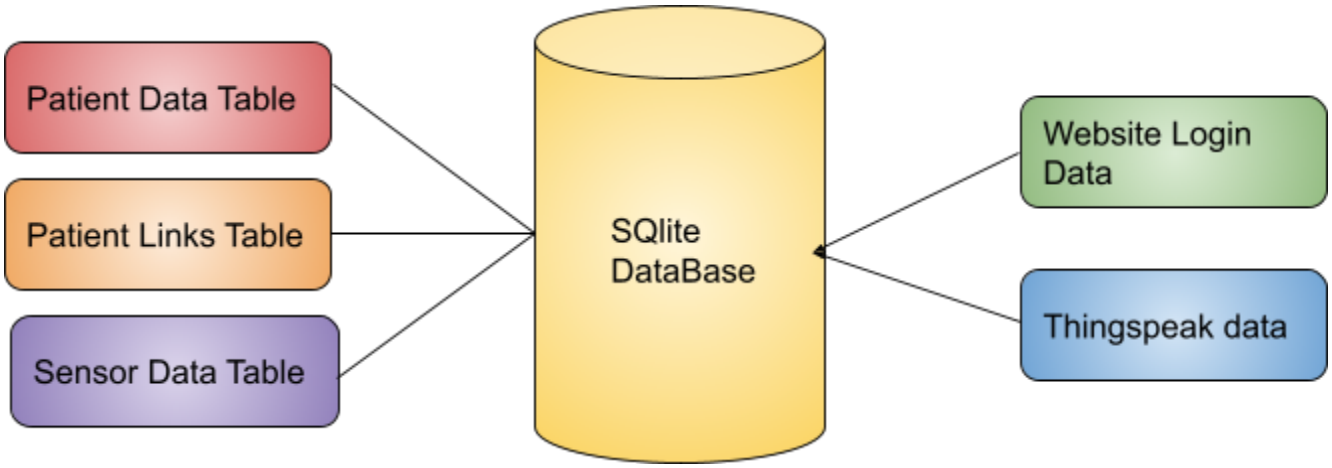
Django Framework :

- We are using Django as the back end to our website and sqlite as our database.
- Django is a python based free and open source web framework. Its main goals are simplicity, flexibility, reliability, and scalability.
- Django has its own naming system for all functions and components (e.g., HTTP responses are called “views”). It also has an admin panel.
- Django follows the model-template-views architectural pattern.
    - Model: Model consists of Tables where we determine the Data and Datatype it contains.
    - Template: All the HTML files come under this category.
    - Views: Views contain program files for acting upon the given commands.



SQlite database :

We use sqlite database in our website. In our model data generated using Arduino Uno and sensors interface is sent to thingspeak cloud server. Update button in the home page can be used to update data in the sqlite database which will be displayed in the web page. Sqlite db: SQLite is an in-process library that implements a self-contained, serverless, zero-configuration, transactional SQL database engine. The code for SQLite is in the public domain and is thus free for use for any purpose, commercial or private.(from: SQlite website)



DB Browser for SQLite - C:\Users\balak\Desktop\smarthealth\btp-project\db.sqlite3

File Edit View Tools Help

New Database | Open Database | Write Changes | Revert Changes | Open Project | Save Project | Attach Database

Database Structure | Browse Data | Edit Pragmas | Execute SQL

Table: products_patientdata | Filter in any column

	id	title	name	Age	Gender	PhoneNumber	Area	pub_date	hunter_id
	Filter	Filter	Filter	Filter	Filter	Filter	Filter	Filter	Filter
1	1	balakrishna	krishna	21.0	male	9381328036.0	khammam	2021-11-24 21:00:00.451779	10
2	2	balakrishna	krishna	21.0	male	9381328036.0	khammam	2021-11-24 21:00:22.058304	10
3	3	Balakrishnanair	balakrishna2	21.0	male	9381328036.0	khammam	2021-11-24 21:45:46.696035	11
4	4	mani	manikanta	22.0	male	111111.0	tada	2021-11-27 16:05:27.039641	13

Simulation of the System:

Proteus : Proteus 7.0 is a Virtual System Modelling developed by Labcenter Electronics that was basically developed to co-simulate the microcontroller based designs which integrate animated components, circuit simulation and microprocessor models.

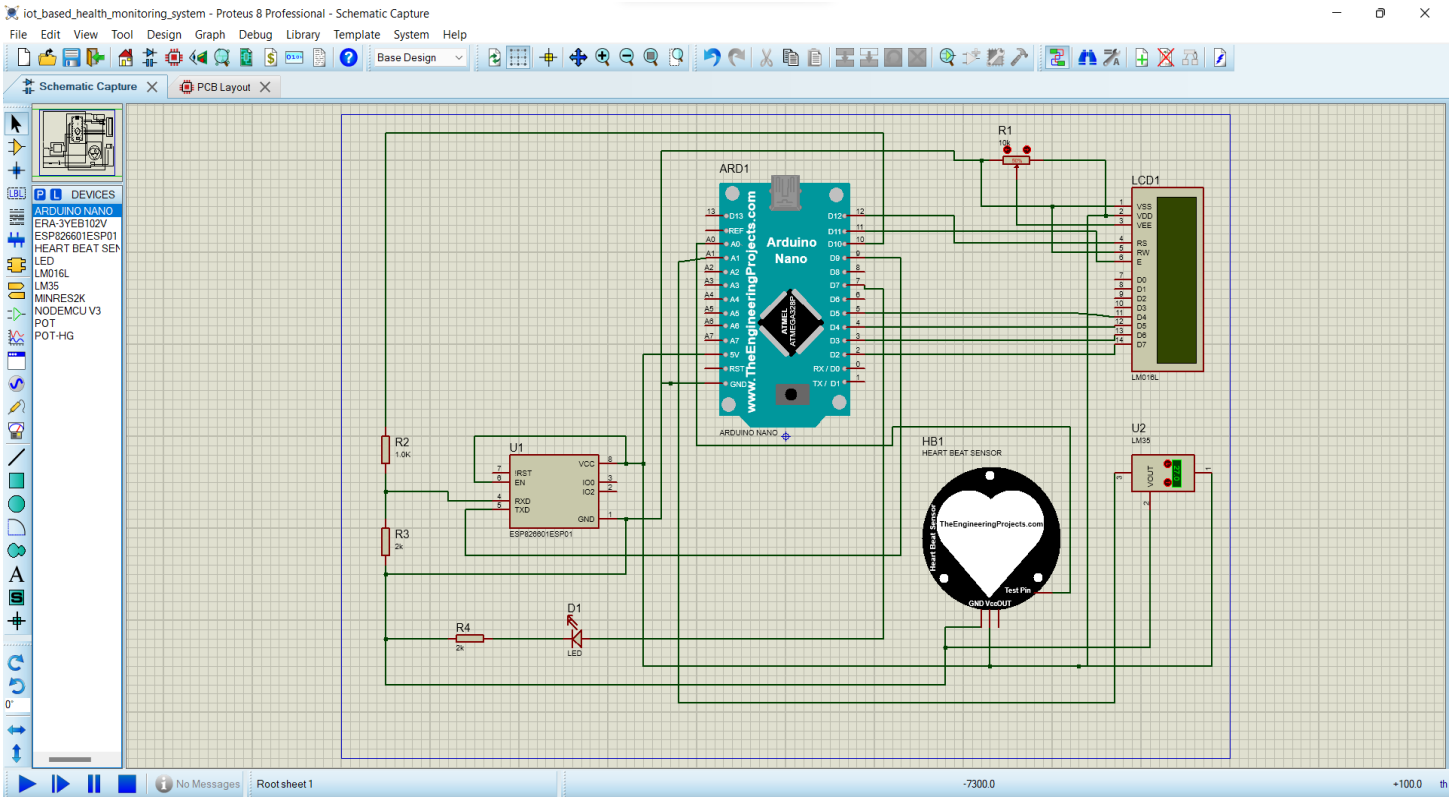


Figure : circuit simulation design

Conclusion

- A prime necessity of the modern world is better technology that is fast, affordable and accessible to all kinds of people. This could also be implemented in a way so that the patient and the doctor can be many kilometres away but still keep the patient's health in a stable condition.
- The readings are collected in a simple cloud database and can be viewed remotely by a doctor.
- I also feel that this system is a user-friendly setup that will help even a person with no technical knowledge be able to operate the system
- And with increased internet penetration in most developing countries through mobile phones, and with the use of the Internet of things (IoT) this system will become adopted at a faster rate in near future.
- The Remote Health Care system utilizes these concepts to come up with a system for a better quality of life for people in society.

Future Work

- To send an alert message during emergencies to the doctor and Guardian.
- Deleting users directly through the website.
- Adding additional data to the patients (spO2 level , Glucose, ECG etc)
- Buying a Domain name and permanently hosting the website.

And there is some other improvemental work towards the IoT platform projects as a whole.

- Biometric authentication that is face detection, this can be implemented using open-CV. It requires a raspberry pi connected to a camera and some libraries, But Bio-authentication using only the patient's face is not ideal as multiple guardians may also monitor the website for patients vital parameters and

Other optional works include :

- Analysis of patients data : With the arrival of Data analysis in every field, this will certainly create a space where we can analyse different patients and find commonness among their disease and be able to come up with the cure, even if the patients are in different countries.
- Downloading patient data : Patients can keep track of their medical history digitally in a safe way.

List of Abbreviations and Symbols

IoT - Internet of Things.

COVID-19 - coronavirus disease of 2019

VNC stands for Virtual Network Computing

Opencv - Open Computer Vision

ECG - Electrocardiography

SQL - Structured Query Language

HTML - Hypertext Markup Language

UI - User Interface

API - Application Programming Interface

Contributions :

N. Balakrishna Nair - Frontend, Backend work of Website, Arduino Sensor interfacing circuit, Arduino, RaspberryPi codes.

M. Manikanta - Simulation, Presentation, Report.

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