SMART HOSPITAL ROOM ALLOTMENT APPLICATION USING IOT, CLOUD AND DATA ANALYSIS

A Project Report Submitted

in Partial Fulfilment of the Requirements

for the Degree of

B.Tech

in

COMPUTER SCIENCE AND ENGINEERING

by

HARSH KUMAR SINGH

(Roll No. 2015BCS0012)

to

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

INDIAN INSTITUTE OF INFORMATION TECHNOLOGY KOTTAYAM - 686635, INDIA

April 2019

DECLARATION

I, **HARSH KUMAR SINGH** (**Roll No: 2015BCS0012**), hereby declare that, this report entitled **"SMART HOSPITAL ROOM ALLOTMENT APPLICATION USING IOT, CLOUD AND DATA ANALYSIS"** submitted to Indian Institute of Information Technology Kottayam towards partial requirement of **Bachelor of Technology(Hons.)** in **Computer Science and Engineering** is an original work carried out by me under the supervision of **Dr. Shajulin Benedict** and has not formed the basis for the award of any degree or diploma, in this or any other institution or university. I have sincerely tried to uphold the academic ethics and honesty. Whenever an external information or statement or result is used then, that have been duly acknowledged and cited.

Valaoor - 686 635 **HARSH KUMAR SINGH**

April 2019

CERTIFICATE

This is to certify that the work contained in this project report entitled **'SMART HOSPITAL ROOM ALLOTMENT APPLICATION USING IOT, CLOUD DATA ANALYSIS'** submitted by **HARSH KUMAR SINGH** (**Roll No: 2015BCS0012** to Indian Institute of Information Technology Kottayam towards partial requirement of **Bachelor of Technology(Hons.)** in **IIIT Kottayam** has been carried out by him under my supervision and that it has not been submitted elsewhere for the award of any degree.

Valavoor - 686 635
April 2019

Dr. Shajulin Benedict
Project Supervisor

ABSTRACT

All living creature in the earth can't live without water, air, food. Air, temperature, humidity are the dimensions of life for a human being. The level of air pollution increased with times by a lot of factors such as increased vehicle utilization, misused industrialization, urbanization, and so forth. These industrialization have also caused uneven changed in atmospheric temperature. These factors have heavily affected the health of human being as they are exposed to it.

In our previous phase of project we have developed an air quality monitoring system that checks the pollution level from anywhere through browsers or smart phone devices using technologies such as IoT and cloud. But in this phase of project we have developed a system with more features of the environment and use those features to automate the room allocation process in the hospital for more precise allocation.

The main objective is to analyze various diseases that are generally reported in the hospital with the help of domain expert and collect the data about those favourable and unfavourable conditions for those diseases. Then we will finally build a complete smart application which will automatically allocate the rooms to the patients inside the hospital according to their conditions.

Contents

List of Figures

Chapter 1

Introduction

Due to increase of patient inflows and types of medical services demanded over a time period, the hospital administration is faced with the problem of assigning bed for various medical services in a hospital.Ward beds are primary resources under the control of hospital management. We develop a method from determining an optimum distribution of beds in a ward.

Inpatient rooms are critical resources in the hospital, which is a determinant of the hospitals grade and size.Usually, the capacity of inpatient rooms is limit because the budget or space is restricted. These critical resources are shared among multiple types of patients.

This work studies the optimal configuration of hospital inpatient rooms with private rooms and semiprivate rooms and capacity allocation within multiple types of patients.It is important to configure and allocate the limit resources to multiple patient types and manage patient access for maximizing hospital revenue and patients equity for public hospitals.

All living creature in the earth can't live without water, air, food. Air,

temperature, humidity are the dimensions of life for a human being. The level of air pollution increased with times by a lot of factors such as increased vehicle utilization, misused industrialization, urbanization, and so forth.These industrialization have also caused uneven changed in atmospheric temperature. These factors have heavily affected the health of human being as they are exposed to it.

In our previous phase of project we have developed an air quality monitoring system that checks the pollution level from anywhere through browsers or smart phone devices using technologies such as IoT and cloud. But in this phase of project we have developed a system with more features of the environment and use those features to automate the room allocation process in the hospital for more precise allocation.

The main objective is to analyze various diseases that are generally reported in the hospital with the help of domain expert and collect the data about those favourable and unfavourable conditions for those diseases. Then we will finally build a complete smart application which will automatically allocate the rooms to the patients inside the hospital according to their conditions.

1.1 Importance of Internet of Things

The Internet of Things (IoT) is the latest buzzword being talked about everywhere. Internet of Things refers to the development of Internet connectivity for everyday devices, which allows them to send and receive data. These devices include everything from your toaster to your car, printer, alarm clock, thermometer, phone, and a variety of machines, but the list doesnt end there. IoT seeks to connect anything with an on and off switch to the Internet so it can better serve the user.

Every industry in the world now relies on data for business needs. IoT will expand and improve that data by connecting billions of devices capable of immediately sharing, receiving, and analyzing massive amounts of it to better meet business needs and improve decision-making.

Due to flexibility and low cost Internet of things (IoT) is getting popular day by day. We can say businesses are clamoring to incorporate IoT because utilizing these connected devices drastically lowers operating costs, increases productivity, efficiency, and revenue, allows them to expand to new markets or develop new products, and provides insights never before imagined.

1.2 Existing Model in Market

In the current market there are lot of devices which can measure different parameter of air, temperature, humidity.There are many commercial meters which are available in the market like Fluke carbon monoxide meter for CO, Amprobe CO2 meter for CO2 carbon dioxide, ForbixSemicon LPG gas leakage sensor alarm for LPG leakage detection.

The researchers in this field have proposed various air quality monitoring systems based on WSN (Wireless sensor network), GSM (Global System for Mobile Communications) and GIS (Geographic Information System).

GIS based system is designed, implemented and tested to monitor the pinpoints of air pollution of any area like dust,nitrogen,carbon dioxide.It consists of a micro-controller like Arduino, gas sensors, mobile unit, a temporary memory buffer or cloud and a web server with internet connectivity which collects data from different locations along with coordinates information at multiples time during whole day. The Global Positioning System (GPS) module is attached to a system to provide accurate representation of pollution sources in any area. The recorded data is periodically transferred to a computer through a General Packet Radio Service (GPRS) connection and then the data will be displayed on the dedicated website and smart phone as per the user needs.

But the product we have developed is unique since it is using different parameter values to automate the hospital room allocation process. This kind of product does not exist in the market.

1.3 Motivation for this project

Hospitals play a vital role in the health and well-being of people.In recent times there are more patients visiting the hospitals owing to various reasons. In a country like Indian where the hospital to patient ratio is very high it is essential to focus towards improving internal processes in order to attain maximum efficiency levels.

Although most patients are essentially well enough to be able to resist or to adapt to unfavourable ambient conditions, this may not be so with an ill patient or one who is having or has had a serious operation. These climatic conditions of these operating room are needed to be discussed. It is difficult or impossible to achieve climatic conditions in the operating room that are acceptable to all. The needs of the patient are of special importance and are largely neglected.

Hence as a computer engineer we have developed an automated hospital room allocation application so that patient gets the room according to his needs.

1.4 Chapter Description

- **CHAPTER 2**: Preliminary Work

  In this chapter preliminary work that is done in phase-I of the project is discussed. Previously used algorithm, architecture, proposed algorithm, and result are briefly discussed in this section.

- **CHAPTER 3:** Literature Survey

  In this chapter the existing and established theory and research is discussed. This segment gives context for our work. This area is used for filling an apparent hole in the current hypothesis.

- **CHAPTER 4:** Proposed Architecture

  In this chapter proposed architecture, terminologies and definitions regarding our projects are thoroughly discussed.

- **CHAPTER 5:** Implementation

  In this chapter implementations details with the quality parameters and the tools and libraries included in the project are thoroughly discussed.

- **CHAPTER 6:** Result and Discussion

  In this chapter whole summary of the project is explained as the result and brief discussion on it.

Chapter 2

Preliminary Work

In this chapter preliminary work that is done in phase-I of the project is discussed. Previously used algorithm, architecture, proposed algorithm, performance, and result are briefly discussed in this section.

In order to monitor the air quality level in the various location in various time interval this device can be used.It is necessary to monitor air quality and keep it under control for a better future and healthy living in large scale. We are going to make an IOT(Internet of Things) based air pollution monitoring system in which we will monitor the Air Quality over a web server using internet and will trigger a alarm when the air quality goes down below a certain level, means when there is sufficient amount of harmful dust so that Asthma patient can use this at their home. It will show the air quality in screen and as well as on web-page so that we can monitor it very easily.In this IOT project, you can monitor the pollution level from anywhere using your computer or mobile. This System is designed,implemented and tested to monitor the pinpoints of air pollution of any area like dust dimension of

air.

2.1 Air Quality Parameters

Some important parameters that are considered in the Air Quality Monitoring framework include:-

2.1.1 Dust

About 1 million people are in habit of tobacco and smoking globally of which majority of population is from developing countries.

Human health effects of dust relate mainly to the size of dust particles. Dust may contain microscopic solids or liquid droplets that are small enough to get deep into the lungs and cause serious health problems. Large particles may irritate the nose, throat and eyes. The particle size is a major determinant of how serious the health effect will be,especially for lung diseases and the effects on the heart.

Health effects from various dusts can include irritation of the airways, coughing, wheezing and difficulty breathing, Reduced lung function, Aggravate asthma other chronic lung conditions like wheezing, coughing, shortness of breath and increased frequency and severity of attacks, sometimes particles may also increase the risk of heart attacks and stroke in susceptible people.

Every year nearly 4.9 million people died due to smoking according to 2007 report. In addition, smoke and dust is serious threat to the health of people of all ages causes 41000 deaths each year. In various construction

sites due to lots of dusts particles sometimes it get worst to breathe. This dimension of air is our most concerned part of my project hence this device is a dust concerned device.

2.1.2 Carbon Dioxide

CO2 is odorless gas, non-combustible gas and colorless. Moreover, it is considered under the category of asphyxiate(cause to die, unconsciousness) gases that have capability of interfering the availability of oxygen for tissues.

Carbon Dioxide is a greenhouse gas that is natural and harmless in small quantities but as levels rise it can be dangerous to your health. Most commonly produced by the air we exhale, CO2 levels concentrate indoors with less ventilation.

It is one of the most important gases on the earth because plants use it to produce carbohydrates in a process called photosynthesis. Since humans and animals depend on plants for food, photosynthesis is necessary for the survival of life on earth.However, CO2 can also have negative effects. As CO2 builds up in our atmosphere it has a warming effect that could change the earths climate. Indoors, CO2 levels easily rise above the recommended amount which has adverse effects.

The concentration of carbon dioxide has increased due mainly to massive amount of fossil fuels burning. This increase makes plants grow rapidly. The rapid growth of undesirable plants leads to the increase use of chemicals to eliminate them.

When levels of CO2 rise and there is less fresh air, it can cause headaches, restlessness, drowsiness and more. High levels are directly correlated to low

productivity, high sick leave and infectious disease transmission, making this a crucial concern in office, school and home environments.

Fresh air contains about 400ppm (ppm is parts per million) of CO2. Indoor CO2 levels are acceptable up to around 1000ppm and ideally shouldn't rise above 1500ppm.Above 2000ppm must be avoided, as more serious symptoms like sweating, increased heart rate and difficulty breathing will occur.

2.1.3 Sulphur Dioxide

Sulphur Dioxide is colorless gas,which is detectable by the distinct odour and taste like CO2, it is mainly produced due to fossil fuels burning and to industrial processes.In high concentrations it may cause respiratory problems, especially in sensitive groups, like asthmatics. It also contributes to acid rains which is dangerous.

Sulfur dioxide affects the respiratory system, particularly lung function, and can irritate the eyes. Sulfur dioxide irritates the respiratory tract and increases the risk of tract infections. It causes coughing, mucus secretion and aggravates conditions such as asthma and chronic bronchitis.

2.1.4 Nitrogen Dioxide

Nitrogen Dioxide is a brownish gas that is easily detectable for its odour, very corrosive and highly oxidant by its nature. It is produced as the result of fossil fuels burning. Usually NO gas thrown to the atmosphere is converted in NO2 by chemical processes. In high concentrations, NO2 may lead to respiratory problems and like SO2, it contributes to acid rains.

Nitrogen dioxide is a nasty-smelling gas. Some nitrogen dioxide is formed naturally in the atmosphere by lightning and some is produced by plants, soil and water. The main effect of breathing in raised levels of nitrogen dioxide is the increased likelihood of respiratory problems. Nitrogen dioxide inflames the lining of the lungs, and it can reduce immunity to lung infections. This can cause problems such as wheezing, coughing, colds, flu and bronchitis.Increased levels of nitrogen dioxide can have significant impacts on people with asthma because it can cause more frequent and more intense attacks. Children with asthma and older people with heart disease are most at risk.

2.1.5 LPG (Liquefied petroleum gas)

Liquefied petroleum gas (LPG) is an colorless and odorless liquid which evaporates readily into a gas. Leakage is normally detected by adding an odor-ant (a substance used to give a particular odour to a product) into it. It is considered under the category of highly flammable gases and it can be classified as a carcinogen and mutagen. If it leaks in the form of a liquid it evaporates quickly and will eventually form large cloud of gas in air which is relatively heavier than air thus drops to the ground. Gas leads to burn or sometimes explode after getting in touch with a source of ignition.

2.2 Sensors used in Air Pollution Monitoring Device

The different components of the device along with their intended purpose and specifications are discussed below:

2.2.1 GP2Y1010AU0F Air Quality Sensor

Sharp's GP2Y1010AU0F is an optical air quality sensor and it is also known as optical dust sensor.It is designed to sense dust particles. An infrared emitting diode and a phototransistor are diagonally arranged into this device, to allow it to detect the reflected light of dust in air. It is even effective in detecting very fine particles like cigarette smoke and is commonly used in air purifier systems.

To interface with this sensor, you need to connect to its 6-pin, 1.5mm pitch connector by using mating connector. Fig 2.1 shows GP2Y1010AU0F Air Quality Sensor.

Specifications:

- Low Current Consumption (MAX: 20 mA)
- Typical Operating Voltage: 4.5V to 5.5V (MAX: 7V)
- The presence of dust can be detected by the photometry of only one pulse
- Enable to distinguish smoke from house dust

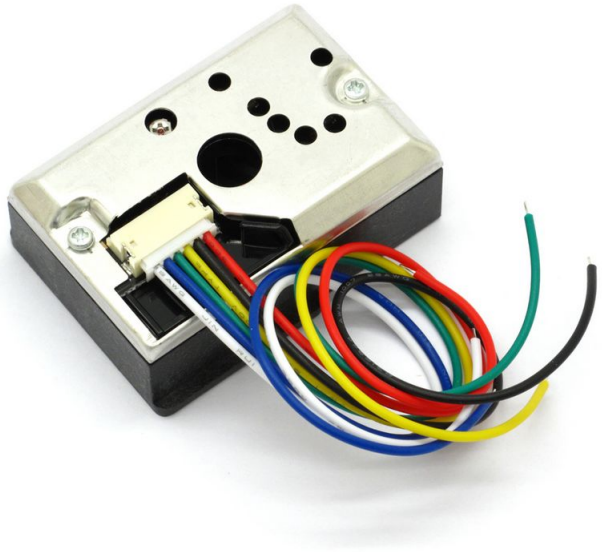


Figure 2.1: GP2Y1010AU0F Air Quality Sensor
src: https://goo.gl/images/5A8j7s

2.2.2 Arduino Uno R3 microcontroller

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are capable of reading inputs - light on a sensor, a finger on a button, or Twitter message and turn it into an output - activating a motor, turning on an LED, publishing something online ,etc.

Arduino boards are completely open-source, empowering users to build them independently and eventually adapt them to their particular needs. Fig 2.2 shows the pin diagram of Arduino Uno board.

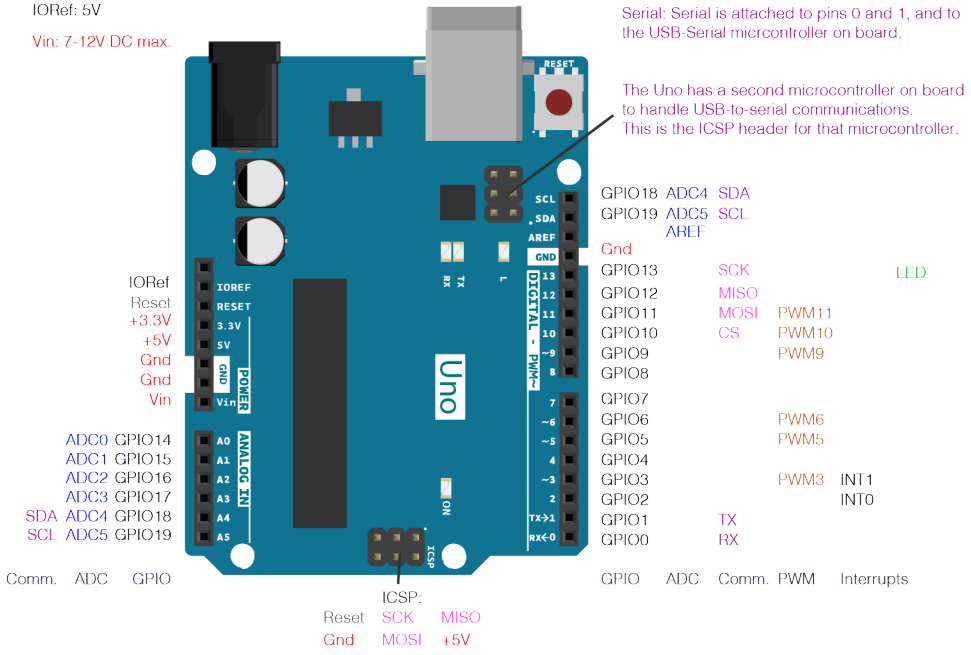


Figure 2.2: Arduino Uno R3 microcontroller
src: https://goo.gl/images/tBjHLD

2.2.3 ESP8266 WiFi Module

ESP8266 is WiFi enabled system on chip (SoC) module developed by Espressif system. It is mostly used for development of IoT (Internet of Things) embedded applications. It employs a 32-bit RISC CPU based on the Tensilica Xtensa L106 running at 80 MHz (or overclocked to 160 MHz). It has a 64 KB boot ROM, 64 KB instruction RAM and 96 KB data RAM. External flash memory can be accessed through SPI. ESP8266 module is low cost standalone wireless transceiver that can be used for end-point IoT developments.

2.2.4 Breadboard

A breadboard is a solder less device for temporary prototype with electronics and test circuit designs. Most electronic components in electronic circuits can be interconnected by inserting their leads or terminals into the holes and then making connections through wires where appropriate.

2.2.5 Piezo Buzzer

The piezo buzzer produces sound based on reverse of the piezoelectric effect. The generation of pressure variation or strain by the application of electric potential across a piezoelectric material is the underlying principle. These buzzers can be used alert a user of an event corresponding to a switching action, counter signal or sensor input. They are also used in alarm circuits.

The buzzer produces a same noisy sound irrespective of the voltage variation applied to it. It consists of piezo crystals between two conductors. When a potential is applied across these crystals, they push on one conductor and

pull on the other. This, push and pull action, results in a sound wave. Most buzzers produce sound in the range of 2 to 4 kHz.

2.2.6 Resistor

A resistor is an electrical component that limits or regulates the flow of electrical current in an electronic circuit. Resistors can also be used to provide a specific voltage for an active device such as a transistor. A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses. For our device we have used 100 ohm and 150 ohm resistors.

2.2.7 Capacitor

Capacitors are simple passive device that can store an electrical charge on their plates when connected to a voltage source. There are many different kinds of capacitors available from very small capacitor beads used in resonance circuits to large power factor correction capacitors, but they all do the same thing, they store charge. For our device we have used 220 micro F capacitor.

2.3 Proposed Architecture

2.3.1 List of Components needed

1. Arduino Uno
2. WiFi module ESP8266
3. GP2Y1010AU0F Air Quality Sensor
4. Jumper wire(Male-Male, Male-Female)
5. Breadboard
6. 1K ohm resistors
7. 220 ohm resistors
8. Piezo Buzzer

Here in Fig 2.3 shows the overall architecture of the device as a top layer view model. Here in Fig 2.4 shows the circuit diagram of the device.

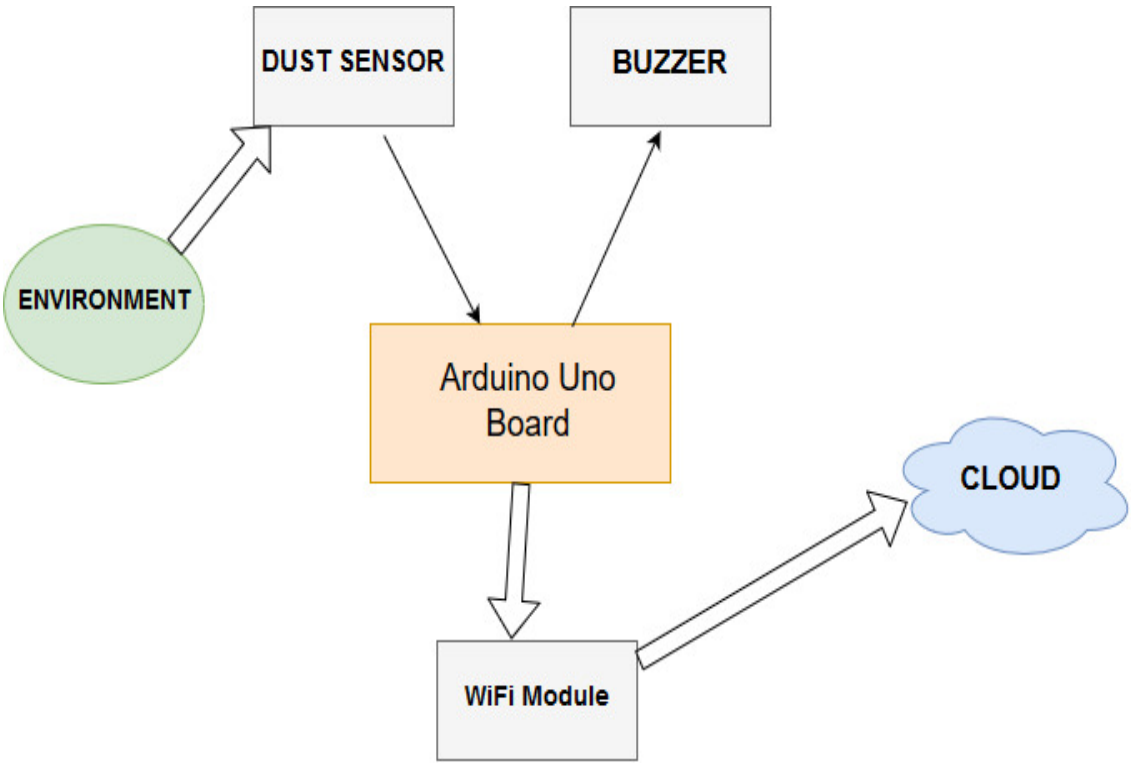


Figure 2.3: Proposed Architecture

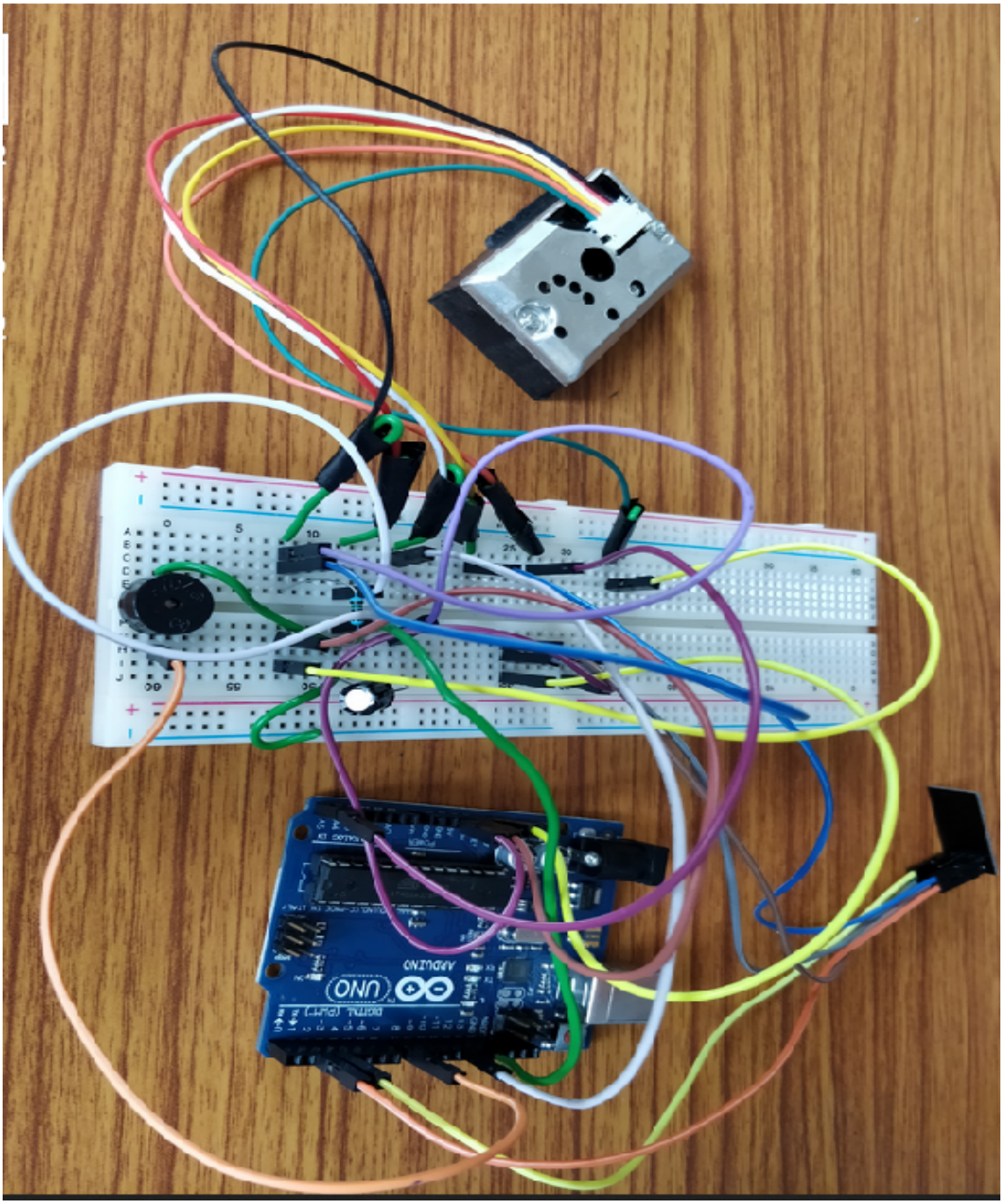


Figure 2.4: Proposed Architecture

2.4 Experimental Analysis

2.4.1 Implementation

We start with connecting the ESP8266 with the Arduino. ESP8266 runs on 3.3V and if you will give it 5V from the Arduino then it wont work properly and it may get damage.

Connect the VCC to the 3.3V pin of Arduino. The RX pin of ESP8266 works on 3.3V and it will not communicate with the Arduino when we will connect it directly to the Arduino.

Connect the TX pin of the ESP8266 to the pin 3 of the Arduino and the RX pin of the esp8266 to the pin 2 of Arduino through the resistors.

ESP8266 Wifi module gives your projects access to Wifi or internet. It is a very cheap device and makes your projects very powerful. It can communicate with any microcontroller and it is used in most leading devices based on the IOT platform. Optionally you can connect MQ135 sensor with the Arduino for covering more dimensions of air.Connect the VCC and the ground pin of the sensor to the 5V and ground of the Arduino and the Analog pin of sensor to the A5 of the Arduino. Connect a buzzer to the pin 8 of the Arduino which will start to beep when the condition becomes true.

The GP2Y1010AU0F sensor can sense smoke and dust so it is perfect gas sensor for our Air Quality Monitoring Project.When we will connect it to the Arduino board then it will start sensing the dust particles, and we will get the Pollution level in the form of dust density. GP2Y1010AU0F sensor gives the output in form of voltage levels and we need to convert it into dust density. Fig 2.5 shows the block diagram of the device.

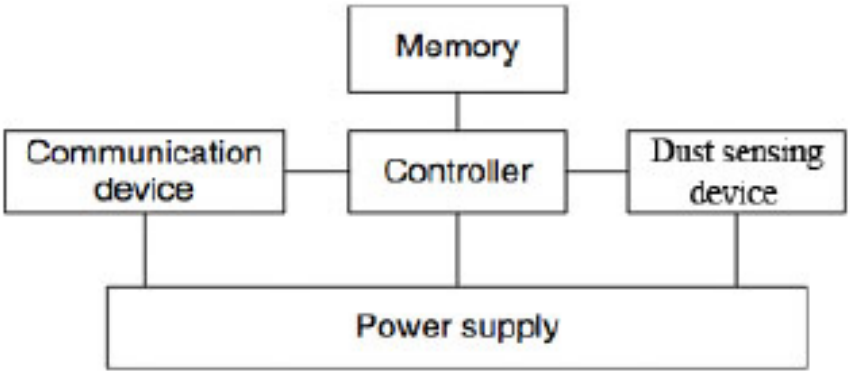


Figure 2.5: Sensor Node Structure

2.4.2 Sensor data Conversion

Conversion of output in dust density is detailed discussed in the code. In the code we have used 3 variables for the sensor data.

1. voMeasured
2. calcVoltage
3. dustDensity

"voMeasured" is the analog reading taken by the Sharp GP2Y1010AU0F air quality sensor form the environment through the pin A5.

Then we calculate the "calcVoltage" from the "voMeasured" by the mathematical equation :

calcVoltage = voMeasured*(5.0/1024);

```
void loop(){

digitalWrite(ledPower,LOW);
  delayMicroseconds(samplingTime);

  voMeasured = analogRead(measurePin);

  delayMicroseconds(deltaTime);
  digitalWrite(ledPower,HIGH);
  delayMicroseconds(sleepTime);

  calcVoltage = voMeasured*(5.0/1024);
  dustDensity = 0.17*calcVoltage-0.1;
```

Figure 2.6: Sensor Data Conversion

Then we will calculate "dustDensity" from the "calcVoltage" by the mathematical equation :

dustDensity = 0.17*calcVoltage-0.1;

We have connected the Pizeo buzzer in pin 8 so that whenever the dust concentration is above some level it will start ringing and make the user alert about the environment and he can wear mask and use air Purifier.

2.4.3 Different levels of Dust concentration

We have categorized the air quality levels in 5 levels :-

1. Very poor Air Quality
2. Poor Air Quality
3. Fair Air Quality
4. Very Good Air Quality
5. Excellent Air Quality

Very poor Air Quality

Condition: if(voMeasured greater than 3000)

Action tone(piezoPin, 1000, 500);

buzzer will start ringing when we will enter in this level

Poor Air Quality

Condition: if(voMeasured greater than 1050 and voMeasured less than 3000)

Action tone(piezoPin, 1000, 100);

buzzer will start ringing when we will enter in this level with different frequency.

Fair Air Quality

Condition: if(voMeasured greater than 300 and voMeasured less than 1050)

Action //tone(piezoPin, 1000, 500);

no buzzer will ringing after we will enter in this level.

very Good Air Quality

Condition: if(voMeasured greater than 75 and voMeasured less than 300)

Action //tone(piezoPin, 1000, 500);

no buzzer will ringing after we will enter in this level.

Excellent Air Quality

Condition: if(voMeasured greater than 0 and voMeasured less than 75)

Action //tone(piezoPin, 1000, 500);

no buzzer will ringing after we will enter in this level.

2.5 Inference from preliminary work and future work

We have successfully established the Wifi connection as shown in Fig 2.7. Fig 2.8, Fig 2.9, Fig 2.10, Fig 2.11 shows the sample result we got in different time instance.

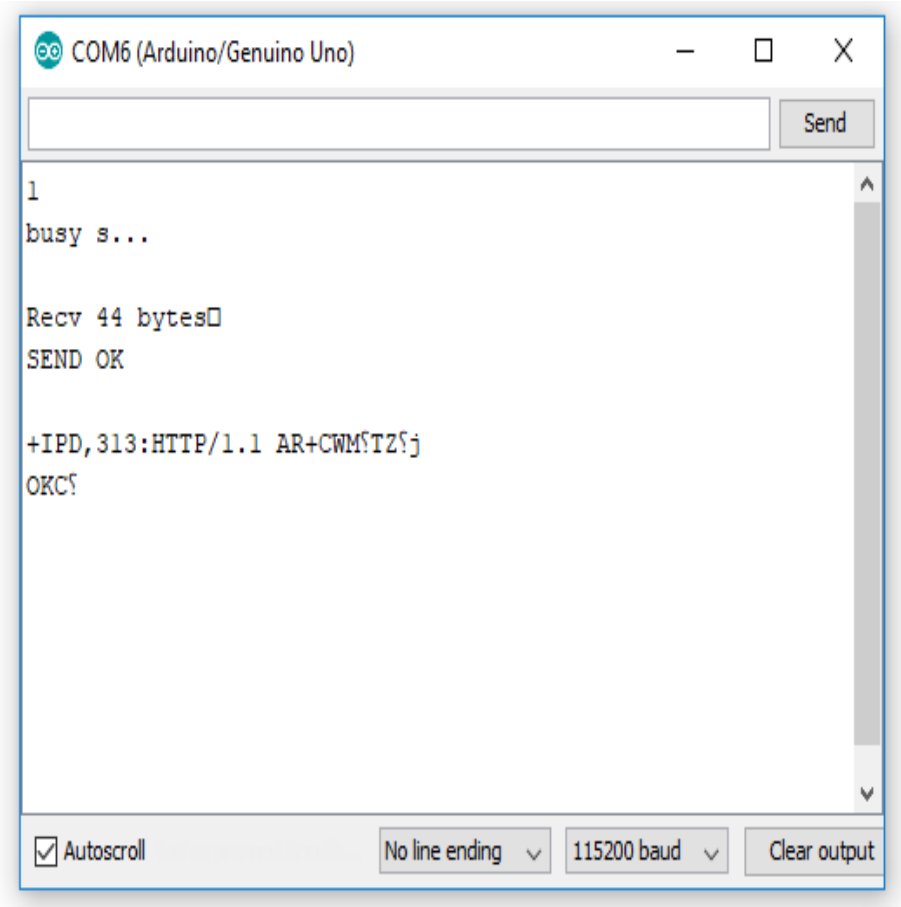


Figure 2.7: Wifi connection establishment

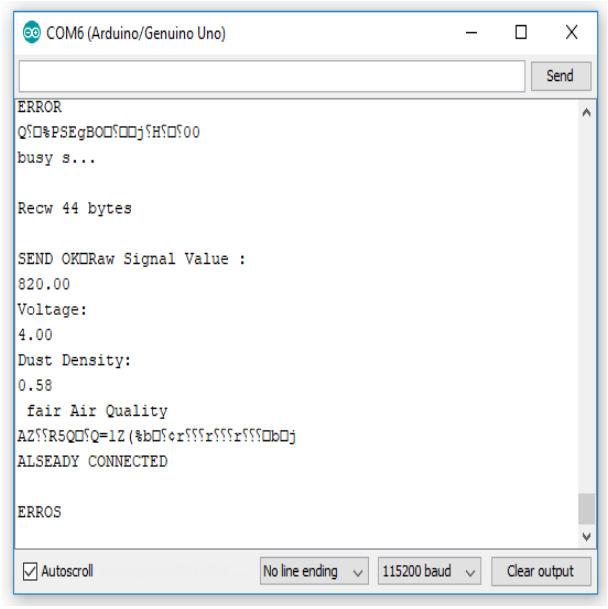


Figure 2.8: T1:Sample result 1

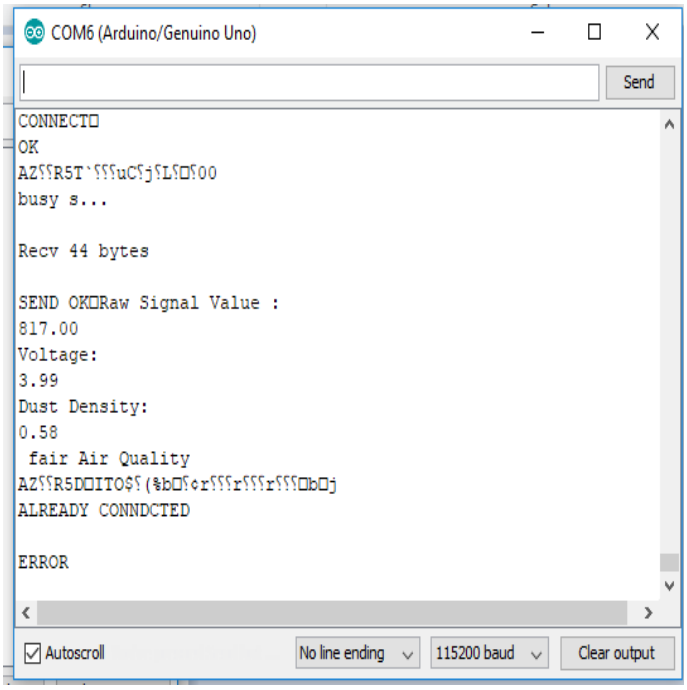


Figure 2.9: T2:Sample result 2

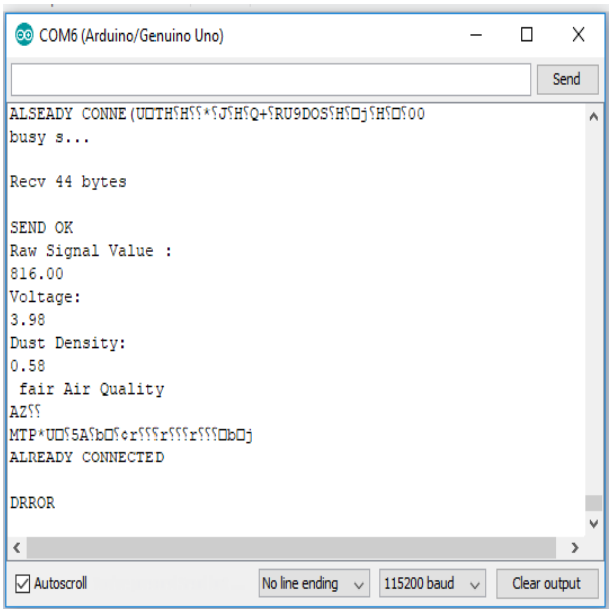


Figure 2.10: T3:Sample result 3

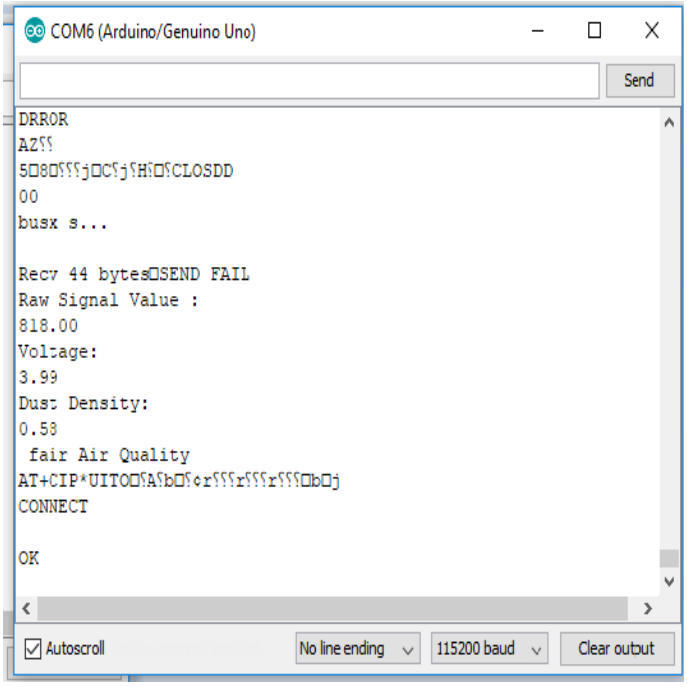


Figure 2.11: T4:Sample result 4

After all this condition checking at last in this project we are casting the result in the screen with all the output values and we are connecting the application to the Things.

We will send the data collected by the sensor to the cloud so that we can access the data from anywhere just by a click.

Fig 2.12 shows the cloud connection establishment with the device.

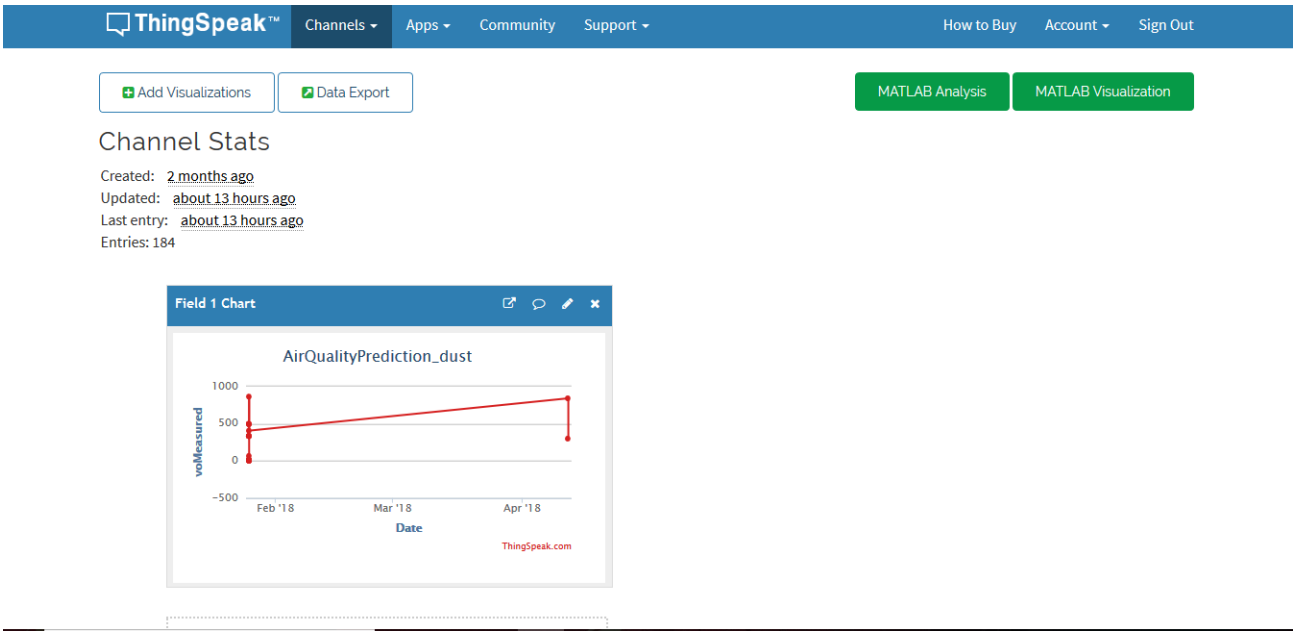


Figure 2.12: Connection of sensor with cloud using ThingSpeak

Now we will use this device as an tool to automate the Hospital room allotment process.

Chapter 3

Literature Survey

In this chapter the existing and established theory and research is discussed. This segment gives context for our work. This area is used for filling an apparent hole in the current hypothesis.

[10] A ***Gunjan Bhatia, Shubham Chauhan Ajay Lala*** in their paper " **Implementation of Cloud Computing Technology for the Improvement of Entire Health care Services in India** " they have discussed about the way of monitoring of Doctors and Hospitals by their projected scheme and thus special care will be taken to provide cheap and effective service to every resident of our country without caring about the social status, economic condition or influence of the person. This will going to put end to the peoples doubt in government hospitals. Also it will going to stop the monopoly of private hospitals. A unique health care system will be formed.So they have concluded that by using the technology inside the hospital the practicality between the rich and poor can be minimized.

[5] ***Bryan J.Hubbell, Amanda Kaufman, Louie Rivers, Kayla***

Schulte in their paper "**Understanding social and behavioral drivers and impacts of air quality sensor use** " they have discussed about how the air quality sensor can be used in the welfare of humanity. They have talked about sensors and sensor data. They have also talked about the assessing methods for communicating sensor data.

[15] ***Min Ye Thu, Wunna Htun, Yan Lin Aung, Pyone Ei Ei Shwe*** in their paper "**Smart Air Quality Monitoring System with LoRaWAN (Long Range Wide Area Network)**" they have proposed a scalable smart air quality monitoring system with low-cost sensors and long-range communication protocol. The sensors collect four parameters, temperature, humidity, dust and carbon dioxide in the air. The proposed end-to-end system has been implemented and deployed in Yangon, the business capital of Myanmar, as a case study since Jun 2018. The system allows the users to log in to an online dashboard to monitor the real-time status.In addition, based the collected air quality parameters for the past two months, a machine learning model has been trained to make predictions of parameters such that proactive actions can be taken to alleviate the impacts from air pollution.

[6] ***Byron Guanochanga, Rolando Cachipuendo, Walter Fuertes, Santiago Salvador, Diego S. Bentez, Theofilos Toulkeridis*** in their paper "**Real-Time Air Pollution Monitoring Systems Using Wireless Sensor Networks Connected in a Cloud-Computing, Wrapped up Web Services**" have presented a design and implementation of a secure and low-cost real-time air pollution monitoring system. They have implemented three-layer architecture system. The first layer contains sensors connected

to an Arduino platform towards the data processing node (Raspberrys Pi), which through a wireless network sends messages. The application layer consists of a server published in the cloud infrastructure having an MQTT Broker service, which performs the gateway functions of the messages sent from the sensor layer. The client layer can be accessed from a Web browser, a PC or smart phone.

[9] ***G. Nalini Priya, P. Anandhakumar, K.G. Maheswari*** in their paper "**Dynamic scheduler - a pervasive healthcare system in smartThis can be done by optimally allocating doctors and appointment slots to the patients instead of following first come first serve technique. hospitals using RFID**" they have presented a solution to this multi objective dynamic scheduling problem using evolutionary algorithms.The aim was to minimize the patient waiting (idle) time, and the appointment slots for doctors should be rendered continuously.That can be done by optimally allocating doctors and appointment slots to the patients instead of following first come first serve technique. Thus it can be concluded that dynamic scheduling algorithm efficiently handles the resource allocation problem (RAP) by using evolutionary approach.

[18] **Sahar Imtiaz, Hadi Ghauch, George P. Koudouridis, James Gross** in their paper "**Random forests resource allocation for 5G systems: Performance and robustness study**" the main hypothesis behind this study is that both the coordinated resource allocation complexity and the signalling overhead can be significantly reduced by exploiting explicit knowledge about a terminal's position to make resource allocation predictions. More specifically, They have presented a design of a learning-based resource

allocation scheme for 5G systems that uses Random Forests as multi-class classifier. In this paper it is shown that even for quite large variations the learning-based approach can still exhibit good performance.This hypothesis of resource allocation can be used in our project for rooms allocation

[2] **Antionio Griffo, Jiabin Wang "Real-Time Measurement of Temperature Sensitive Electrical Parameters in SiC Power MOSFETs**" in this paper they have examined a number of techniques for junction temperature estimation of silicon carbide (SiC) MOSFETs devices (metal oxide semiconductor field effect transistor) based on the measurement of temperature sensitive electrical parameters for use in online condition monitoring.Linearity, sensitivity to temperature, and circuit design for practical implementation are discussed in detail. They have proposed an method that can provide a valuable tool for continuous health monitoring in emerging applications of SiC devices to high-reliability applications.

[3] **Arnab Kumar Saha, Sachet Sircar "A raspberry Pi controlled cloud based air and sound pollution monitoring system with temperature and humidity sensing**" they have proposed an IOT-based method to monitor the Air Quality Index and the Noise Intensity of a region, have been proposed. The recommended technology comprises of four modules namely, the Air Quality Index Monitoring Module, the Sound Intensity Detection Module, the Cloud-based Monitoring Module and the Anomaly Notification Module. The Air Quality Index is measured considering the presence of the five criteria air pollutants. Then the sound intensity is detected using respective sensor. After that, the Cloud-based Monitoring Module ensures the process of acquiring the data with the help of Wi-fi-module present in

Raspberry Pi which fulfills the objective of analysis of information on a periodical basis. Finally, the Anomaly Notification Module alerts the user in case of an undesired condition.

.

Chapter 4

Proposed Architecture

In this chapter proposed architecture, terminologies and definitions regarding our projects are thoroughly discussed.

We will analyze the various diseases which the hospital generally witness.

Then we will make the data set which will be HEALTH CARE DATA-SET hence few misleading entries are present in the data set, hence we are going to pre processed the data set i.e. we are going to do DATA CLEANING.

After that we will build a DEVICE MODEL with the help of sensors which will sense the environmental conditions of every room present in the hospital.

After getting these reading from the sensor device we will make an application and with the help of dataset we have made we will automate the hospital room allocation process. Fig 4.1 is the proposed architecture of the system.

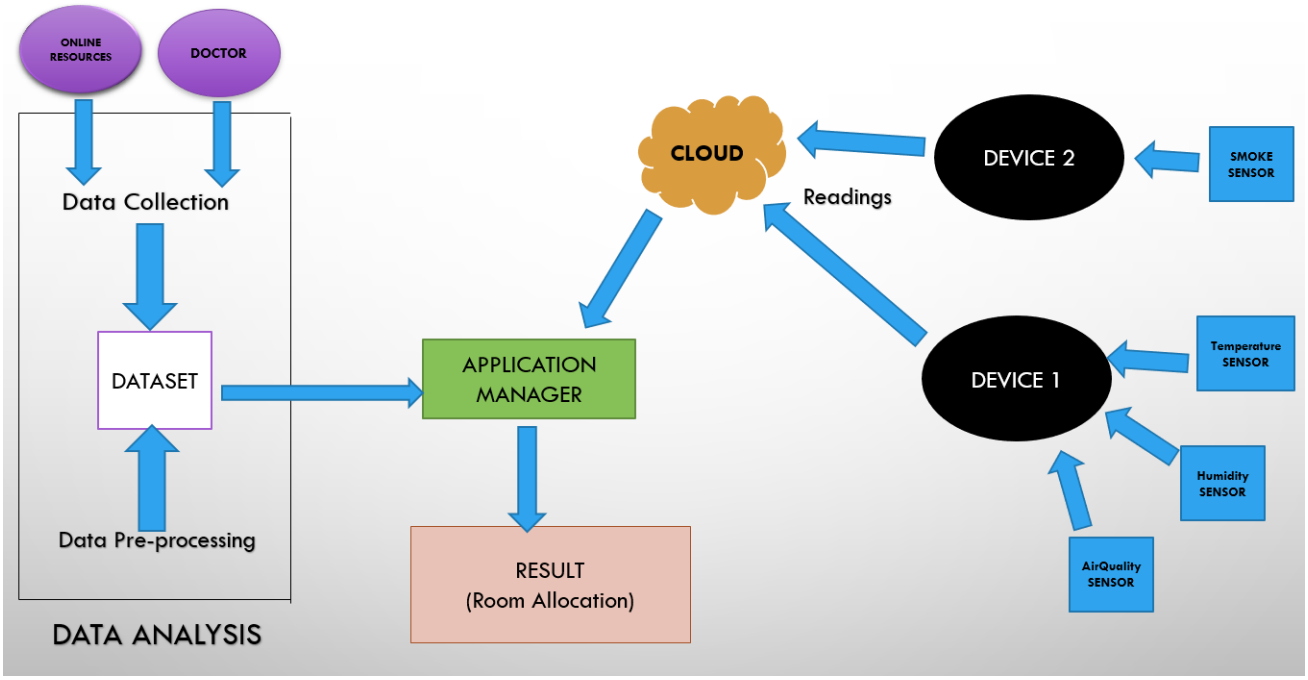


Figure 4.1: Architecture of the System

4.1 Definitions

In this section we will discuss about the various terminologies used in the project.

4.1.1 Hypothesis Generation

Understanding the problem better by brainstorming possible factors that can impact the outcome.

This is done before looking at the data, and we end up creating a laundry list of the different analysis which we can potentially perform if data is available.

4.1.2 Data Analysis

The process of evaluating data using analytical and logical reasoning to examine each component of the data provided. This form of analysis is just one of the many steps that must be completed when conducting a research experiment. Data from various sources is gathered, reviewed, and then analyzed to form some sort of finding or conclusion. There are a variety of specific data analysis method, some of which include data mining, text analytics, business intelligence, and data visualizations.

4.1.3 Data Cleaning

Data cleaning is the process of detecting and correcting (or removing) corrupt or inaccurate records from a record set, table, or database and refers to identifying incomplete, incorrect, inaccurate or irrelevant parts of the data

and then replacing, modifying, or deleting the dirty or coarse data.
The inconsistencies detected or removed may have been originally caused by user entry errors, by corruption in transmission or storage, or by different data dictionary definitions of similar entities in different stores.

The process of Data Cleaning

1. **Parsing :** for the detection of syntax errors. A parser decides whether a string of data is acceptable within the allowed data specification. This is similar to the way a parser works with grammars and languages.

2. **Data transformation:**Data transformation allows the mapping of the data from its given format into the format expected by the appropriate application. This includes value conversions or translation functions, as well as normalizing numeric values to conform to minimum and maximum values.

3. **Duplicate elimination:**Duplicate detection requires an algorithm for determining whether data contains duplicate representations of the same entity. Usually, data is sorted by a key that would bring duplicate entries closer together for faster identification.

4. **Statistical methods:**By analyzing the data using the values of mean, standard deviation, range, or clustering algorithms, it is possible for an expert to find values that are unexpected and thus erroneous. Although the correction of such data is difficult since the true value is not known, it can be resolved by setting the values to an average or other statistical value.

4.1.4 IOT (Internet of Things)

The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer the data over a network without requiring human-to-human or human-to-computer interaction directly. Internet of Things has evolved from the convergence of wireless technologies, micro-electro mechanical systems (MEMS), micro services and the internet.

The convergence has helped tear down the silo walls between operational technology (OT) and information technology (IT).

4.1.5 Arduino

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are capable of reading inputs - light on a sensor, a finger on a button, or Twitter message and turn it into an output - activating a motor, turning on an LED, publishing something online ,etc.

Arduino boards are completely open-source, empowering users to build them independently and eventually adapt them to their particular needs.

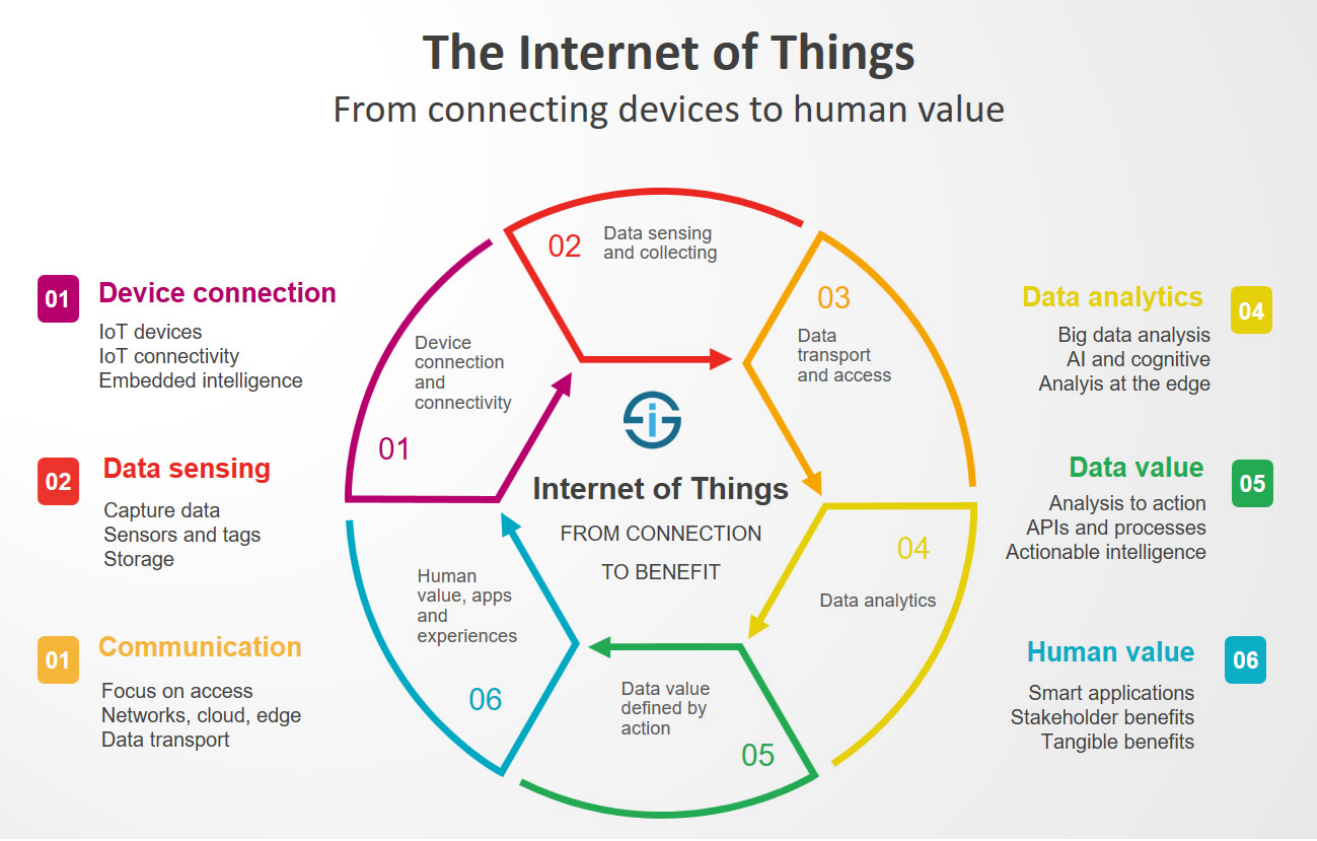


Figure 4.2: Conceptual diagram of IOT
href:- https://goo.gl/images/ddK6lp

Chapter 5

Implementation

In this chapter implementations details with the quality parameters and the tools and libraries included in the project are thoroughly discussed.

5.1 About the Data set

We have made 2 data sets the first data set is about the diseases and their suitable and desired temperature, humidity, air quality, disease description for the patients which are going to be treated in the hospitals.

The next dataset is about the available rooms temperature, humidity, air quality, status value so that we can easily allocate the rooms to the patients.

5.1.1 Attributes in Disease Dataset

1. **Disease :** This attribute tells the name of the disease.

2. **Temperature :** This attribute tells what is the suitable value of tem-

perature for the patients suffering from that disease. Patients can stay in room which have the temperature value less than the given temperature in the dataset.

3. **Humidity :** This attribute tells what is the suitable value of humidity for the patients suffering from that disease. Patients can stay in room which have the humidity value less than the given humidity in the dataset.

4. **AirQuality :** This attribute tells what is the suitable value of AirQuality for the patients suffering from that disease. Patients can stay in room which have the AirQuality value less than the given AirQuality in the dataset.

5. **Descripition :** This attribute tells the type of disease and the description related to it.

5.1.2 Attributes in Room Dataset

1. **RoomNo :** This attribute is room number identifier which can be used to identify the specific room in whole hospital.

2. **Temperature :** This attribute tells what is the temperature inside that room.

3. **Humidity :** This attribute tells what is the humidity inside that room.

4. **AirQuality :** This attribute tells what is the AirQuality (dust) inside that room.

5. **Status :** This attribute tells whether room is already occupied or not. Zero is denoted as empty room and One means room is already occupied by patient.

5.2 Tools

We have used several tools to make our project such as :

1. **The Jupyter Notebook :** The Jupyter Notebook is an open-source web application that allows you to create and share documents that contain live code, equations, visualizations and narrative text. Uses include: data cleaning and transformation, numerical simulation, statistical modeling, data visualization, and much more.

2. **Qt Designer :** Qt Designer is the Qt tool for designing and building graphical user interfaces. It allows you to design widgets, dialog or complete main windows using on-screen forms and a simple drag-and-drop interface. It has the ability to preview your designs to ensure they work as you intended, and to allow you to prototype them with your users, before you have to write any code.

3. **Microsoft Excel :** Microsoft Excel is a spreadsheet program included in the Microsoft Office suite of applications. Spreadsheets present tables of values arranged in rows and columns that can be manipulated mathematically using both basic and complex arithmetic operations and functions. Microsoft Word is a word processing program used for writing letters, memos, reports and paper presentations. Microsoft Ex-

cel is a spreadsheet program used for calculations, making charts and recording data about all sorts of business processes.

4. **Arduino Software (IDE) :** The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software. The Arduino integrated development environment is a cross-platform application that is written in the programming language Java. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards. This software can be used with any Arduino board.

5.2.1 Libraries

We have tools used several libraries to make our project such as :

1. **Pandas :** pandas is an open source, it is a library providing high-performance, easy-to-use data structures and data analysis tools for the Python programming language.

2. **NumPy :** NumPy is the fundamental package for scientific computing with Python. Arbitrary data-types can be defined. This allows NumPy to seamlessly and speedily integrate with a wide variety of databases. It contains following features:

    - a powerful N-dimensional array object
    - sophisticated (broadcasting) functions

- tools for integrating C/C++ and Fortran code
- useful linear algebra, Fourier transform, and random number capabilities

3. **SciPy :** SciPy is a Python-based ecosystem of open-source software for mathematics, science, and engineering.

4. **SoftwareSerial :** The SoftwareSerial library has been developed to allow serial communication on other digital pins of the Arduino, using software to replicate the functionality (hence the name "SoftwareSerial"). It is possible to have multiple software serial ports with speeds up to 115200 bps. A parameter enables inverted signaling for devices which require that protocol.

5.3 Data Collection

Data collection is the process of gathering and measuring information on variables of interest, in an established systematic fashion that enables one to answer stated research questions, test hypotheses, and evaluate outcomes.

Special thanks to Saumya Singhal(MBBS Final year, Government Medical College, Raigarh) for dedicating her time and energy into this dataset formation process, without the domain expert its too difficult to trust the dataset.

5.4 Data Cleaning

Data cleansing or data cleaning is the process of detecting and correcting corrupt or inaccurate records from a record set, table, or database and refers to identifying incomplete, incorrect, inaccurate or irrelevant parts of the data and then replacing, modifying, or deleting the dirty or coarse data.

5.4.1 Imputing Missing Values

We have encounter lot of variables as null value since we didn't got the data related to that disease like suitable humidity value for the broken leg issue.

Hence in those cases we imputed the values. Since it is a real life health care data set so values cannot be too varying a lot. So for imputing the values we have used the mean value process and imputed it with the mean value of that column.

5.5 Cloud connection establishment

ThingSpeak is an open-source Internet of Things application and API to store and retrieve data from things using the HTTP protocol over the Internet or via a Local Area Network.ThingSpeak is the open IoT platform with MATLAB analytics.

We have made an device which will sense the temperature, humidity, and AirQuality value of the condition inside the hospital rooms in every few fixed interval of time and the device will send that data to the cloud platform called ThingSpeak. In every 10 minutes the values of temperature, humidity, and

AirQuality are updated in the room dataset from the cloud platform.

5.6 Graphical User Interface for the Application

Since this application is for the receptionist present in reception to allocate the room, So application should be simple and easy to use, it should not contain the complex features to make the allocation more complex.

Receptionist will enter the name of the disease and press the button of "Search Rooms" then she will get list of suitable rooms available in the hospital. Then from the pool of available rooms Receptionist will choose the room and press the allocate button then it will automatically change the status attribute value in the room data set so that there will be proper functioning of the room allocation process. If some room is already filled then it will not show in the available room list.

Chapter 6

Result and Discussion

We have successfully developed an application which can allocate the rooms to the patients according to their conditions. Fig 6.1 shows the temperature and humidity value in the serial monitor of the Ardunio IDE and Temperature is in C and the humidity is expressed in units of grams of water vapor per cubic meter of air (g/m3).

Fig 6.2 shows the dust sensor readings by the device , we can see that we are getting the electrical voltage value and we have converted it in other units, we are also getting the dust density value is expressed in kilogram per cubic meter.

Fig 6.3 shows the MQ-8 sensor reading of hydrogen in the air and on the y axis represents particles of hydrogen per million i.e. ppm and x axis shows time instant at which reading was taken.

Fig 6.4 shows the MQ-135 sensor reading of ammonia in the air and on the y axis represents particles of ammonia per million i.e. ppm and x axis shows time instant at which reading was taken.

Fig 6.5 shows the MQ-7 sensor reading of carbon monoxide in the air and on the y axis represents particles of carbon monoxide per million i.e. ppm and x axis shows time instant at which reading was taken.

Fig 6.6 is the GUI of our application where receptionist will input the disease name and press the "Search Available Rooms" button and he will get the list of suitable available rooms from that list receptionist will input 1 room in the box and press "Allocate" then that room will be allocated to patients and that room will not be seen for other patients since it is already booked.

The data is successfully sent to the cloud and can be retrieve from the cloud. Hence our device is ready to be deployed in the hospital to automate the room allocation process.

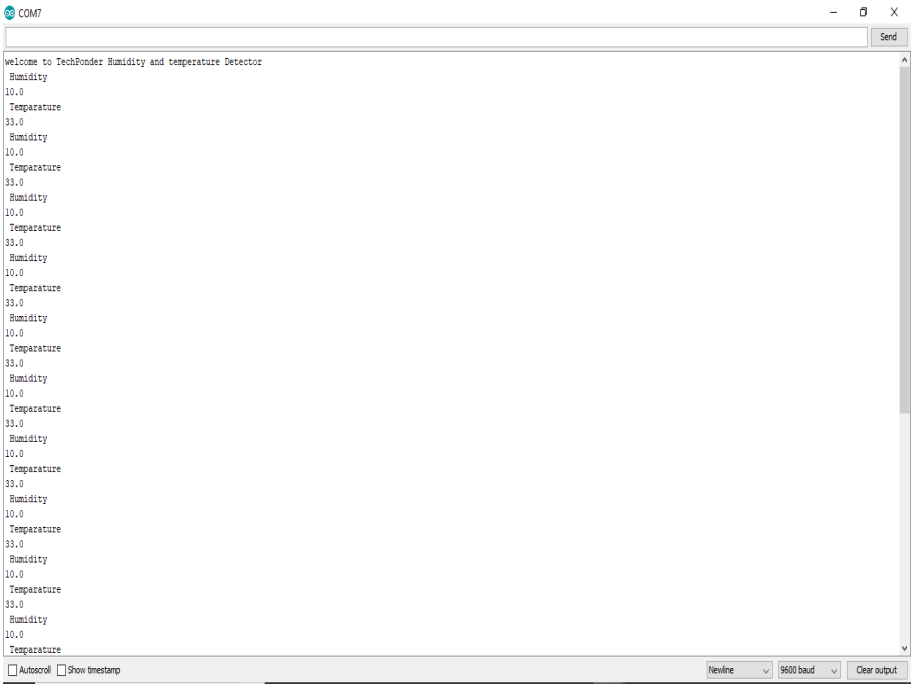


Figure 6.1: Temperature and Humidity readings

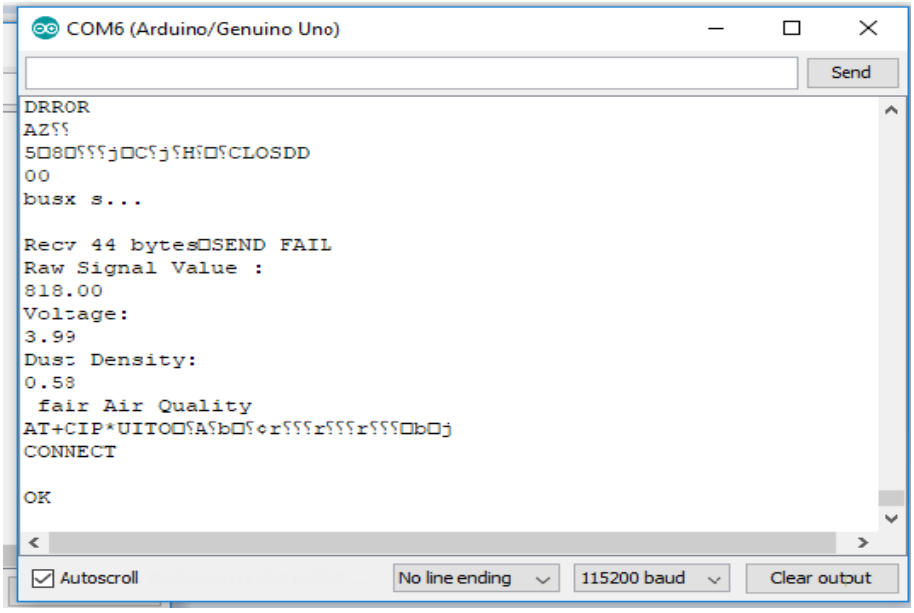
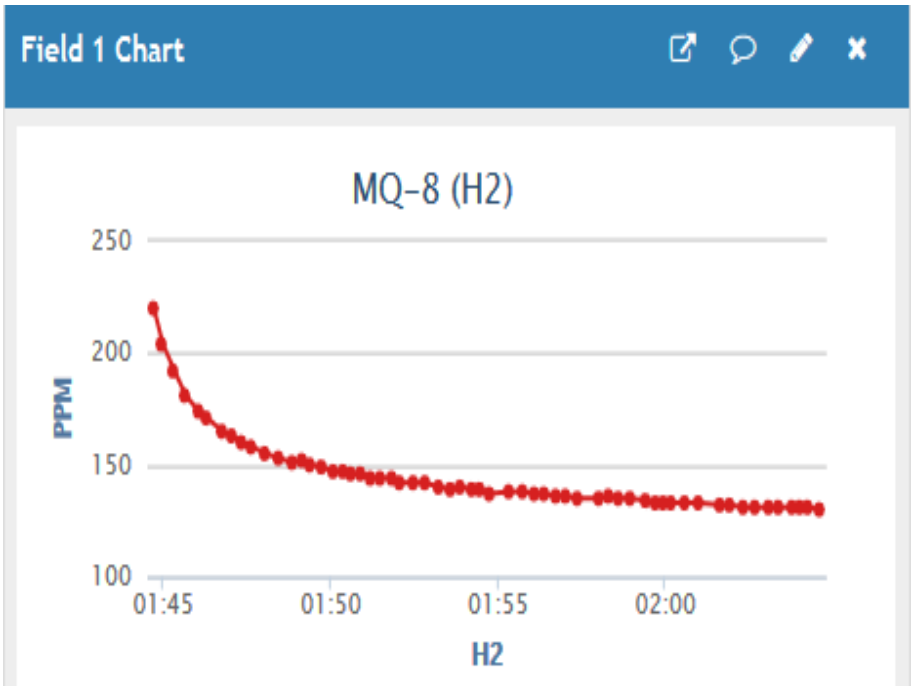


Figure 6.2: Dust sensor readings



8.png

Figure 6.3: Hydrogen readings

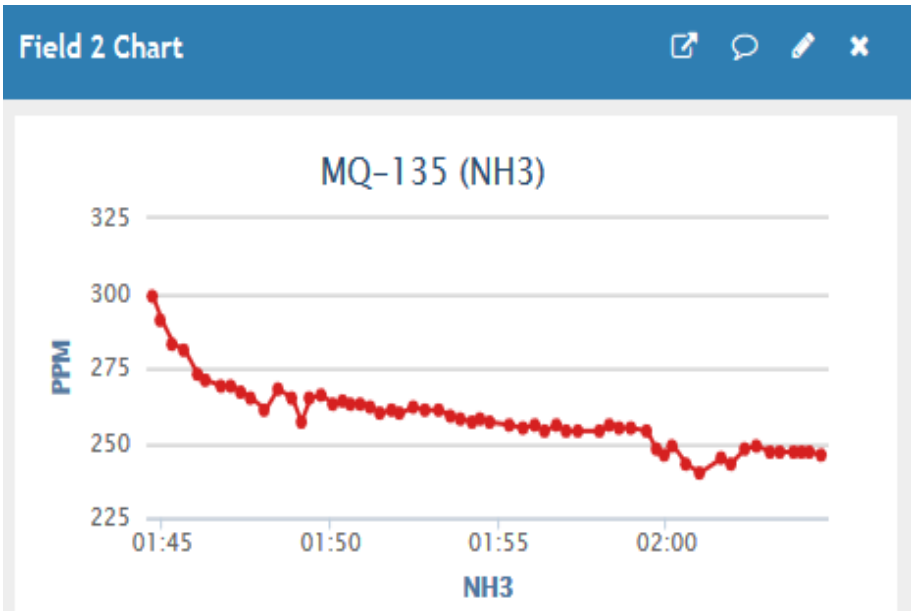


Figure 6.4: Ammonia NH3 readings

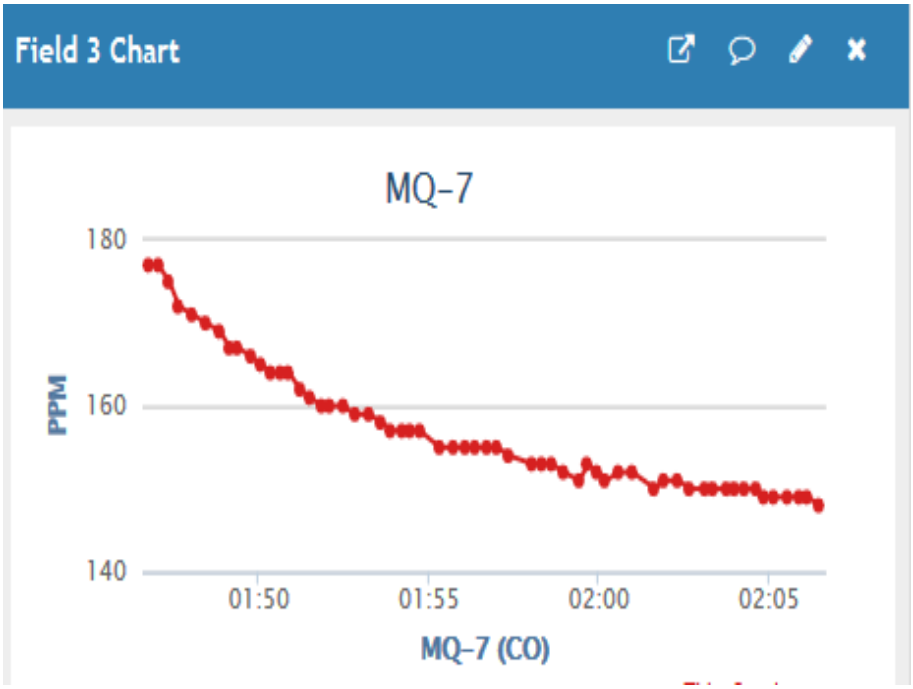


Figure 6.5: Carbon Monoxide CO readings

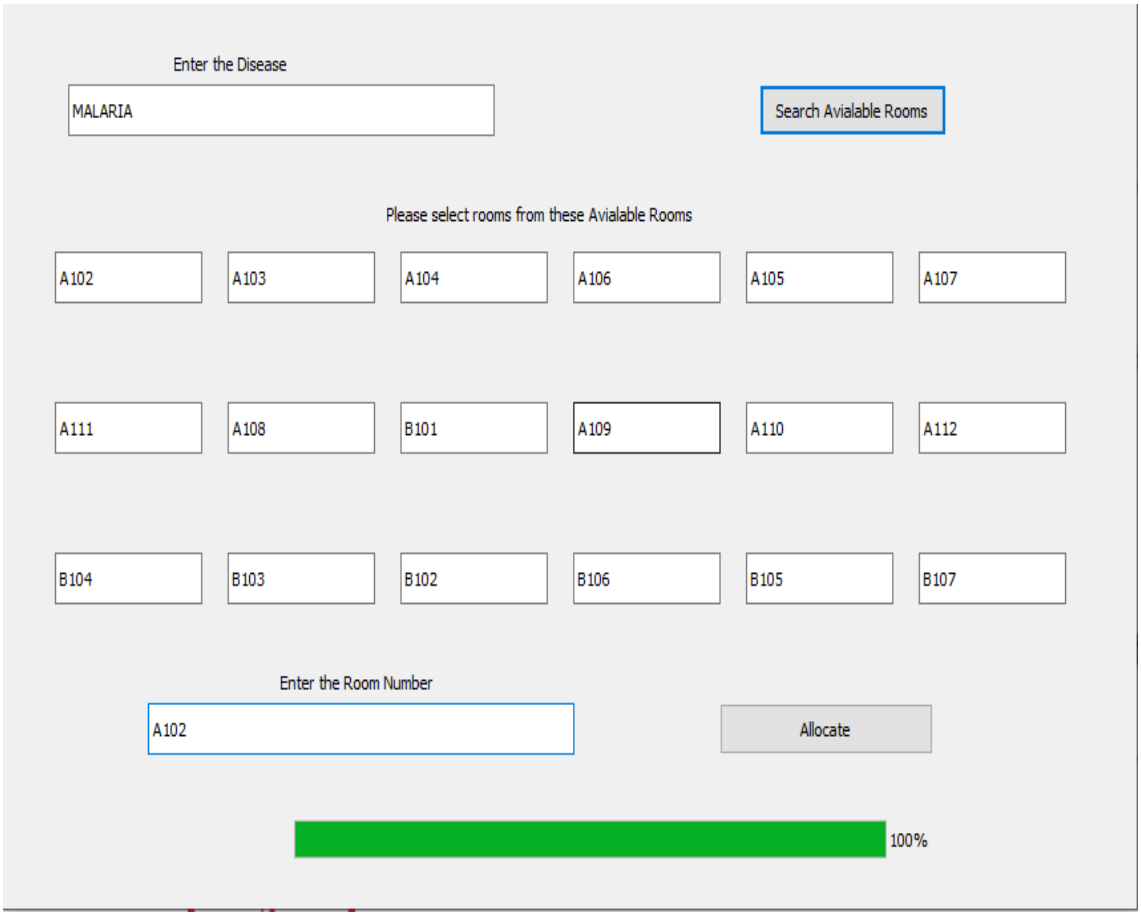


Figure 6.6: Graphical User Interface of our application

Bibliography

[1] H Rivano A Boubrima, W Bechkit. Optimal wsn deployment models for air pollution monitoring. *IEEE*, 2017.

[2] Jiabin Wang Antionio Griffo. Real-time measurement of temperature sensitive electrical parameters in sic power mosfets. *Transactions on Industrial Electronics*, 65, 2018.

[3] Sachet Sircar Arnab Kumar Saha. A raspberry pi controlled cloud based air and sound pollution monitoring system with temperature and humidity sensing. *8th Annual Computing and Communication Workshop and Conference (CCWC)*, 2018.

[4] Scott E. Hudson Brad Myers, Scott E. Hudson. Past, present, and future of user interface software tools. *Human-computer interaction in the new millennium, ACM*, Vol 7:p3–28, 2001.

[5] Louie Rivers Kayla Schulte Bryan J Hubbell, Amanda Kaufman. Understanding social and behavioral drivers and impacts of air quality sensor use. In *Science of The Total Environment*. IEEE, 2018.

[6] Walter Fuertes Santiago Salvador Diego S Bentez Theofilos Toulkeridis Byron Guanochanga, Rolando Cachipuendo. Real-time air pollution monitoring systems using wireless sensor networks connected in a cloud-computing, wrapped up web services. *Proceedings of the Future Technologies Conference (FTC) 2018*, 171-184, 2018.

[7] L. Gugliermetti D and Astiaso Garcia. A cheap and third-age-friendly home device for monitoring indoor air quality. *International Journal of Environmental Science and Technology*, 15, Jan 2018.

[8] Innocent Kamwa Esmaeil Ghahremani. Optimal placement of multiple-type facts devices to maximize power system loadability using a generic graphical user interface. *Transactions on Power Systems, IEEE*, Vol 2:p764–778, 2012.

[9] K.G. Maheswari G. Nalini Priya, P. Anandhakumar. Dynamic scheduler - a pervasive healthcare system in smartthis can be done by optimally allocating doctors and appointment slots to the patients instead of following first come first serve technique. hospitals using rfid. *2008 International Conference on Computing*, 2008.

[10] Ajay Lala Gunjan Bhatia, Shubham Chauhan. *Implementation of Cloud Computing Technology for the Improvement of Entire Healthcare Services in India*. International Conference on Advances in Technology and Engineering, IEEE, 2013.

[11] Rajkumar Buyya JayavardhanaGubbi and Slaven Marusic. Internet of things (iot): A vision, architectural elements, and future directions. *Future Generation Computer Systems, Elsevier*, 29:1645–1660, 2013.

[12] ByungWan Jo and Rana Muhammad Asad Khan. An internet of things system for underground mine air quality pollutant prediction based on azure machine learning. *Department of Civil and Environmental Engineering*, 18, 2018.

[13] Pradeep D Landge and R.R.Harne. Air quality monitoring system for city:a review. *International Research Journal of Engineering and Technology (IRJET)*, 5, Jan 2018.

[14] Gonalo Marques and Rui Pitarma. An indoor monitoring system for ambient assisted living based on internet of things architecture. *Unit for Inland Development, Polytechnic Institute of Guarda*, 13, 2016.

[15] Yan Lin Aung Pyone Ei Ei Shwe Min Ye Thu, Wunna Htun. Smart air quality monitoring system with lorawan (long range wide area network. In *2018 IEEE International Conference on Internet of Things and Intelligence System*. IEEE, 2018.

[16] Subhas Mukhopadhyay. *IoT and WSN Based Health and Home Management*. Second Edition. IEEE,Macquarie University, 2017.

[17] Philipp Schneider Matthias Vogt Uri Lerner Barak Fishbain David Broday Alena Bartonova Nuria Castell, Franck R. Dauge. Can commercial low-cost sensor platforms contribute to air quality monitoring and exposure estimates? In *Environment International*. Elsevier, 2016.

[18] George P. Koudouridis James Gross Sahar Imtiaz, Hadi Ghauch. Random forests resource allocation for 5g systems: Performance and robustness study. *Wireless Communications and Networking Conference Workshops (WCNCW)*, 2018.

[19] W Romine U Jaimini, T Banerjee. Investigation of an indoor air quality sensor for asthma management in children. *IEEE*, 2017.

[20] Mukulika Maity Varun Jain, Mansi Goel. Scalable measurement of air pollution using iot devices. *10th International Conference on Communication Systems Networks (COMSNETS), IEEE*, Jan 2018.