CLIMATE-SAVER SYSTEM BASED ON IOT

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering

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APPROVAL

This Project/internship titled **"Climate-Saver System Based on IoT"**, submitted by Mosfiqun Nahid Hassan, FM Galib, Janntun Nayeem Diba, ID No: 161-15-7029, 161-15-6804, 161-15-7025 to the Department of Computer Science and Engineering, Daffodil International University has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 05-12-2019.

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We hereby declare that, this project has been done by us under the supervision of **Fahad Faisal, Assistant Professor, Department of CSE** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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ABSTRACT

21st century is the era of science and technology. With the advancement of technology to create a safe & clean environment, the number of electronic devices in our daily lives has increased. There is a strong need to build a trustable air monitoring system for the community that will easily collect data from all these devices from a distance and not only minimize the complexity of handling the number of devices at the same time, but also save power using renewable energy. This report presents the future of environmental monitoring system and climate change. This is an IoT based project. After testing, we will make a successful environment monitoring system model and cost-consuming device to generate data set for the environment. Using the Sensors, microcontroller, cloud, big data & overall IoT technology we design an environment monitoring system which is called **"Climate-Saver System based on IoT"**. Where the entire electrical item will be controlled. Using the internet people can also monitor temperature, humidity, gas detection, detect harmful gas presence in environment (Indoor & Outdoor) through the user friendly web application and also makes a notification system. Comparing to others this system is low cost, attractive user friendly interface which is cloud based platform independent and it's very easy to monitoring & visualize data. The system is evaluated in different stages after the implementation of all functions and it operates effectively as an environmental monitoring station. After collect dataset we can also try to predict the gas emission level, temperature and other data analysis using machine learning algorithms. One person can make a difference, but together, we can make a movement. Save the ecosystem, save the environment & save the climate.

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CHAPTER 1
INTRODUCTION

1.1 Introduction

Climate Change is one of the most challenging topics in the world. Most of the government, semi-government, public organizations are preparing to face this challenge and trying to make the world a better place to live for humans. The world has warmed before, but never this quickly, and it is due in large part to human activities. On the other hand, the Internet of Things (IoT) is currently a very potential and growing element of technology.If we can integrate all IoT elements to track and collect data for our country or any place using IoT-based devices, then facing the climate challenge can be a powerful weapon. In climate change, greenhouse gas, methane emissions, carbon emissions are a major factor. This project will mostly do all the data and metrics collection and make it available to be reused by any means for further use. Our project can work in any environment and can collect or measure important indicators of climate change and store the small piece of data in any big data system for further use and advance use by anyone to detect any meaningful climate change and useful metrics. Using the IoT concept, it becomes much more flexible and interactive to the user. Different types of wireless network technology such as WIFI, GSM & Sensors make the monitoring system for the environment more efficient. To save power, it also retains a renewable energy (solar). Energy saver as a power supply provides a renewable energy. It is also directly related to climate change to predict gas emissions such as carbon dioxide (CO_2) and methane (CH_4). To connect to the internet, the Arduino uses Wi-Fi. The client uses the web browser to position a specific API to access the web application. Near the address of the IP The client must insert a key to operate the home computer. For better understanding anywhere in the world, we need to keep data visualization, data analysis tools and technology firmly in place. The client also monitors the current state of air pollution through this web application. Also monitoring all kinds of gas sensors and a solar power house when something gets wrong using webcam.

1.2 Motivation

Air pollution is the biggest problem of every nation, whether it is developed or developing. Health problems have risen more rapidly, especially in urban areas in developing countries where industrialization and the growing number of vehicles have resulted in the release of a lot of gaseous pollutants. Harmful pollution effects include mild allergic reactions such as throat, eyes, and nose irritation, as well as some serious problems such as bronchitis, heart disease, pneumonia, lung, and aggravated asthma. Climate change is a global challenge in which national borders are not respected. Emissions all over the place affect people. It is an issue that requires solutions that need to be coordinated at the international level and it requires international cooperation to help developing countries move toward a low-carbon economy. But it is not possible for a single person, single country. We are humans who want the same thing every other human wants a safe place to live on this planet we call home. So while our work must continue to be unbiased and objective, increasingly we are raising our voices, adding to the clear message that climate change is real and humans are responsible, the impacts are serious and we must act now. It’s abundantly clear that climate change is already having an impact on human rights. And that this impact will only intensify in coming years. Taking climate action now makes good economic sense. The more we delay, the more we pay.

We can promote economic growth, eradicate extreme poverty, and we can boost people's health and well-being by working today. We will limit global temperature rises to less than 2 degrees if we take action now. It is in the interests of all that we need to act now in all countries and all sectors of society. Cities are where to a large extent the weather war will be won or lost.

1.3 Rational of the Study

Climate Change & Air Monitoring System is a very common topic around the world. Now-a-days Air Monitoring and IoT integrated together. Many real-life initiatives and research are being developed or are being developed on the basis of an IoT-based platform for environmental monitoring. The Internet of Things (IoT), also sometimes referred to as the Internet of All (IoE), is made up of all web-enabled devices that use embedded sensors, processors and communication hardware to collect, send and act on data acquired from their surroundings. These devices, often called "connected" or "smart" devices, can sometimes talk to other related devices, a process called machine-to-machine (M2M) communication, and act on the information they get from one another. The key benefit of the IoT-based Environment Monitoring System is that users can monitor visualization of information remotely and track the entire database. Many environmental monitoring systems compared to Bangladesh are relatively expensive. For the IoT-based air monitoring system, security is not a major concern. If it works with Ethernet then the security is a massive term. So the IoT based Air Monitoring system is a great field to develop and work. Here is still a great opportunity to improve the reliability and safety of Climate Saver and Environment Monitoring System based on IoT. UN Climate Change News, October 11, 2019 — In today's speech at Copenhagen's C40 World Mayors Summit, UN Secretary-General António Guterres said cities would ultimately win or lose the fight against climate, naming the world's first climate emergency responders. "With cities accounting for more than 70% of global CO2 emissions, he said that the choices that will be made on urban infrastructure in the coming decades – on construction, housing, energy efficiency, energy generation and transportation – will have" a tremendous impact on the emission curve". He said the consequences without climate-conscious urban planning would be dramatic, with approximately seven out of every ten people expected to live in urban areas by 2050, and he said he was pleased that the C40 network was leading the way.

1.4 Expected Output

Collect, store, analyze and visualize climate change related data and metrics for public use. Our IoT elements or devices can be installed anywhere (even can be portable) to detect data and metrics from various locations to get the most accurate data. Real-time our IoT device will emit important events and data to our big data storage system. we provide data, tools, and information to help people understand and prepare for climate variability and change.

To easily analyze and visualize our data we can use modern software and tools and furthermore, we can build mobile app or cost efficient technology tools for public use as well as we can open source the data to national and international climate related organizations that helps them to build a better world for the human race.

Our IOT device could have tremendous positive impacts on environment. Pocket sized environmental sensors can now be carried around. Our device is intended to be used for....

- Monitoring the Air quality including hazardous chemical presence and other environmental indicators.
- Tracking Gas Emission Rate.
- Measuring Gas quality.
- Recording Temperature and other weather sensitive metrics.
- Detect Storm, Rain possibility and other related natural disasters.
- Real-time data visualization, public alert and open source database for public, government, semi-government organization’s use.

1.5 Report Layout

There is a strong need to develop a trustworthy public environment monitoring system that will easily collect data from all these devices from a distance and not only reduce the difficulty of managing the number of devices simultaneously, but also save power using renewable energy. Air pollution is the biggest challenge for every country, whether it is produced or established. Health problems have been growing at a faster rate, especially in urban areas in developing countries where industrialization and a rising number of vehicles have resulted in a lot of gaseous pollutants being released. We can limit global temperature rises to below 2 degrees if we take action now. It is in the interests of all that we need to act now in all countries and all sectors of society. Capture, store, interpret, and document climate change information and measurements for public use. Our IoT components or tools can be mounted anywhere (including portable) to track data and measurements from various locations in order to obtain the most accurate data. A small number of gas detection devices are also available, but in this venture, IoT, big software for a lot of data and cloud technology have also added a tier.

We face some problems to develop this venture. If the device is set indoors, we can easily power it up, but if it needs to be used for data collection in the outdoor environment, then there is a problem with sustainable power supply. The device needs a battery to run outdoors and it is necessary to use solar energy to charge the battery without any hustle. The machine is initially operated by the battery and then sends data to the website of Thing speak where the data is shown on the map. When the system is switched on, the sensors start to work.

The device has the shape of a box. All sensors, microcontrollers, vero boards and all are connected together. It has different battery and circuit board compartments and sensors. The battery and the circuit board and sensors are located in the lower compartment.

The sensor data we collect from the system is displayed directly on Thing speak in different charts. The sensor values PPM format is displayed. Then the subject data will be shown in various graphs and tables on our website. Read the API and view the information on our website. In fact, this data is stored in our Big Data program. The main indoor experiment was conducted. The sensor reads the indoor environment by its state. Changes in the artificial environment are made to play with the sensor data by leaking smoke, burner LPG fuel, etc. The values we derive from the sensors are thus different from the normal state and the fluctuation of information is shown in real time.

Then these data will be shown in graphs or online, which are in real time data from the phone. To construct and evaluate the data collection, these data are stored in our Big Data system.

CHAPTER 2
BACKGROUND

2.1 Introduction

We're going to make a climate saver based on IOT in this venture. Environmental monitoring system in which we monitor air quality through an internet-based web server and cause an alert if air quality goes beyond a certain level means there is a sufficient amount of harmful gases in the atmosphere such as CO2, smoke, CH4, NOx, LPG, CNG, SOx, CO & NH3 etc. It will show the air quality in PPM on the LCD and on the webpage, so we can monitor it very easily. In other appliances, similar gas can be measured. Only a small number of gas detector apps are available, but in this venture IoT, large data for a lot of data and cloud technology also included a tier.

2.2 Related Works

The Climate Change & Air Monitoring System is a very common topic around the world. Already mixed-a-day air monitoring and IoT. Several real-life projects and work are being developed or are being developed on the basis of an air monitoring system based on IoT. Lots of people are working with this area. Lots of ideas have already been released about this field. We found lots of tools around us to monitor air pollution, such as devices for gas detection and provide alert or other disturbing massage. Other developed countries want to make sure their level of the atmosphere is below the cross line. As a result they are working with that kind of device and using IoT technology to get smart system. Outdoor Air Quality Monitor Using MQTT Protocol on Smart Campus Network [1]. Internet of Things (IoT) is a global "smart device" system capable of sensing, connecting to, and interacting with users and other systems. IOT Based Weather Intelligence [2]. The long-standing climate change has been largely attributed to the increased level of carbon dioxide in the atmosphere. The campus needs good air quality as a learning environment, and it needs to be monitored and handled so that academics can engage in healthy and successful activities.

Plan for Clean Air and Sustainable Environment (CASE) [3]. Air is a significant environmental element. Without it, the human being can't survive for more than a minute. Alarmingly, some anthropogenic activities are seriously polluting this crucial component of the environment, which causes great harm to human health, nature and properties.

2.3 Comparative Studies

Water is the most important need for interacting and reproducing humans and other living beings. Air consists of the necessary gasses and gasses harmful to humans, particularly humans. Air pollution is a severe and growing problem, people are looking for improved urban air quality.

The required gas should be available in sufficient quantities and not below the minimum level. The gas could disrupt the living creatures at some stage when carrying out their life activities. Because of their unpleasant and dangerous nature, the processing of these gases is known as waste. Air quality is closely linked to the amount of air gas containing both beneficial and negative gases. The air is no longer relatively clean in urban areas with a lot of construction, waste and heavy traffic. The water is exposed to a number of polluters in polluted industrial areas. Let us make no mistake, we are facing an urgent crisis. So for this, we are developing a system that has more functionality all together then most of the projects out there, besides it is also cheaper.

All the components used in this project are easily collectable from stores around us. We are using NodeMcu instead of arduino uno or raspberry pi. Node mcu is available in the market and cheap priced which also comes with a wifi module. For gas measurement, we are using almost all the MQ series sensors which are easily found in the market and very cheap in price. By combining these sensors and node mcu, we are able to store data to our online database and showing the real time data on web API. We use BIG DATA technologies to save huge amounts of data for data storage. We use cloud services such as the Google Cloud Platform (GCP) to manage nodes that send such huge amounts of data. We also provide a user-friendly php web application with graph from our computer to view real-time & analytical information.

2.4 Scope of the Problem

Climate change is the defining issue of our time and now is the defining moment to do something about it. There is still time to tackle climate change, but it will require an unprecedented effort from all sectors of society. If we buy real IP then it can accessible using the internet from anywhere in the world. The project interface is very user friendly. It’s a web application which is platform independent. That’s why this application runs on any browser in any smartphone or PCs. To build this project, we are facing some problems. One of them is sustainable power to run the device for a longer period of time. If the device is set indoors, then we can easily power it up, but if it has to be used for outdoor environment data collection, then the problem of sustainable power supply arises. the device needs a battery to run outdoors and for charging the battery without any hustle, solar energy has to be used. After the problem of power supply, here comes the problem of 24 hours internet connection. For sending the data we get from the device, we need a reliable internet connection via Wi-Fi. So a continuous Wi-Fi connection is required. Another problem we faced is the format of data. Node mcu has only one analog pin, but MQ gas sensors needs analog pins. We used so many sensors that we have to use ADS1115 to extend the analog pins for Node mcu. Because of ADS1115, the value of analog voltage from the mq sensors are a bit noisy.

2.5 Challenges

This section deals with the problems we faced during our project's growth and implementation process and the solutions we had to come up with. We faced a problem with sustainable power supply for 24 hours for our device. As solution, we are using a portable battery with the device for direct power supply for a large amount of time. To charge the battery from outdoor, a solar panel is used, so that we don't have to worry about the power supply any more. It will automatically charge itself and the device can be operable for a long time without any hampers. Now comes the problem of 24 hours internet connection. Our world is developing on network and internet day by day. Most of the places are covered in internet. It has become so easy to be connected by the internet from anywhere in the world. Wi-Fi network is mostly available everywhere, we can easily connect our device to any network and make it work. If Wi-Fi is not available, we can use GSM for the internet connection. Not but not least, the data format. As the MQ sensors provides raw analog voltage as output data, we have to use a method to convert the analog voltage reading to PPM/PPB or Percentage value. Besides the ADS1115 also puts an impact on the reading, so it has to be eliminated by calculating out the extra voltage reading it gives.

CHAPTER 3
REQUIREMENT SPECIFICATION

3.1 Software Requirements Specification

A Specification for Software Requirements (SRS) is a complete description of system behavior to be created. This includes a use case collection that defines all users ' software experiences. A Specification for System Requirements (SRS) is a complete description of the software behavior to be developed. Non-functional (or additional) SRS specifications are also available. Non-functional specifications are criteria that enforce constraints on design or development (such as performance standards, quality standards or restrictions on design).
The code specifications for our venture are summarized below.

3.1.1 Hardware Requirements

- RAM: 256 MB
- Hard drive space: 200 MB (For executing any internet browser)
- Internet Connection
- Node Mcu 8266
- MQ series gas sensors -

    MQ 2 - Methane, Butane, LPG, Smoke
    MQ 4 - Methane, CNG
    MQ 5 - Natural Gas, LPG
    MQ 7 - Carbon Monoxide Gas
    MQ 8 - Hydrogen Gas
    MQ 135 - Air Quality (NOx, CO2, O2, NH3 etc.)

- DHT22 (Temperature & Humidity)
- Dust sensor for measuring PM2.5 (particulate matter)

- ADS1115 (ADC - Analog to Digital Converter) is used to get analog reading from MQ sensors by the Node Mcu.
- GPS (Global Positioning System)
- Vero Board
- Rechargeable LIPO (3cell, 1550mah) battery is used as power supply unit, and buck module is used to supply power to the circuit as per power requirement.
- Solar panel is used for charging the battery as a renewable energy.
- Adapter (5v, 3v)

3.1.2 Software Requirement

- Arduino IDE (Uploading Code)
- TeraTerm (software for saving the reading directly as a CSV file, for storing and showing data in Microsoft Excel sheet)
- Any kinds of Internet Browser (Google Chrome, Firefox, Opera Mini Browser, Internet Explorer, etc)
- Thing Speak as web application for showing real time graph.

3.1.3 Functional Requirement

- Controlling all electrical appliances
- Monitoring the air quality
- Decrease the waste of electricity
- Renewable power energy (Solar)

3.1.4 Non Functional Requirement

- Secured system
- Better design and less complexity

3.2 System Model

The case diagram below illustrates the client or automation function. The nodes / users sends the data to the server using sensors in this process and then the server takes the next step according to the signal of the client. The server also sends the details through the Big Data. Model shown in figure 3.2.

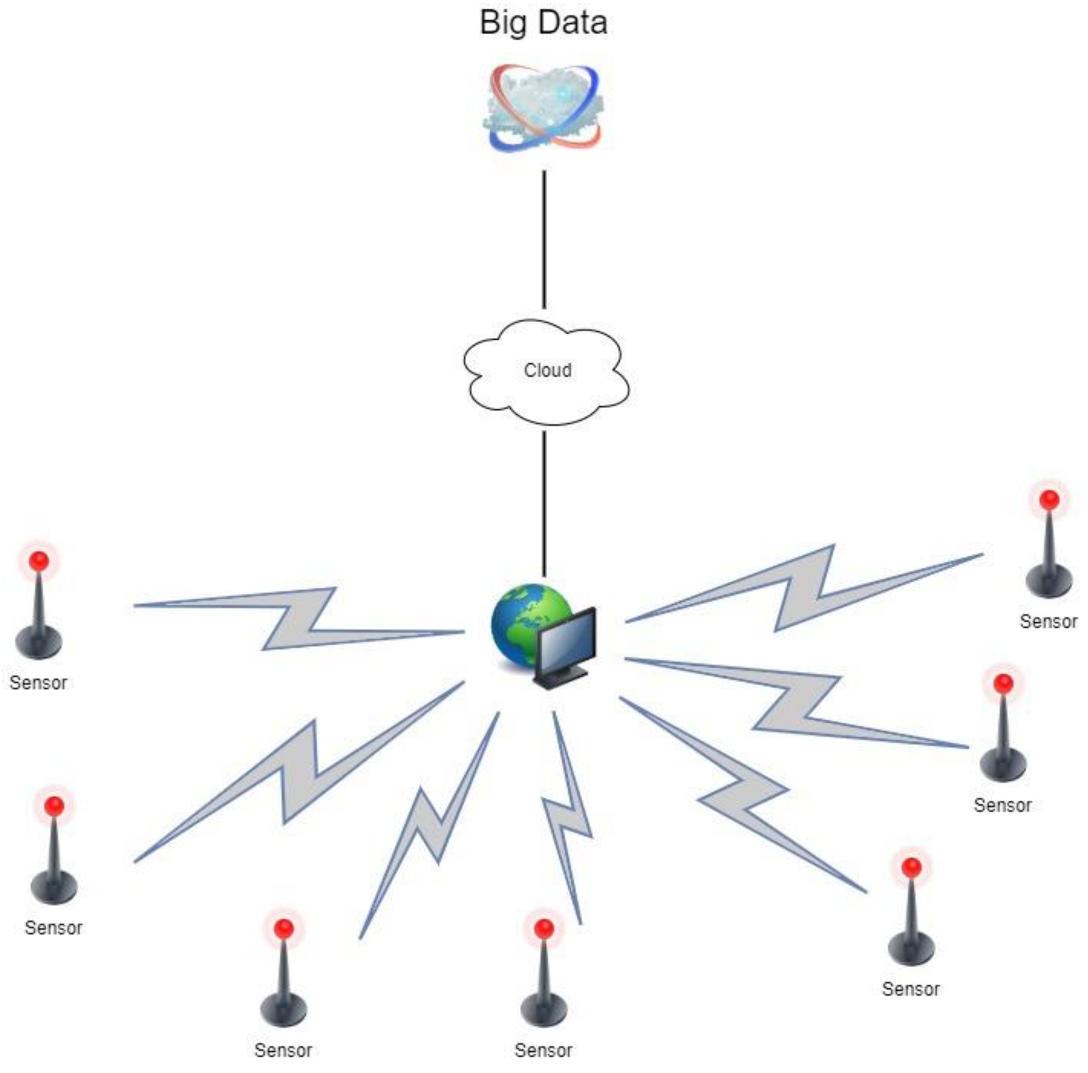

Figure 3.2: Sensor Node System Model

3.3 Logical Data Model

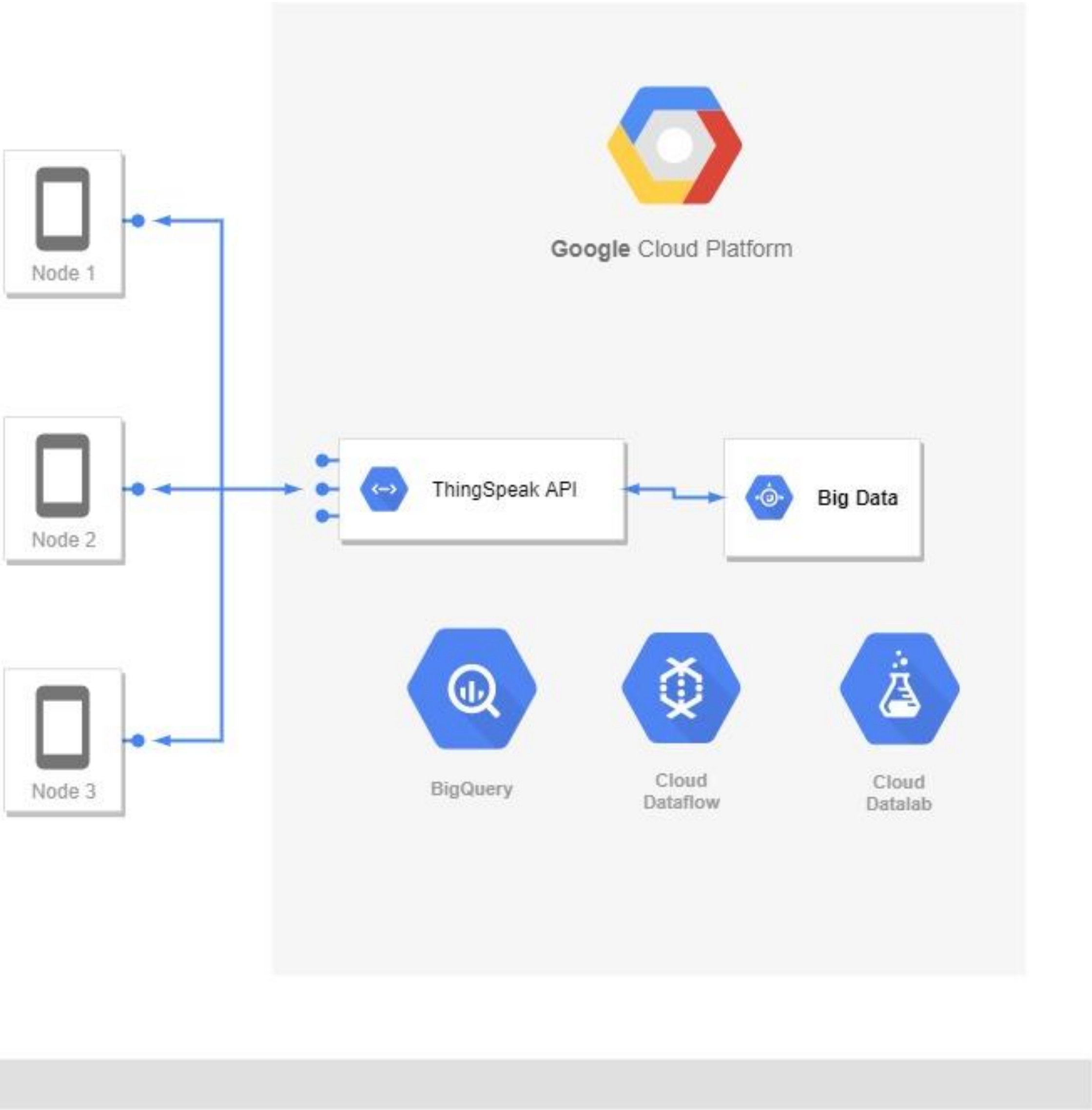

Figure 3.3: Logical Data Model for visualization Data

Logical data model basically the process of full system. Node sends the data and first stage it store on Thing Speak cloud based database. Then we need that data for our project goal. So we are again store the data in our BigData account, calculate on our own Cloud account. Thing Speak API mainly work here for data transform. Figure 3.3.

3.4 Data Collection Procedure

The machine is initially operated by the battery and sends data to the Thingspeak website immediately where the data is displayed on the map. The sensors start to work when the system is switched on. If any gas enters the sensor, it burns and the sensor gives an analog value to the output. In order to speak items, this value is then sent and shown on the map. Every sensor data are shown in various graphs. The graph shows the stamps of the time and date. We can upload the data to CSV, JSON format thingspeak. From minute to minute or even hours and days, we can get details. To escape data collection, all we need to do is turn off the system's power. Shown in figure 3.4.

Export recent data ×

Air Monitoring Syetem Channel Feed:	JSON XML CSV
Field 1 Data: Smoke level	JSON XML CSV
Field 2 Data: Methen (CH4) level	JSON XML CSV
Field 3 Data: Natural Gas level	JSON XML CSV
Field 4 Data: Carbon Monoxide (CO)	JSON XML CSV
Field 5 Data: CO2,NOX and air quality level	JSON XML CSV
Field 6 Data: Temperature level	JSON XML CSV
Field 7 Data: Humidity level	JSON XML CSV

Figure 3.4: Thing Speak Data Collection (Export)

3.5 Implementation Requirements

- Node Mcu 8266 (Arduino + WiFi Module)

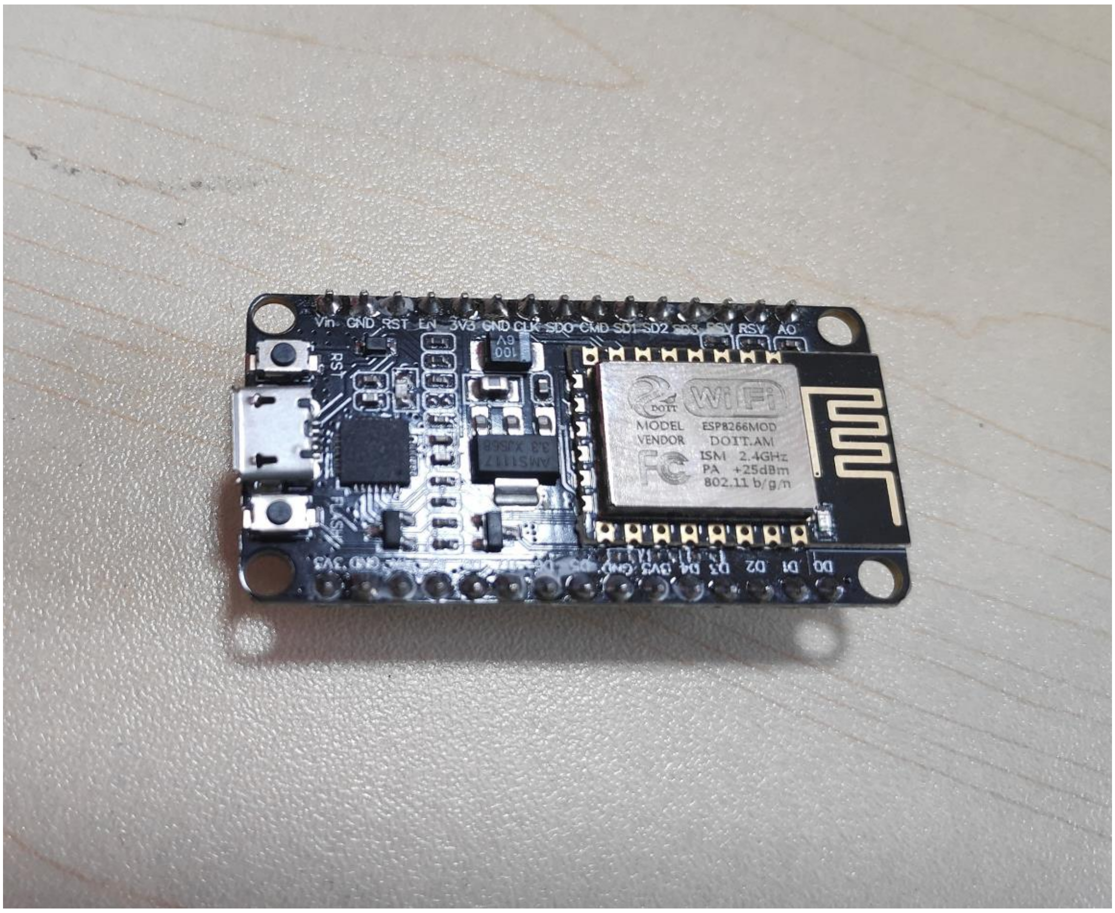

Figure 3.5: NodeMcu 8266 (Arduino + WiFi Module)

- MQ series gas sensors -

  MQ 2 - Methane, Butane, LPG, Smoke

  MQ 4 - Methane, CNG

  MQ 5 - Natural Gas, LPG

  MQ 7 - Carbon Monoxide Gas

  MQ 8 - Hydrogen Gas

  MQ 135 - Air Quality (NOx, CO_2, O_2, NH_3 etc)

- DHT22 (Temperature & Humidity)
- Dust sensor for measuring PM2.5 (particulate matter)

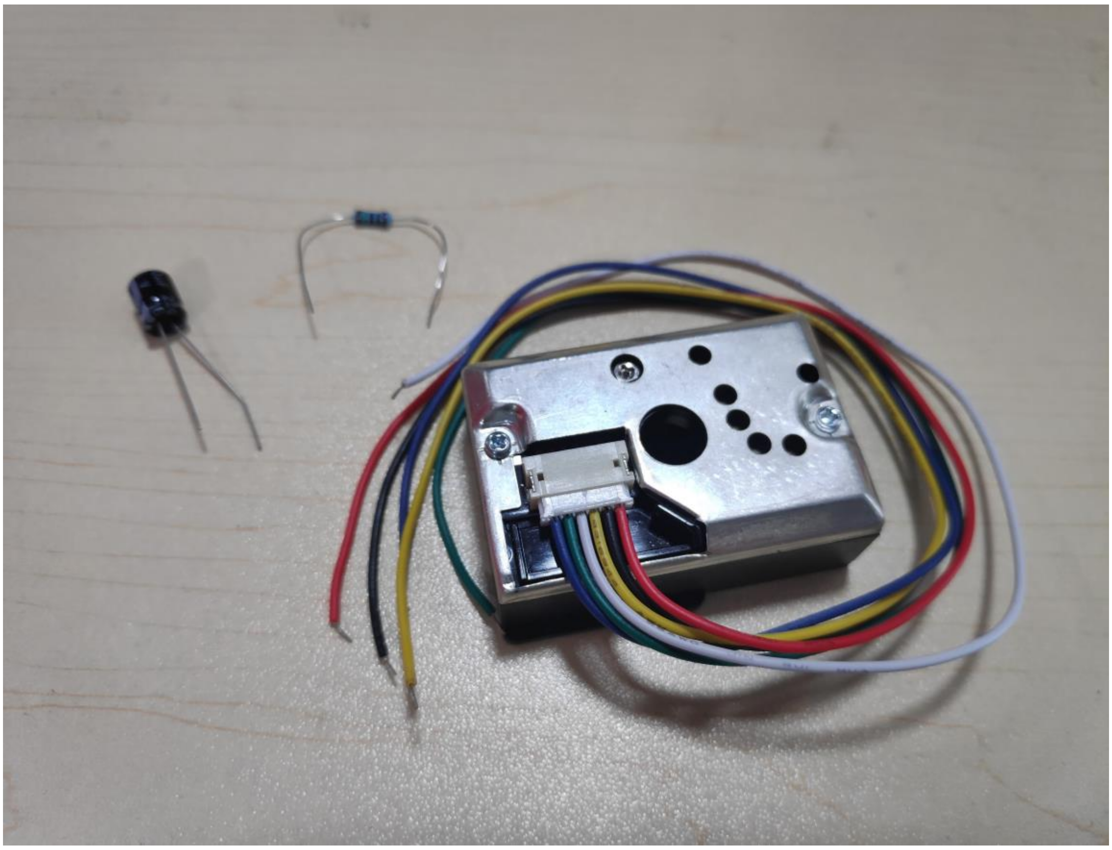

Figure 3.5.1: Dust sensor for measuring PM2.5 (particulate matter)

- ADS1115 (ADS - Analog to Digital Converter) is used to get analog reading from MQ sensors by the NodeMcu.

- GPS (Global Positioning System)

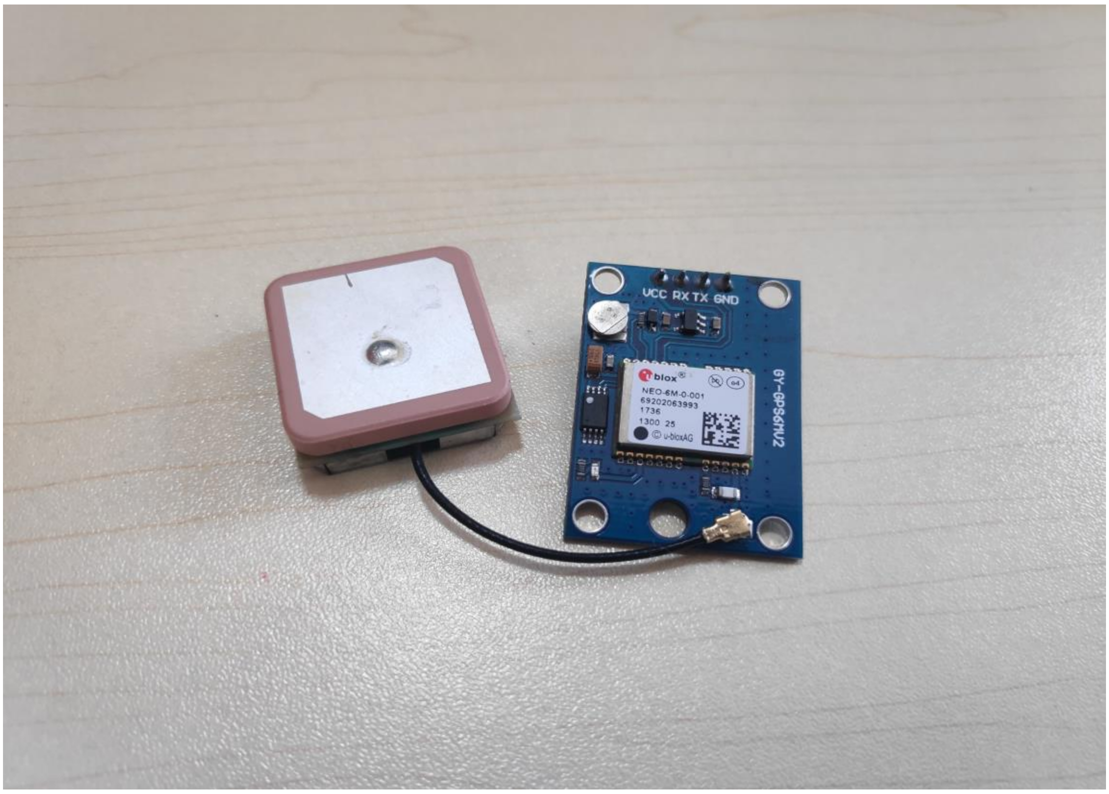

Figure 3.5.2: GPS (Global Positioning System)

- Vero Board
- Rechargeable battery is used as power supply unit, and buck module (figure 3.5.3) is used to supply power to the circuit as per power requirement.

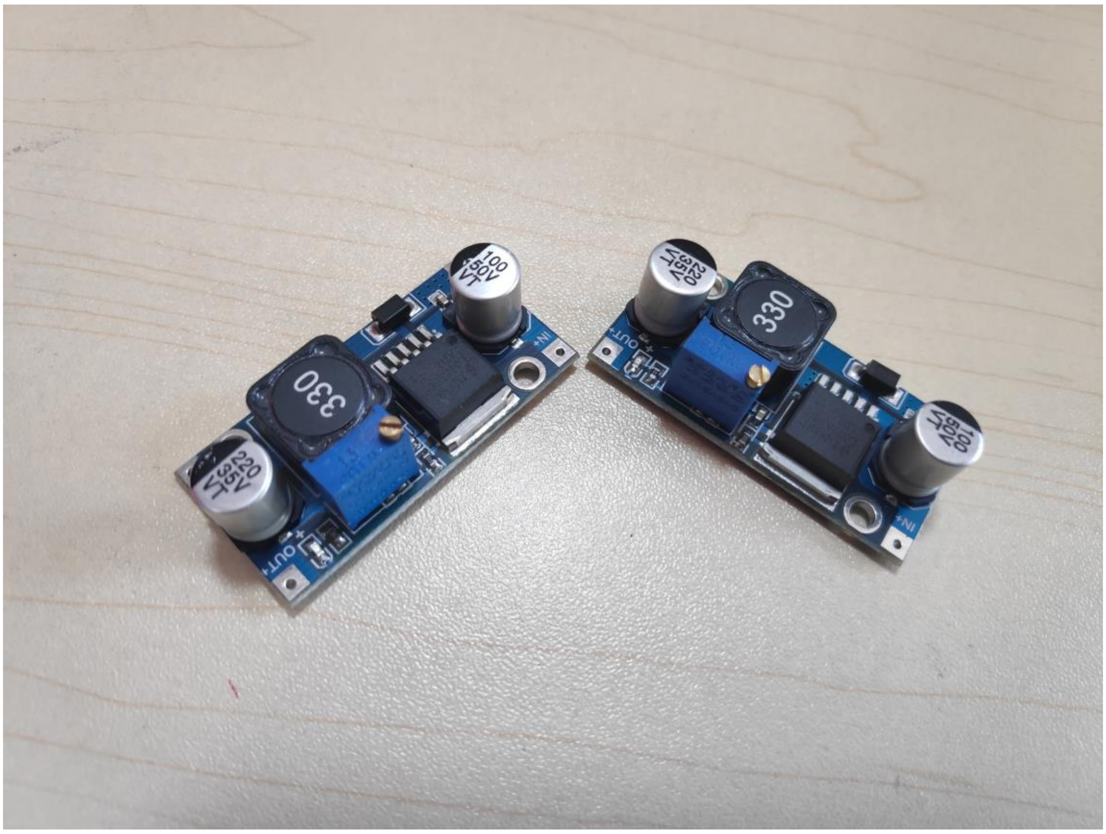

Figure 3.5.3: Buck Module

- Solar panel (20W) is used for charging the battery as a renewable energy.
- Adapter (5v, 3v)

Developing Tools:

- Arduino IDE
- Breadboard
- Wire

Language:

- Embedded programming.
- PHP, HTML and CSS (For designing web application)

Technical:

- Mobile/Computer

- Internet browser
- Internet Connection

Non-Technical:

- Users

CHAPTER 4
DESIGN SPECIFICATION

4.1 Device Design

The device has a box's shape. There is connection between all sensors, microcontrollers, vero boards and all. It has different compartments and sensors for the battery and circuit board. In the lower compartment are the battery and the circuit board and sensors.The battery is in the lower section and the boards and detectors are right above the panel. Which can be inserted in and out easily. Fuel sensors are mounted on one side and dust and humidity sensors are positioned on the other side.

4.2 Controlling Sensors

The battery uses the buck unit to support 5 volts on the deck. The ground and vcc pins were mounted serially on the deck to control the sensors. The buck module is used to provide NodeMcu with 3.3 volts. When the power switch of the device is activated, the sensors are all powered by 5 volts and the node mcu is instantly powered by 3 volts. The NodeMcu then reads the sensor data of each sensor and begins to send data to the database.

4.3 Controlling Power Supply

The power unit consists of a 12.5 volt battery. Two buck module is used individually to supply 3.3 volts and 5 volts. One provides 3.3 volts for the NodeMcu and the other provides 5 volts for their power to the sensors.

4.4 Parts list with Cost Estimation

A lot of components are used in this project. Some are only listed here with the value. To reduce costs, they use goods sold in local shops with relatively low costs but also good and reliable products. Price shown in table 4.4.

Table 4.4: Table of Parts list with Cost Estimation

	Components	Price
1	Node Mcu 8266 (Arduino + WiFi Module)	250 Taka
2	MQ series gas sensors	1000 Taka
3	DHT22 sensor	500 Taka
4	Dust sensor	650 Taka
5	ADS1115	700 Taka
6	GPS	700 Taka
7	Vero Board	200 Taka
8	Rechargeable Battery	1600 Taka

4.5 Implementation Requirements Design

The device has a box shape, shown in figure 4.5. There is a link between all sensors, microcontrollers, vero board and all. It has various compartments and sensors for the battery and circuit board. In the lower compartment are the battery and the circuit board and sensors.The battery is in the bottom section and the boards and controls are just above the table. Which can easily slide in and out. On the one hand, gas detectors are as usual, and on the other hand, dust and humidity sensors. The battery serves 5 volts on the deck using the buck unit. The ground and vcc pins were mounted serially on the board to control the sensors. Another buck module is used to supply 3.3 volts to NodeMcu. When the power switch of the system is activated, the sensors are all powered by 5 volts and the node mcu is powered by 3 volts immediately. The node mcu then reads the sensor data of each sensor and starts to send data to the database. Two buck modules are used separately to deliver 3.3 volts and 5 volts. One provides 3.3 volts for the Node mcu and the other provides 5 volts for their power to the sensors.

Figure 4.5: Implementation Requirements Design

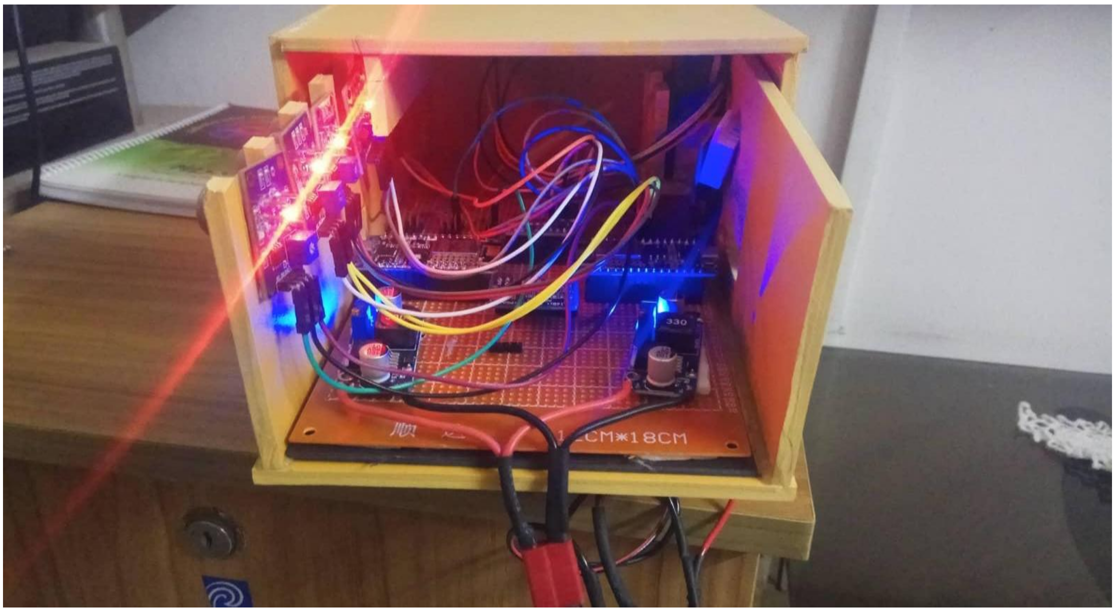

Figure 4.5.1: Implementation Requirements Design

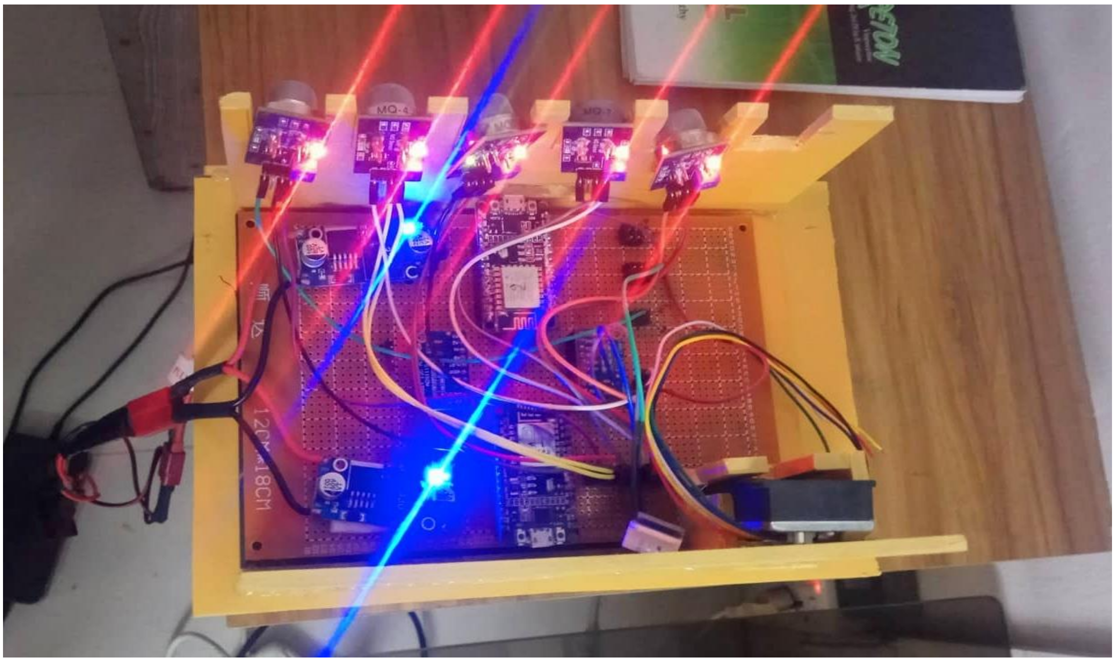

Figure 4.5.2: Implementation Requirements Design

CHAPTER 5
IMPLEMENTATION AND TESTING

5.1 Implementation of Database

In this project, a database is mandatory. As the air quality, dust and gases are being monitored, the data we are getting must be stored and shown. So a database is so important. Big Data is being used for storing the massive amount of data (figure 5.1). To handle, analysis and visualisation, Big Data is the perfect technology at this time. when a project have main goal is create or produce dataset, then that project must have a strong database. We already introduced BigData, Google Cloud Platform (GCP) and other new technology. So we are trying to work this kind of new technology.

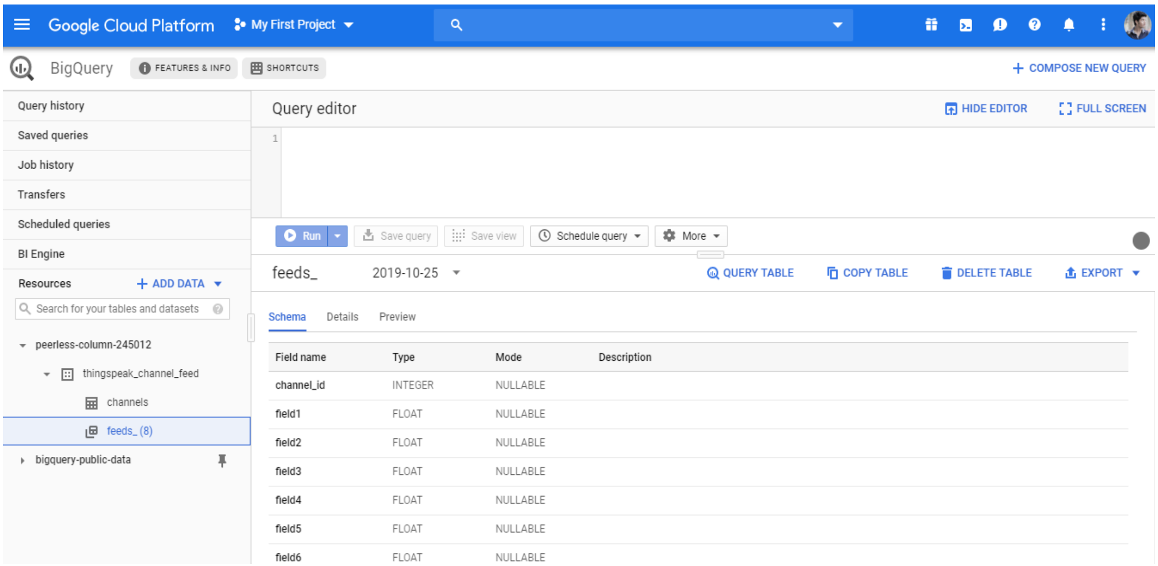

Figure 5.1: Implementation of Database (Big Data GCP)

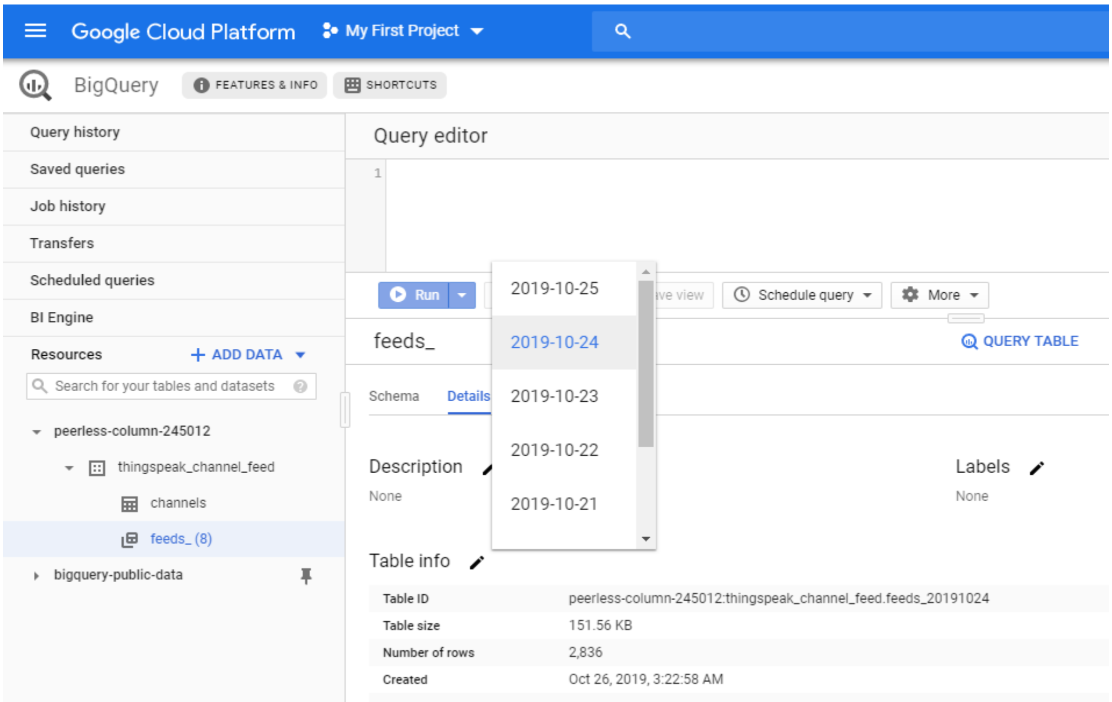

Figure 5.1.1: Implementation of Database (Big Data GCP)

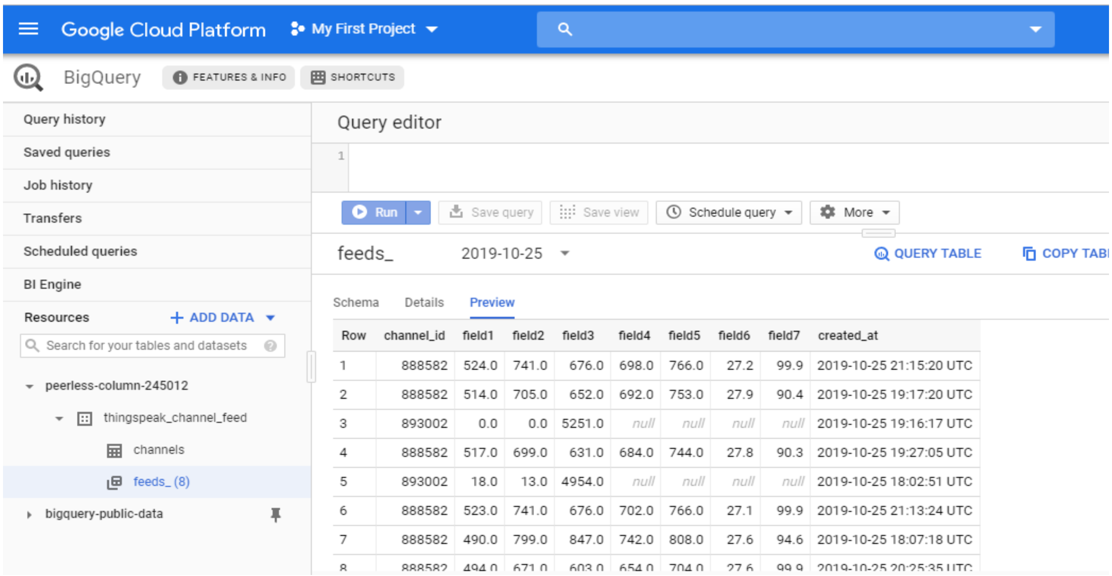

Figure 5.1.2: Implementation of Database (Big Data GCP)

Big Data is being used for storing the massive amount of data. To handle, analysis and visualisation, Big Data is the perfect technology at this time.

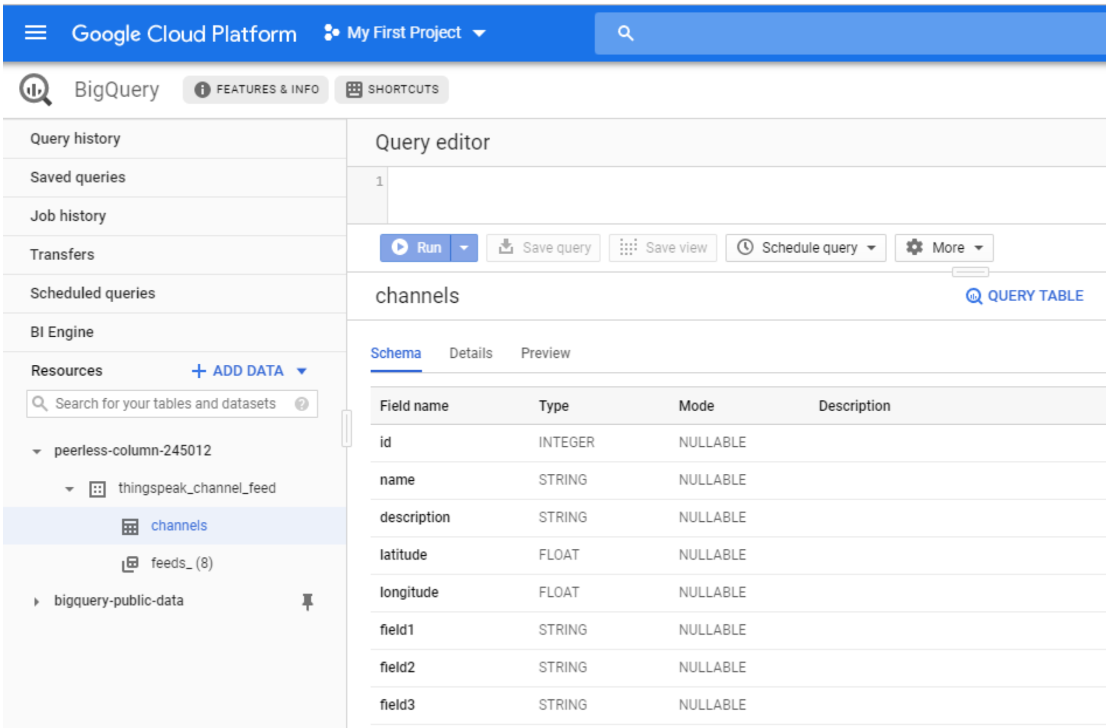

Figure 5.1.3: Implementation of Database (Big Data GCP)

The sensors begin to work when the machine is turned on. If any gas enters the sensor, the sensor will burn and the output will be given an analog value. That quality will then be sent and shown in order to speak on the map. Each sensor data is displayed in various charts. The diagram shows the time and date stamps. We can download the data to Thing speak in CSV, JSON format. We may obtain information from minute to minute, or even hours and days. If we want to avoid the collection of data, all we need to do is just turn off the electricity of the system.

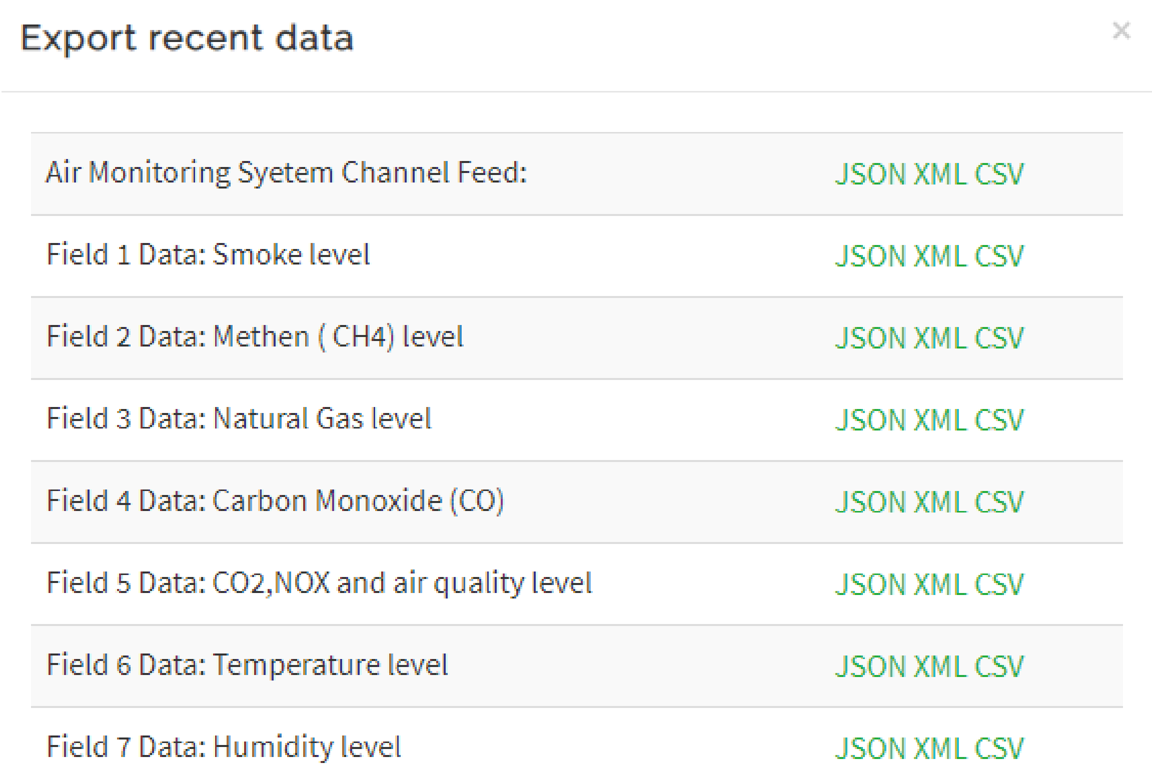

Figure 5.1.4: Implementation of Database (Thing Speak)

5.2 Implementation of Front-end Design

To view the data, a web application is developed (figure 5.2). Here you can see all the details we get from the process. Individual graphs show the smoke, CO, CH4, temperature, moisture, etc. measurement. The unit of gas is the ppm. The data will also be shown in graphs and numbers. The map displays the correct tag for each data in different colors so the graph can be easily understood. To understand the gas and humidity temperature relational behavior, each object information is displayed differently as well as in one map.

Figure 5.2: Climate Saver Home Page Design

5.3 System Testing

All the hardware and software component testing screenshot and camera photograph attached below. If we don't insert a Google ID, Gmail it will not open the web application just open this page again. There's only one way to connect the computer to the network, and the internet connectivity code changes. So when it's all right, board the light on and send the data to thing speak. Then our private server will have access to the storage of that information.

System testing, or end-to-end testing a completely integrated system to verify that it meets its requirements. The System testing result shown in table 5.3:

Table 5.3: Table of System Testing

Test Case	Expected Result	Observed Result	Test Result
User should have successful login this system	Successful login	Successfully login	Pass
User can easily access the Environment switch	Accessible every menu	Easily accessible	Pass
User can control the electrical appliance	Easily controllable	User controlled	Pass
User can see the gas status	Can see the current Environment status	Easily visible home status	Pass
User Can Data diagram service	User can control data service	User can control data show service	Pass

5.4 Authentication Testing

Authentication testing is a process to access the web application to visualization. There is also a process it calls Google oauth. and it's all about authentication testing. Figure 5.4.

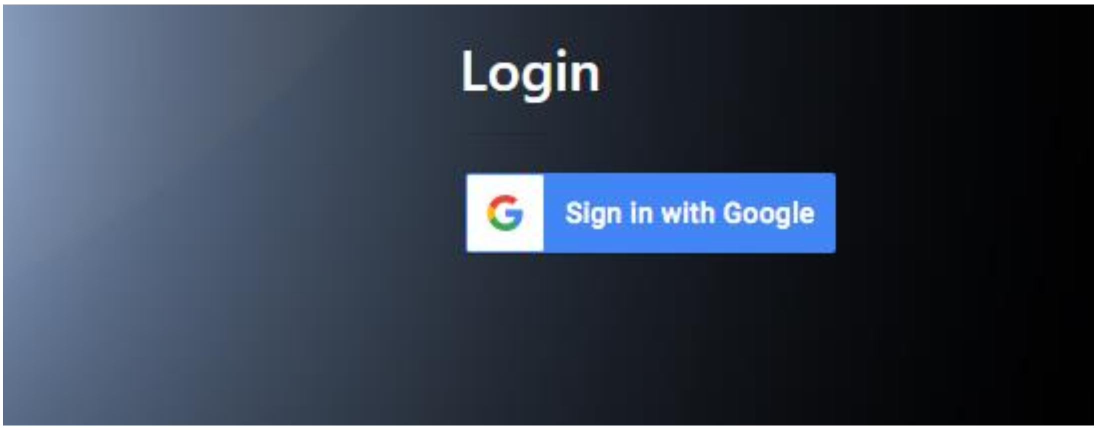

Figure 5.4: Climate Saver Web Application Authentication Testing

5.5 Component Testing

All the hardware and software component testing screenshot and camera photograph attached below. If we don't insert a Google ID, Gmail it will not open the web application just open this page again.

5.5.1 Sensors Testing

MQ 2 - Methane, Butane, LPG, Smoke

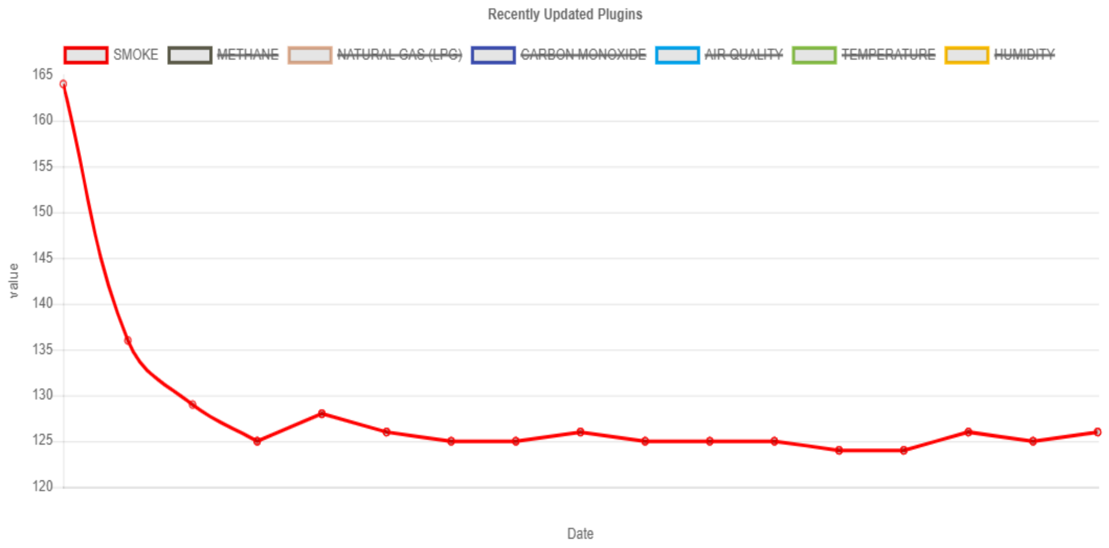

Figure 5.5.1: Graph of Smoke Sensor (MQ2) from Climate Saver

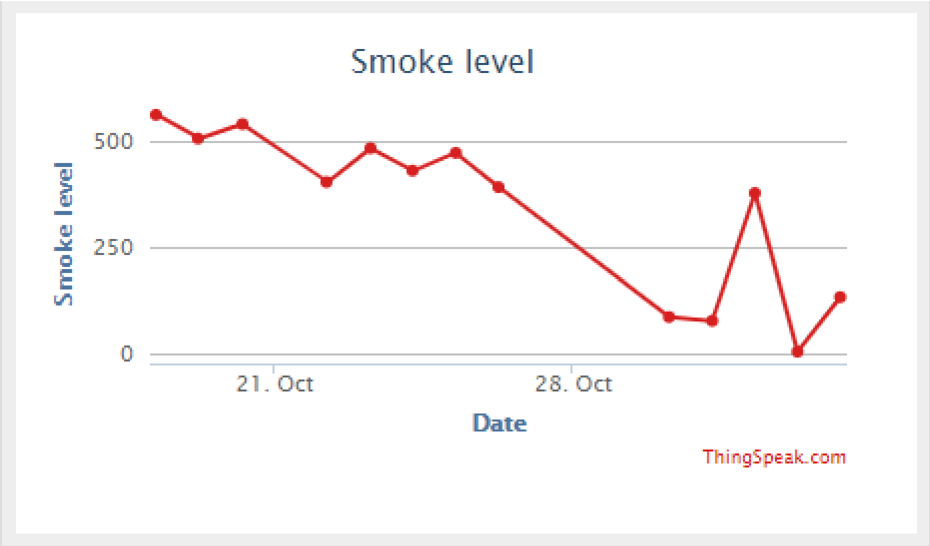

Figure 5.5.1.1: Graph of Smoke Sensor (MQ2) from Thing Speak

MQ 4 - Methane, CNG

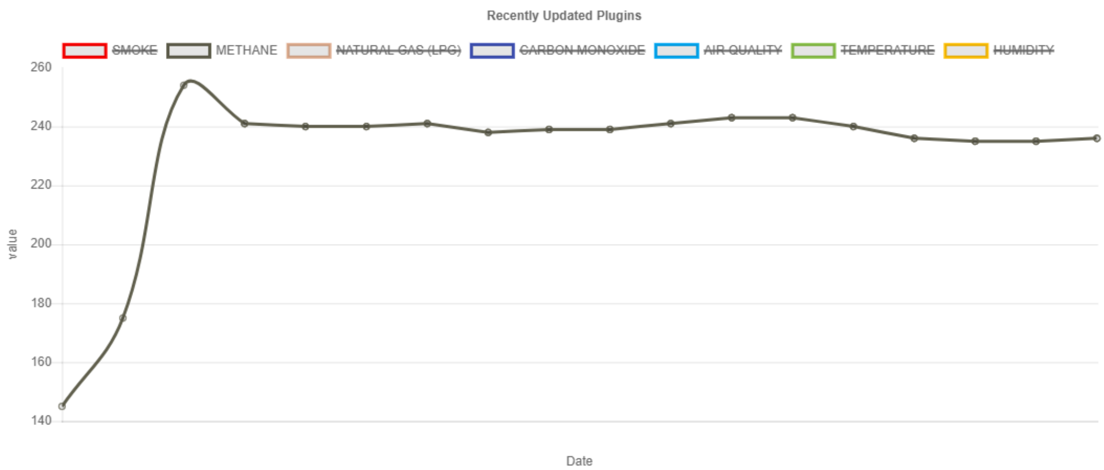

Figure 5.5.1.2: Graph of Methane Sensor (MQ4) from Climate Saver

MQ 5 - Natural Gas, LPG

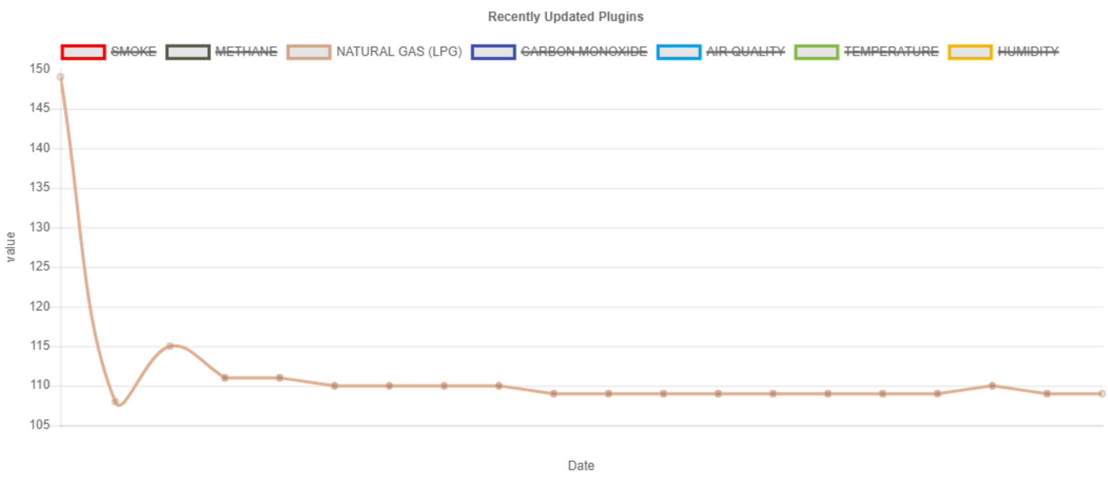

Figure 5.5.1.3: Graph of Natural Gas Sensor (MQ5) from Climate Saver

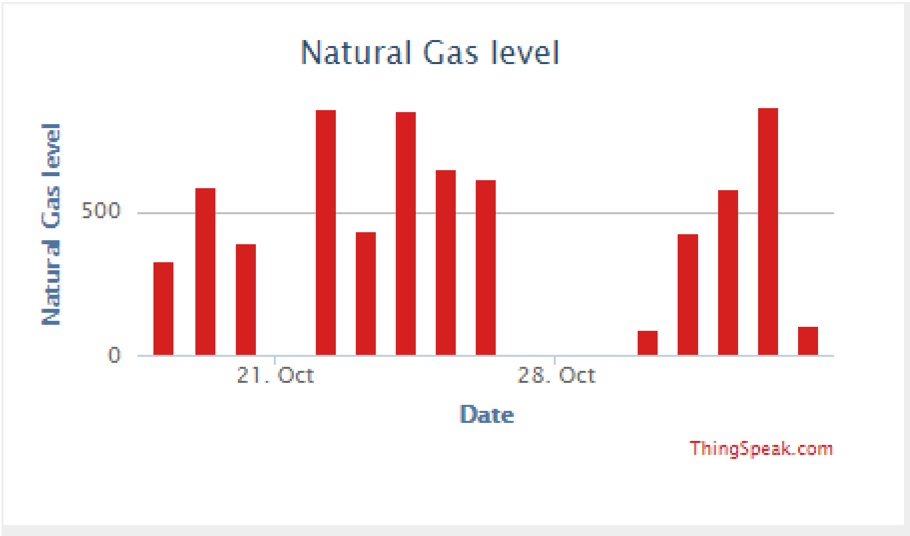

Figure 5.5.1.4: Graph of Natural Gas Sensor (MQ5) from Thing Speak

MQ 7 - Carbon Monoxide Gas

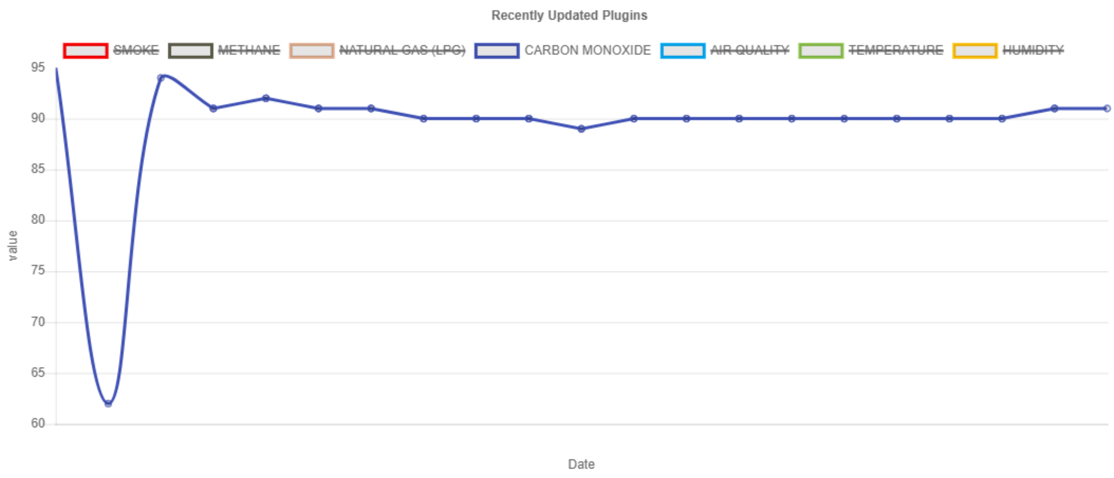

Figure 5.5.1.5: Graph of Carbon Monoxide Gas Sensor (MQ7) from Climate Saver

MQ 135 - Air Quality (NOx, CO2, O2, NH3 etc)

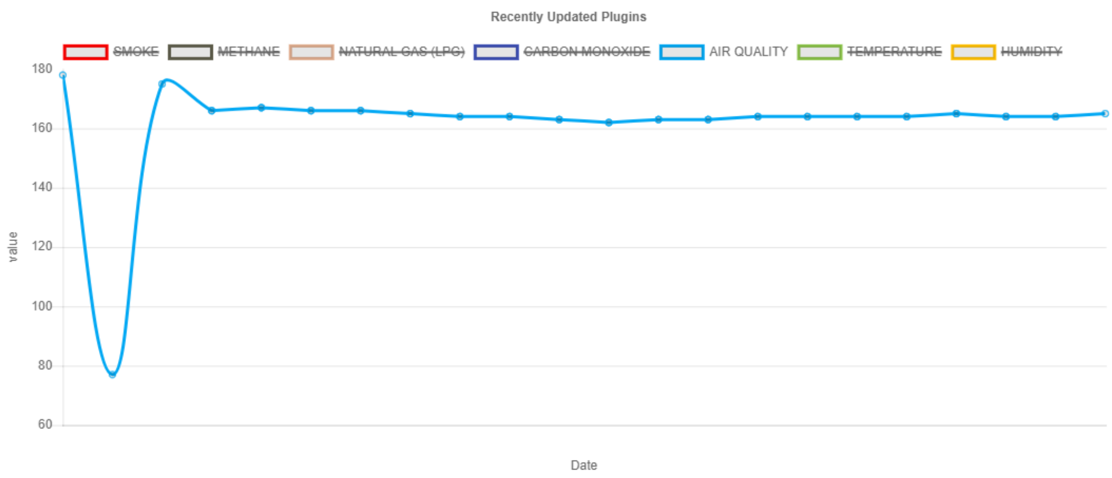

Table 5.5.1.6: Graph of Air Quality (MQ135) from Climate Saver

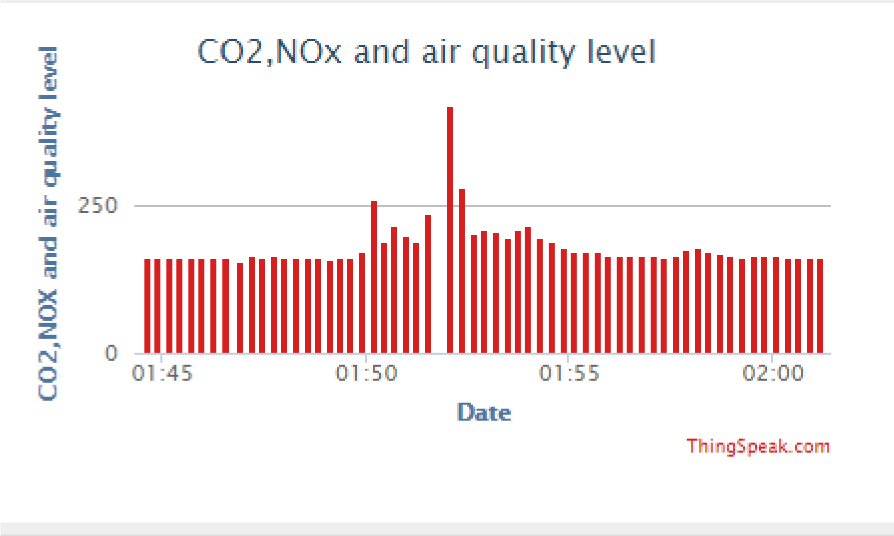

Figure 5.5.1.7: Graph of Air Quality (MQ135) from Thing Speak

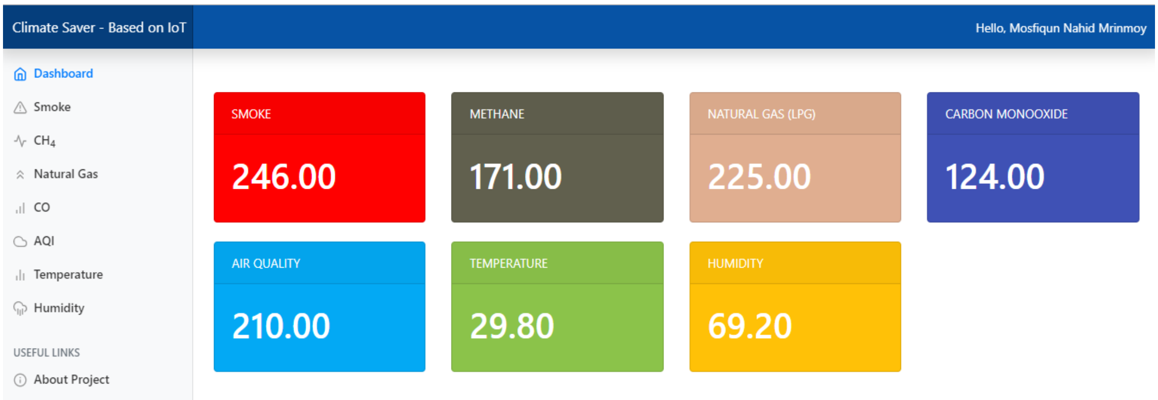

Figure 5.5.1.8: Data to Graph Generate from Climate Saver

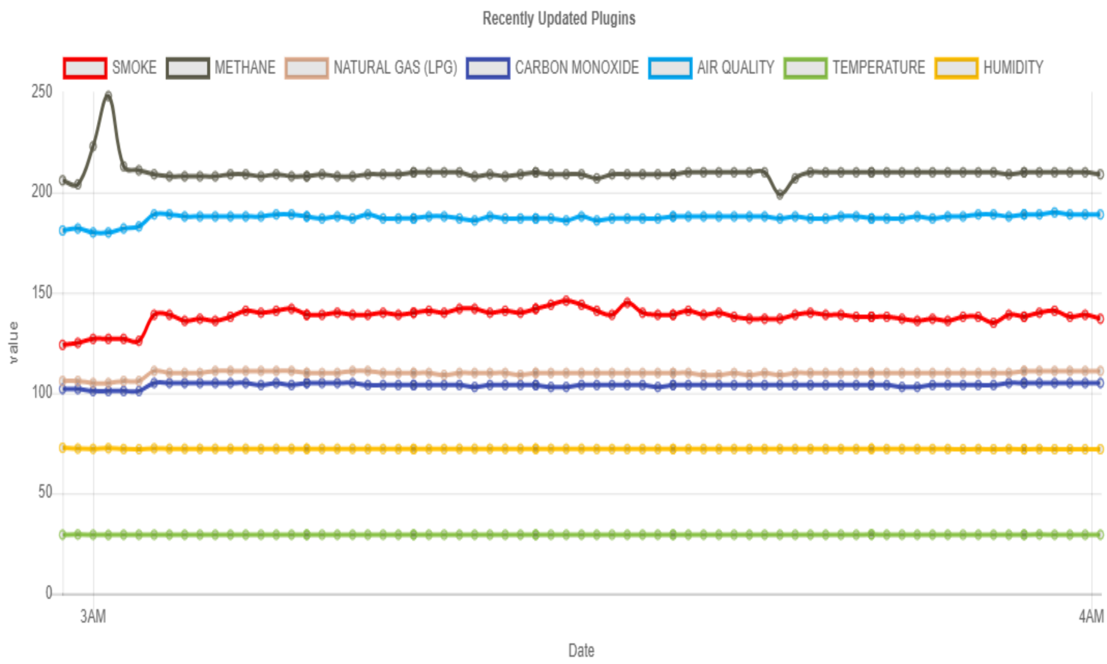

Figure 5.5.1.9: Data to Graph Generate From Climate Saver

5.5.2 Power Supply Testing

The most challenging part is the power supply to this complex project. Thanks to 24 operation and collection of data. If there are any bugs, the whole system will collapse. So we have to make sure that there are many means of generating power and internet. Three forms of power supply were designed for our venture. 12V power supply converter, battery backup & solar panel to provide electricity in any area within 24 hours. So our project goal is to set up our rural area unit, we need to make sure there is electricity.If this is not possible, we have another alternative such as the Solar Panel for renewable energy. It may be possible to generate sufficient energy to supply power to our devices.So that's and obvious that not a big issue is our power supply. We can manage many ways to connect our system to electricity in order to obtain power and to carry out its process of working. When the device absorbs power from the unit of the power supply, the LED light is on.

5.5.3 Internet Connection Testing

Internet of Things (IoT) system needs a connection to the Internet. It doesn't become an internet-free IOT tool. This should be an embedded device first and connect to the internet afterwards. It turns out to be a tool for IOT. So we need to ensure access to the internet. We operate with NodeMcu, and there is a law of such code. Some code for internet connectivity, API code, etc. So there is the possibility of disconnecting its nearby wifi area when we move our device. This requires a new username and password for wifi. It is therefore not possible at this point to fix this problem by sending input outside via the keypad. There's only one way to connect the computer to the network, and the internet connectivity code changes. So when it's all right, board the light on and send the data to thing speak. Then our private server will have access to the storage of that information.

5.5.4 Visualization Testing

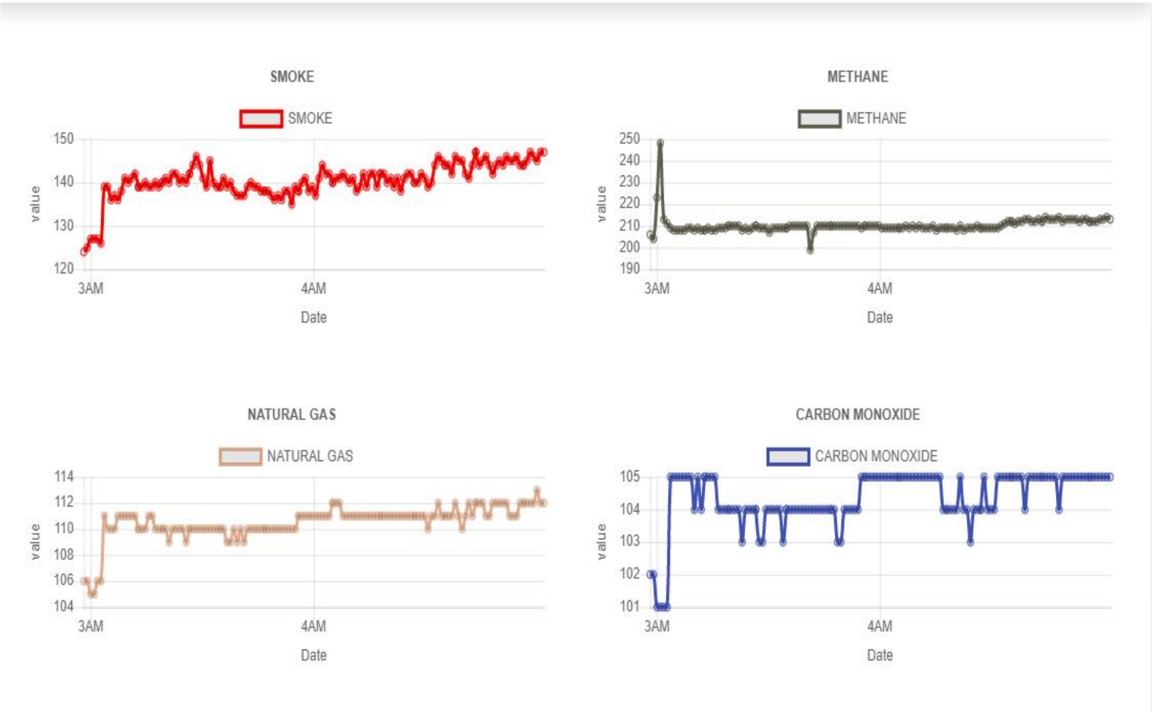

Figure 5.5.4: Data to Graph Visualization Smoke, Methane, Natural Gas & CO Gas

Individual graphs show the smoke, CO, CH4, temperature, moisture, etc. measurement. The unit of gas is the ppm. The details will also be shown in graphs and numbers. In the graph, each data is displayed in different colors with the correct tag so that the graph can be easily understood. Shown in figure 5.5.4.1.

Figure 5.5.4.1: Data to Graph Visualization Natural Gas & CO Gas vs Air Quality & Temperature

5.6 Test Results and Reports

The sensor data we collect from the system is shown directly in different charts on Thing speak. The PPM format of the sensor values is shown. Then in our article, the data from thing speak is shown in various graphs and tables. Reading the thing speak API and then displaying it on our website will achieve this. These data will, however, be stored in our Big Data program. You should login to our website by completing the process for Google Oauth to display data visualization from the data collected.

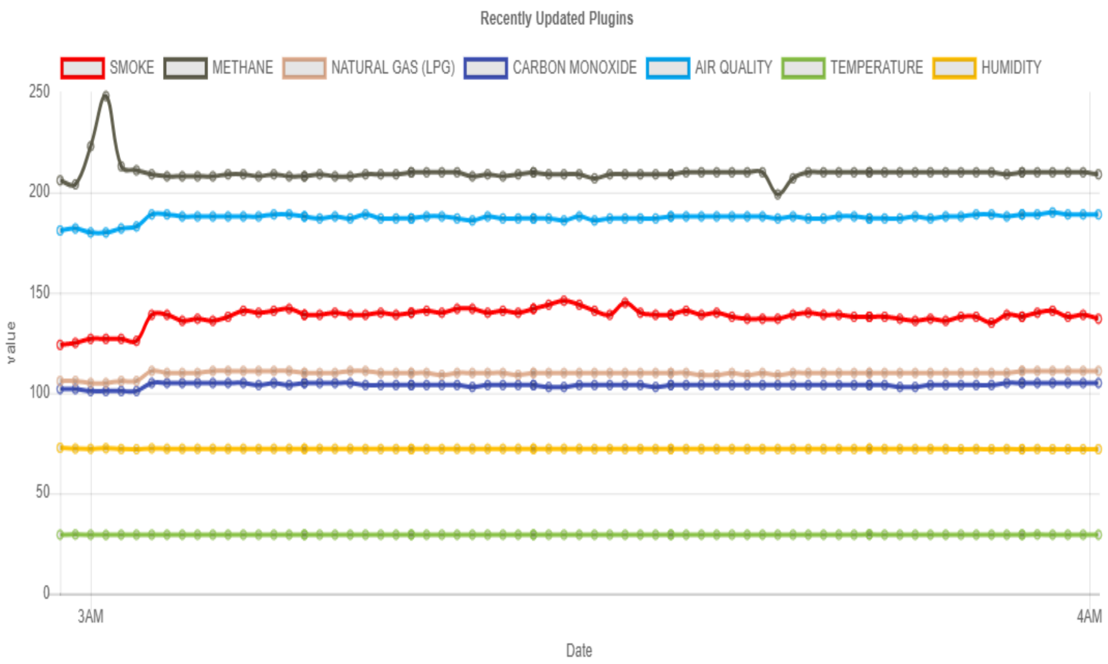

Figure 5.6: All Sensors Data Graph

The dashboard page will then appear where each sensor data is shown in different fields and graphs as well as a composite data graph to understand the behavior of the device's environment data shown in figure 5.6.1.

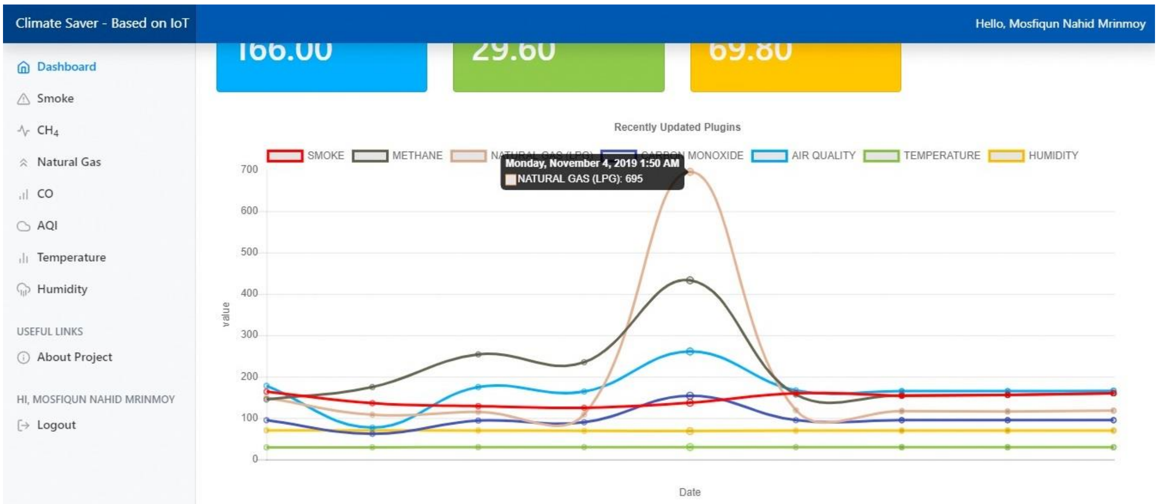

Figure 5.6.1: All Sensors Data Graph

CHAPTER 6

EXPERIMENTAL RESULTS AND DISCUSSION

6.1 Introduction

Individual graphs show the smoke, CO, CH4, temperature, humidity, etc. measurement. The levels of gas are ppm. The data will also be shown in graphs and numbers. These information is shown in different colors in the graph with the right label so the graph can be easily understood.

6.2 Experimental Results

The central indoor experiment was carried out. The sensor reads the indoor environment by its location. Changes in the artificial environment are made to play with the sensor data by leaking smoke, burner LPG fuel, etc. The values we derive from the sensors thus differ from the normal state and fluctuation of information is shown in real time in fig- 6.2.

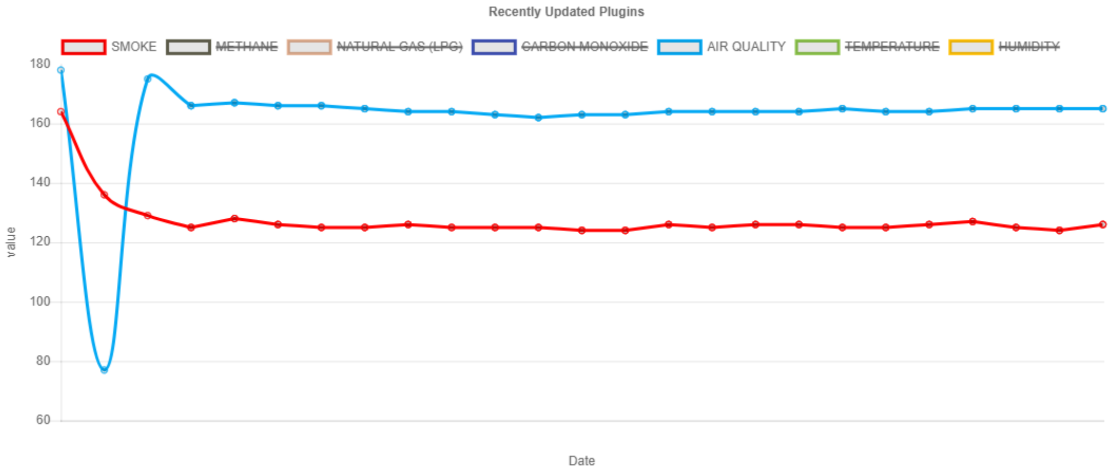

Figure 6.2: Smoke vs Air Quality Graph Data

When smoke is released, it is immediately detected and displayed by the MQ2 sensor. If any gas escapes from the furnace or gas tank of MQ4, it is immediately detected by MQ135 and shows the PPM value in real time. The sensor DHT22 is effective in measuring temperature and humidity.

When all these data are shown in the chart together, we can understand the gas activity depending on the relative humidity and temperature. The dust sensor is used in micrograms per meter cube of air to measure the dust density. GPS sensor detects latitude and longitude when the system works outside, so that the exact location makes the environmental status understandable.

6.3 Descriptive Analysis

All the sensors, microcontrollers, vero board and everything are linked together in the boxed-shaped unit. It has various battery and circuit board compartments and sensors. The battery and the circuit board and sensors are housed in the lower compartment. The battery is in the lower compartment and the boards and controls are right above the compartment. This can easily slide in and out. Gas detectors are serially positioned on one side and on the other side are the dust and humidity sensors. In this way, a lot of components are put in a standard size box that takes up so much space. The most challenging part is this complex project's power supply. Because of 24 processes and information collection. If there are any bugs, the entire system will completely collapse. So we have to make sure that there are many ways of gathering power and internet. Three types of power supply are arranged for our project. 12V power supply adapter, battery backup & solar panel to supply electricity in any area within 24 hours. So our project goal is to set up our rural area unit, we need to make sure there is electricity. If this is not possible, we have another choice, such as the Solar Panel for renewable energy. Sufficient energy can be produced to supply our devices requiring power. So that's so clear that not a big issue is our power supply. We can manage lots of possible ways to connect our device to electricity to get power and carry out its working process. When device get power from power supply module, then LED light on. The sensor data we collect from the unit is shown directly in different graphs on Thing speak. The PPM format of the sensor values is shown (figure 6.3).

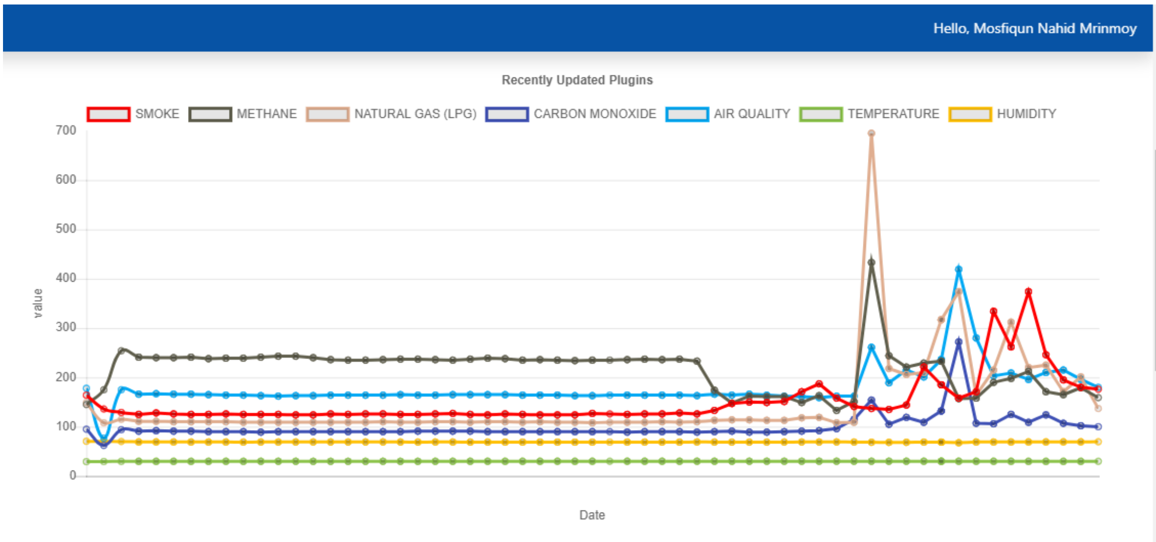

Figure 6.3 : All Sensors Data Graph in Unstable Environment

Then the data from thing speak are shown in different graphs and tables in our website. It is done by reading the API of thing speak and then showing those data to our website. In the meantime, these data are being saved in our Big Data system. To watch data visualisation from the collected data, one has to login to our website by completing Google Oauth process. Then the dashboard page will appear where every single sensor data are shown in different fields and graphs as well as combined data graph to understand the behavior of the data of the environment around the device.

CHAPTER 7

SUMMARY, CONCLUSION AND IMPLEMENTATION FOR FUTURE RESEARCH

7.1 Summary of the Study

Climate is now the most important issue in the world, we need to take the necessary steps as quickly as possible. Therefore, tracking climate change and the creation of data sets is very important. This project is a reflection of this thought. To monitor the environment, various gas sensors, temperature, humidity, air pressure sensors are used. Those data are then shown online and in charts, which are data from the computer in real time. These data are processed in our Big Data infrastructure for the production and evaluation of the dataset.

7.2 Conclusions

This Environment Monitoring System is made from low-cost components that are available and can be used to monitor over hundreds of environment apps. This system can be easily adjusted in any room indoors or outdoors. The designed environmental monitoring system has been tested several times and different controls have been successful. Last but not least, this home automation device can also be introduced via Bluetooth, Infrared and WiFi networking without much design change and yet still be able to control a range of home appliances. This system is therefore flexible and scalable.

7.3 Implication for Future Study

The Internet of Things (IoT) is currently a very potential and increasing part of technology. The era of science and technology is the 21st century. If we can combine all IoT elements to track and collect data for our country or any place using IoT-based devices, then facing the climate challenge can be a very powerful weapon.
We have a wide scope to develop and work with this venture in this phase. We are trying to list a project that will be added in the future.

- Add more sensitivity sensors to detect more precise and ideal measurement.
- More cost-effective sensors and low-cost products for every person with simple system implementation.
- We can make it more user friendly to the web application.
- We can also provide users with a mobile application.
- Can make a prediction from the data collected.
- Voice command code adding such safety issues, such as when gas leakage or smoke is detected by the system, automatically takes the appropriate measures to reduce damage.

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