“Air Quality Monitoring System”

A Report on

Submitted in partial fulfillment of the requirements

For the degree of

Master of Computer Applications

By

Akshay Kumar CP (1BM16MCA05)

Prabhu D (1BM16MCA26)

Under the guidance of

Prof. Dr. Vijayakumar K

BMS College of Engineering

Bull Temple Road, Bangalore – 560019

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Table of Contents

Contents

ABSTRACT

The level of pollution is increasing rapidly due to factors like industries, urbanization, growing in population, vehicle use which can affect human health. IOT Based Air Pollution Monitoring System is used to monitor the Air Quality by using Internet. It will trigger some indication on web page when the air quality decrease a certain level, some of the harmful gases present in the air like CO2, smoke, alcohol, benzene, NH3 and NOx.

The system uses MQ135 sensor for monitoring Air Quality as it detects most harmful gases and can measure their amount truthfully.

In this project we develop an IOT based Air Pollution Monitoring System in which we will monitor the Air Quality over a web server using internet and will trigger an lamp indication when the air quality goes down beyond a certain level, means when there are sufficient amount of harmful gases are present in the air. It will show air quality in PPM on the webpage so that we can monitor it very easily. In this IOT project, one can monitor the pollution level from anywhere using your computer or mobile.

1. INTRODUCTION

Air pollution is a one of the problem of every nation, whether it is developed or developing. Health problems have been increasing at faster rate mainly in urban areas of developing countries where industrialization and growing number of vehicles leads to release of lot of gaseous pollutants. Harmful effects of pollution include mild sensitized reactions such as irritation of the throat, eyes and nose as well as some serious problems like heart diseases, bronchitis, pneumonia, lung and aggravated asthma. According to a survey, due to air pollution 50,000 to 100,000 premature deaths per year occur in the U.S. alone. Whereas in EU number reaches to 300,000 and over 3,000,000 worldwide.

IOT based Air Pollution Monitoring System monitors the Air quality over a web server using Internet and will trigger an alarm when the air quality goes down below a certain threshold level It means when there are significant amount of harmful gases present in the air like CO2, smoke, alcohol, benzene, NH3, LPG and NOx. It will show the air quality in PPM and as well as on webpage so that it can monitor it very easily. LPG sensor is added in this system which is used mostly in houses. The system will show temperature and humidity. The system can be installed anywhere but mostly in industries and houses where gases are mostly to be found and gives an alert message when the system crosses threshold limit.

The main objective of IOT Air Monitoring System is that the Air pollution is a growing issue these days. It is necessary to monitor air quality and keep it under control for a improved future and well living for all. Due to flexibility and low cost, IoT is getting popular day by day. With the urbanization and with the rise in the vehicles on road the atmospheric conditions have significantly affected. Monitoring gives amounts of air pollutant concentrations, which can then be evaluated interpreted and presented. This information can then be valid in many ways. Analysis of monitoring data allows us to assess how bad air pollution is from day to day.

2. PROJECT PLANNING

a. Activity Break down Structure

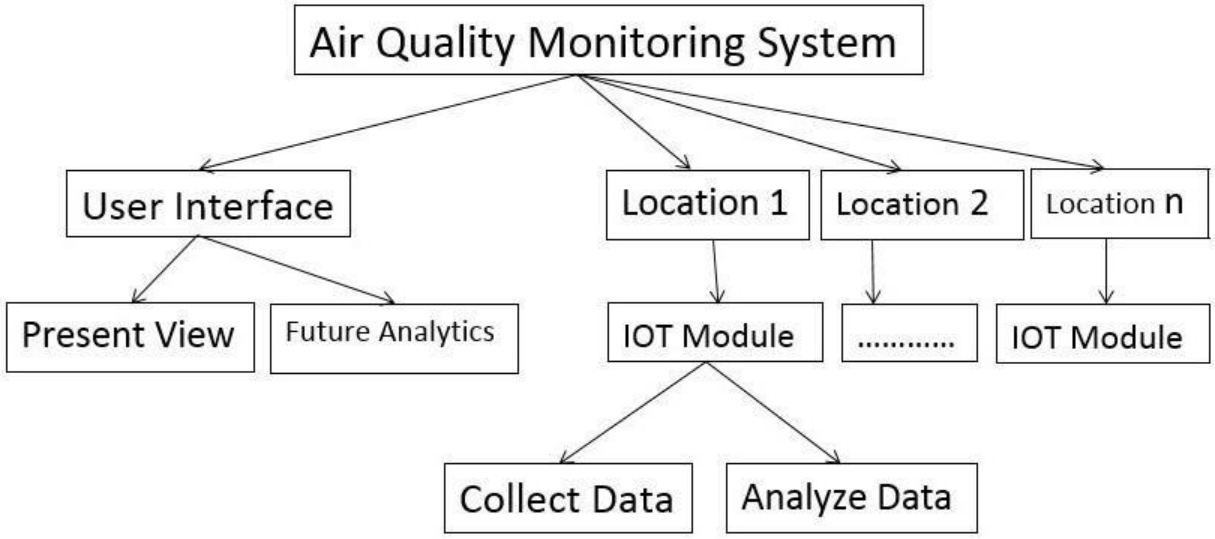

Figure 1. Activity break down structure

b. Project plan

Weekly plan was developed to finish the project in limited duration.

Weeks	Work Done
Week 1	Selection of project.
Week 2	Survey of the project.
Week 3	Requirement gathering and analysis.
Week 4	Collection of hardware and configuration.
Week 5	Configurating devices.
Week 6 and 7	Working on WiFi module.
Week 8	Worked on Cloud Service Platform , ThingSpeak.
Week 9	Implementation and Testing the whole Project.

Table 1. Project plan

c. Activity plan

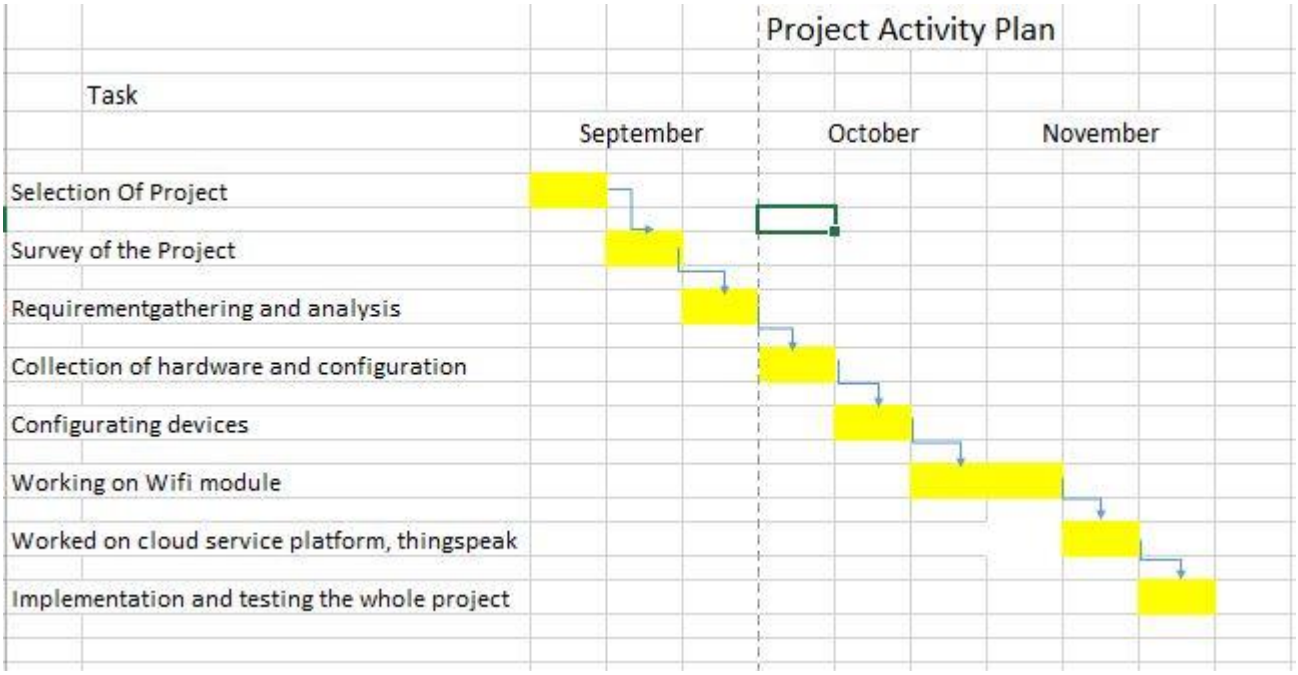

Figure 2. Activity Plan

d. PERT Chart

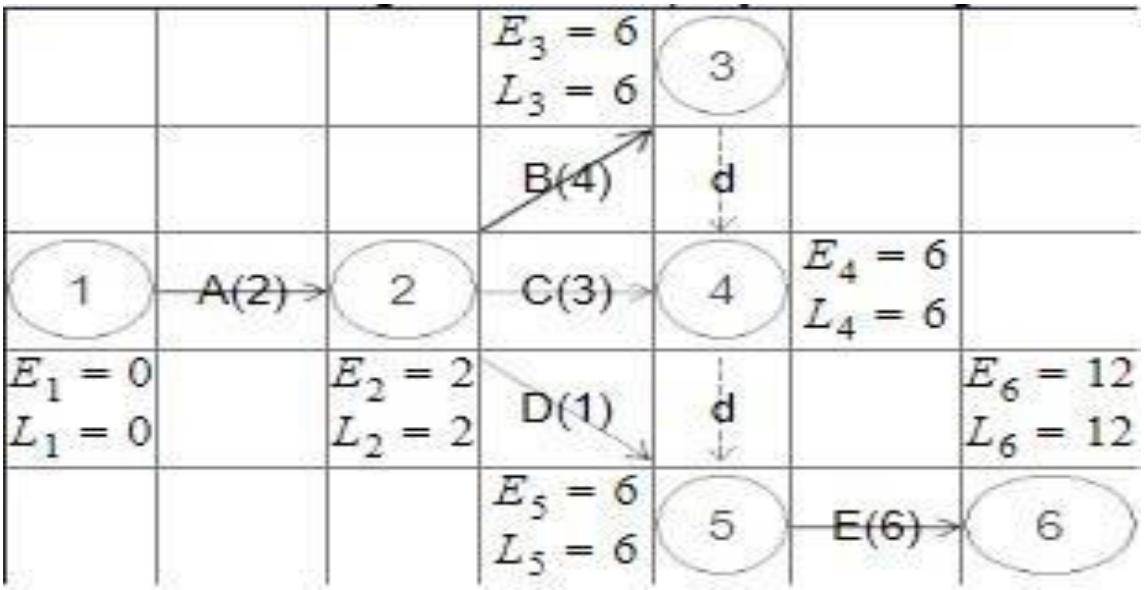

Figure 3. PERT

3. REQUIREMENTS SPECIFICATION

a. EXISTING SYSTEM :

The commercial meters available in the marketare Fluke CO-220 carbon monoxide meter for CO, Amprobe CO2 meter for CO2,ForbixSemicon LPG gas leakage sensor alarm for LPG leakage detection. The researchers in this field have suggested various air quality monitoring systems based on WSN, GSM. Now each technology has limited uses according to the intended function, as Zigbee is meant for users with Zigbee trans-receiver, Bluetooth[8][9].

The commercial meters accessible in the market are Fluke CO220 carbon monoxide meter for CO, Amprobe CO2 meter for CO2, ForbixSemicon LPG gas leak sensor alarm for LPG leakage recognition. The researchers in this field have proposed various air quality monitoring systems based on WSN, GSM and GIS. Now each technology has limited uses according to the intended function, as Zigbee is meant for users with Zigbee trans-receiver, Bluetooth. GIS based system is designed, executed and verified to monitor the identifies of air pollution of any area. It consists of a microcontroller, gas sensors, mobile unit, a temporary memory buffer and a web server with internet connectivity which collects data from different locations along with coordinate's statistics at certain time of a day. The readings for particular location are averaged in a closed time and space.

b. PROPOSED SYSTEM :

In this project we are going to make an IOT Based Air Pollution Monitoring System in which we will monitor the Air Quality over a web server using internet and will display in webpage when the air quality goes down beyond a certain level, means when there are sufficient amount of harmful gases are present in the air like CO2, smoke, alcohol, benzene and NH3. It will show the air quality in PPM and as well as on webpage so that we can monitor it very easily.

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4. DESIGN

The term design defines a final system and the process by which it is developed. It refers to the technical specifications that will be applied in implementations the candidate system. The design may be defined as the process of applying several techniques and principles for the resolve of defining a device, a process or a system in sufficient details to permit its physical realization. The designer's goal is how the output is to be formed and in what format samples of the output and input are also presented. Second input data and database files have to be designed to meet the requirements of the proposed output. The processing phases are handled through the program Construction and Testing[9].

Finally, details related to justification of the system and an estimate of the impact of the candidate system on the user and the organization are documented and evaluated by management as a footstep toward implementation. The importance of software design can be stated in a single Finally, details related to justification of the system and an estimation of the impact of the candidate system on the user and the organization are documented and evaluated by management as a step toward implementation. The standing of software design can be stated in a single word Quality". Design provides us with representations of software that can be assessed for quality. Design is the only way that we can accurately translate a customer's requirements into a finished software product or system without design we risk building an unstable system, that might fail it small changes are made or may be difficult to test, or on who's quality can't be tested. So it is an necessary phase in the development of a software.

a. Hardware Used :

i. MQ135 Gas sensor

Figure 4. MQ135 gas sensor

- The MQ135 sensor can sense NH3, NOx, alcohol, Benzene, smoke, CO2 and some other gases[1].
- It gives the output in form of voltage levels.
- The MQ series of gas **sensors** utilizes a small heater inside with an electro chemical **sensor** these **sensors** are sensitive to a range of gasses are used at room temperature.
- **MQ135** gas sensor is a lower conductivity of clean air.
- VCC Used to power the sensor, Generally the operating voltage is +5V.
- GND Used to connect the module to system ground.
- Analog out pin outputs 0-5V analog voltage based on the intensity of the gas.
- Wide detecting scope
- Fast response and High sensitivity
- Stable and long life
- Operating Voltage is +5V
- Analog output voltage: 0V to 5V
- Digital output voltage: 0V or 5V (TTL Logic)
- Can be used as a Digital or analog sensor
- The Sensitivity of Digital pin can be varied using the potentiometer

ii. Wi-Fi module NodeMCUESP8266

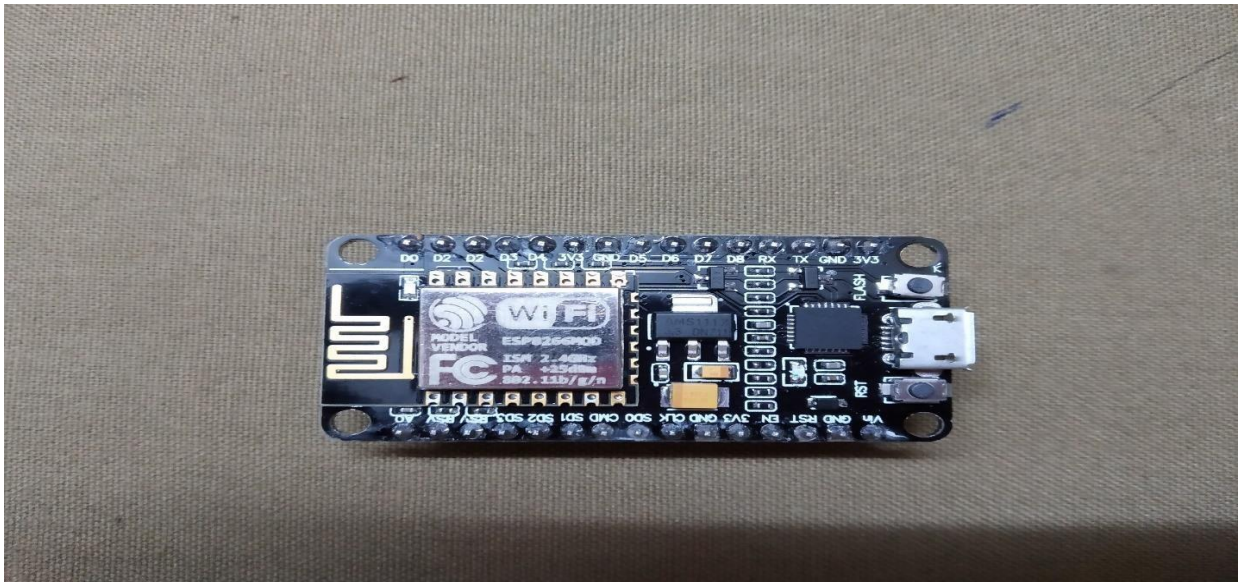

Figure 5. NodeMCUESP8266

- As Arduino.cc began developing new MCU boards based on non- AVR processors like the ARM/SAM MCU and used in the Arduino Due, they needed to modify the Arduino IDE so that it would be relatively easy to change the IDE to support alternate toolchains to allow Arduino C/C++ to be compiled down to these new processors[2][3].
- It has 12 General input/output pins 6 analog inputs, a 16 MHz quartz crystal, a USB Connection, power jack, an ICSP header and a reset and flash button.
- NodeMCU is an open source Lua based firmware for the ESP8266 WiFi and uses an on-module flash-based .bin file system. NodeMCU is implemented in C and is layered on the NON-OS SDK.
- The NodeMCU programming model is similar to that of Node.js, only in Lua. It is asynchronous and event-driven. Many functions, therefore, have parameters for callback functions.

iii. Breadboard

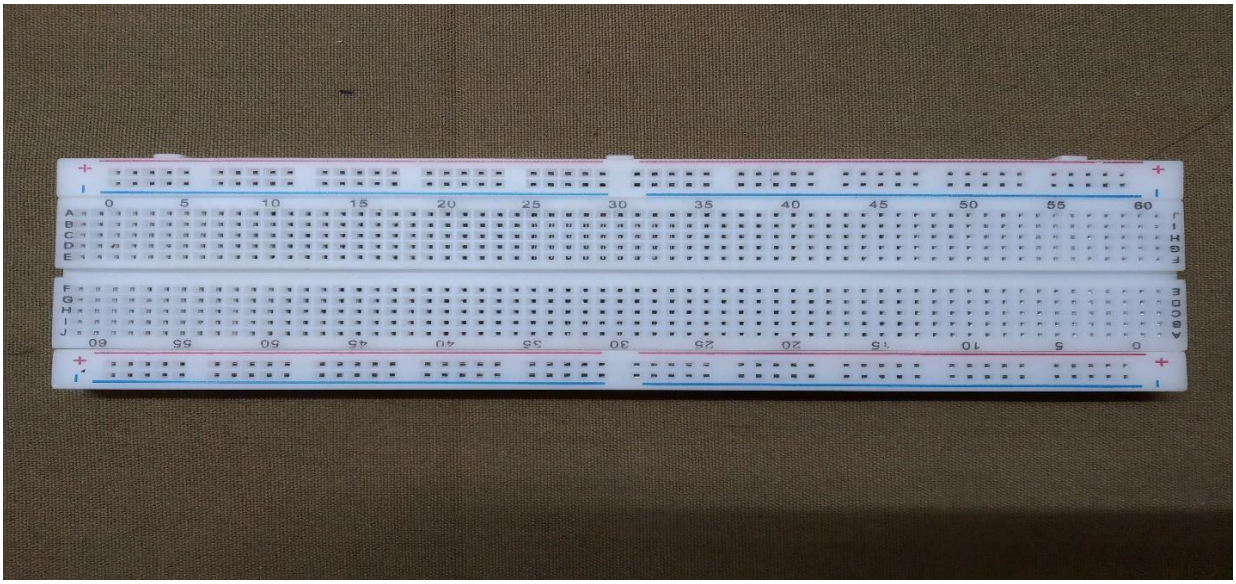

Figure 6. Bread Board

- 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.

iv. 1K ohm resistors.

Figure 7. Resistor

A resistor is a reflexive 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

5. IMPLEMENTATION

MQ135 sensor can sense NH3, NOx, CO2 and some other gases, so it is perfect gas sensor for our Air Quality Monitoring System. When we will connect it to Arduino then it will sense the gases, and we will get the Pollution level in PPM (parts per million). MQ135 gas sensor gives the output in form of voltage levels and we need to convert it into PPM. So for converting the output in PPM, here we have used a library for MQ135 sensor, it is explained in detail in "Code Explanation" section below[8].

Sensor was giving us value of 90 when there was no gas near it and the safe level of air quality is 350 PPM and it should not exceed 1000 PPM. When it exceeds the limit of 1000 PPM, then it starts cause Headaches, sleepiness and stagnant, stale, stuffy air and if exceeds beyond 2000 PPM then it can cause increased heart rate and many other diseases.

When the value will be less than 1000 PPM, then the webpage will display "Fresh Air". Whenever the value will increase 1000 PPM, then the buzzer will start beeping and webpage will display "Poor Air, Open Windows". If it will increase 2000 then the buzzer will keep beeping and the webpage will display[9].

"Danger! Move to fresh Air".

The code has been computed successfully. It is user friendly, and had required options, which can be utilized by the user to perform the desired operations

The code need to be dumped in the Arduino IDE software. The goals that are achieved by the code.

- Less number of human involvement
- Efficient management of water usage
- Cost effective
- Easy construction of the sensors on the tank
- Reduced errors due to human intervention

Portable and flexible for further enhancement

a. SOURCE CODE

```
#include <ESP8266WiFi.h> // library used to connect to the internet via WIFI.
String apiKey = "BWHO48MDSCU52YQI"; //API key from ThingSpeak
const char *ssid = "Prabhu D";  // Wifi Username
const char *pass = "Prabhu D.sp.9468"; // wifi password
const char* server = "api.thingspeak.com"; // Server name
int air = A0;
WiFiClient client;

// initializing parameters
void setup()
{
Serial.begin(115200);// bud rate for NodeMCUESP8266
 delay(100); // sleep 100 MS
 pinMode(air, INPUT); // Sensor pin mode has an input
Serial.println("Connecting to ");
Serial.println(ssid);
WiFi.begin(ssid, pass); // Connecting WIfi by using Wifi usenname and password

//checking for wifi connection status
while (WiFi.status() != WL_CONNECTED)
{
delay(500); Serial.print(".");
//WiFi.begin(ssid, pass);
}
Serial.println(""); Serial.println("WiFi connected");
}

void loop()
{
int analogSensor = analogRead(air); // reading analog value from the sensor MQ135
```

```
Serial.print("sensor adc");
Serial.print(analogSensor);
float per = analogSensor/10.24; Serial.println(per); // normalizing collected data from sensor
int t = (int)per;

// connecting to thingspeak cloud
if (client.connect(server,80))
{
String postStr = apiKey; postStr +="&field1="; //Sending PPM value to cloud
postStr += String(t); postStr +="&field2="; // Sending normalizing data to cloud
postStr += String(analogSensor);
postStr += "\r\n\r\n";
client.print("POST /update HTTP/1.1\n"); // Data will be sent by using HTTP protocol
client.print("Host: api.thingspeak.com\n"); // The data will be stored API of the thingspeak cloud service.
client.print("Connection: close\n"); // Disconnecting thingspeak cloud
client.print("X-THINGSPEAKAPIKEY: "+apiKey+"\n");
client.print("Content-Type:application/x-www-form- urlencoded\n"); // The sended data will be encoded.
client.print("Content-Length: "); // Setting the content length of the data transfer
client.print(postStr.length());
client.print("\n\n");
client.print(postStr);
Serial.println("Polluted Air: "); Serial.print(t); Serial.print("%");
}
client.stop(); Serial.println("Refreshing..."); delay(5000);
}
```

b. RESULTS

Figure 8. PPM View

- X-axis denotes time , date of the collected data.
- Y-axis denotes Parts Per Million (PPM) of the sensed data.
- PPM is standard of measuring air quality.
- PPM maximum value is 1024.
- Data collected from sensor are directly plotted in the above graph.

Figure 9. Percentage View

- X-axis denotes time , date of the collected data.
- Y-axis denotes percentage of the sensed data.
- Percentage is standard of measuring air quality in above graph.
- Percentage maximum value is 100%.
- Percentage is computed using the formula – PPM / 10.24 (max range of sensor I,e 1024 / 100 = 10.24).
- Data collected from sensor are directly plotted in the above graph.

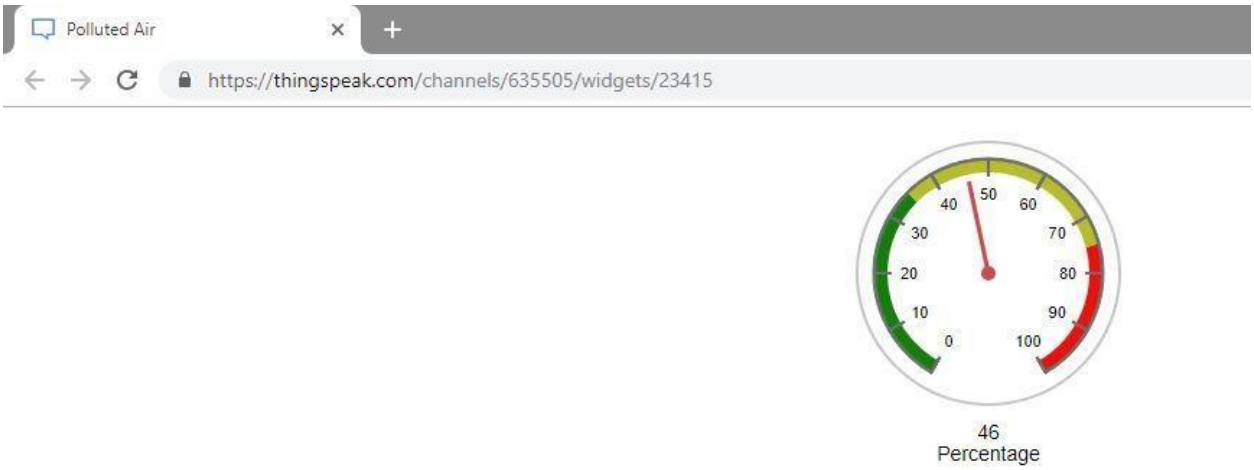

Figure 10. Gauge View

- Data collected from sensor are directly plotted in the above graph.
- There are three colors that indicate its significance such as Green, Yellow and Red.
- Green indicates good air quality.
- Yellow indicates Average air quality.
- Red indicates Danger air quality.
- And an number below the Guage View indicates the Percentage of the Air Quality.

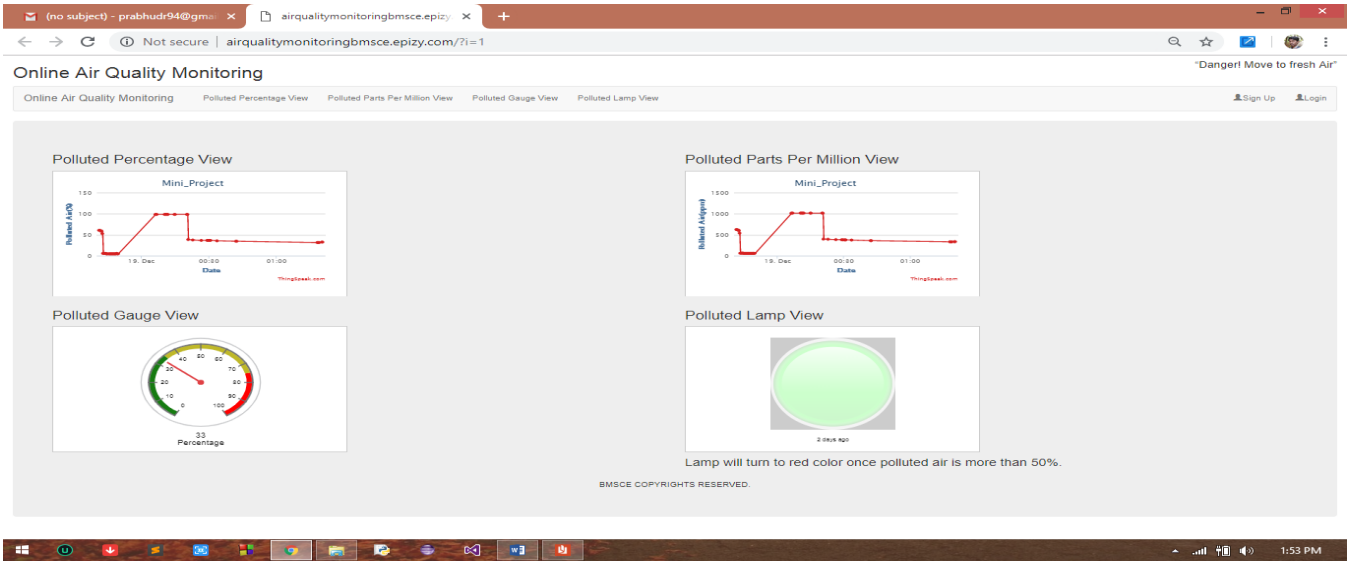

Figure 11. Online View

6. TESTING

Configuration of various components of IOT are tried with various types of configurations. After configurations , various cloud services platform were tried and best one was choosen i,e Thinkspeak. ThinkSpeak cloud platform was learned and experimented at various settings available. For transferring data between IOT devices and cloud various Wifi modules were available , based on survey on Wifi modules - the best option available the best WiFi module were selected and testing for its working. Data collection of air quality was experimented at various locations and observed for the values recored. Public link is available for publics to view the quality of air online.

Test Case 1 :- Different modules such as WiFi, configurations, ThinkSpeak all were tested on various conditions.

Test Case 2 :- For testing the output values received from the IOT devices , the output values were collected from various areas such as BMSCE college, srinivas nagar, Allahabad bank etc.

Test Case 3 :- Configuring WiFi modules was quite a hard, come accrossed various errors and faults. Solved it by frequently working on it via Internet.

Test Case 4 :- An public link is available for end users to view the Air quality. Link was tested for the accurate data representation.

Test Case 5:- First time while connecting to NodeMCU, we should flash the Ai.thinker1.1.1.bin file. After flashing completes, we have to rest the device to upload the code.

Test Case 6 :- While testing with high voltage (I,e >5.0 Volt) is passed to the device, device go crashed. So preferred voltage is between 3.3 and 5.0 volt.

7. CONCLUSION

The system to monitor the air of environment using Arduino microcontroller, IOT Technology is proposed to improve quality of air. With the use of IOT technology enhances the process of monitoring various aspects of environment such as air quality monitoring can be done. Here, using the MQ135 and MQ6 gas sensor have come the sense different types of dangerous gas and arduino is the heart of this project. Which control the entire process. Wi-Fi module connects the whole process to internet and LCD is used for the visual Output.

8. FUTURE ENHANCEMENTS

- Using collected data , forecasting the upcoming days air quality.
- Use of machine learning algorithms for better prediction.
- Implementing IOT hardware devices at various locations to cover maximum coverage of area.

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