IoT based air pollution monitoring system

Name: Shiwani Jeswani

Contact: 7999325263

Email Id: 2018.shiwani.jeswani@ves.ac.in

Index:

INTRODUCTION

A. Existing Problem:

Air pollution refers to the release of pollutants into the air—pollutants which are detrimental to human health and the planet as a whole. According to the World Health Organization (WHO), each year air pollution is responsible for nearly seven million deaths around the globe. Nine out of ten human beings currently breathe air that exceeds the WHO's guideline limits for pollutants, with those living in low- and middle-income countries suffering the most. In the United States, the Clean Air Act, established in 1970, authorizes the U.S. Environmental Protection Agency (EPA) to safeguard public health by regulating the emissions of these harmful air pollutants.

Effects:

- Global Warming.
- Climate Change.
- Acid Rain.
- Smog **effect**.
- Deterioration of fields.
- Extinction of animal species.
- Respiratory **health** problems.
- Deterioration in building materials.

Overview:

Here an **IoT Based Air Pollution Monitoring System** for **monitoring the Air Quality over a webserver using internet** and triggers an alarm when the air quality goes down beyond a certain level, means when there are sufficient

amounts of harmful gases are present in the air like CO2, smoke, alcohol, benzene and NH3. LCD is used to display the air quality in ppm and as well as on webpage so that it can be monitored very easily.

Purpose:

To find out air quality index in ppm and monitoring it using LCD display. Then data is uploaded into firebase so as to get real time updates on web app and use the same for prediction of further AQI using machine learning model.

LITERATURE REVIEW:

Air pollution has been described as one of the "great killers of our age" and as "major threat to health" due to its tremendous and various health effects on humans of all ages and in both genders. In 2014, the World Health Organization (WHO) estimated that 92% of the world population was living in places with less than optimum outdoor air quality. Furthermore, WHO reported that in 2012, outdoor air pollution caused around 3 million deaths worldwide and 6.5 million deaths (11.6% of all global deaths) were associated with indoor and outdoor air pollution together.

Air pollution was linked to cancer, respiratory diseases, negative pregnancy outcomes, infertility, cardiovascular diseases, stroke, cognitive decline, and other adverse medical conditions. Nearly 90% of air-pollution-related deaths occur in low- and middle-income countries, with nearly 2 out of 3 occurring in South-East Asia and Western Pacific regions.

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Types of Air pollution:

Ambient air pollution:

The World Health Organization (WHO) defines ambient air pollution as potentially harmful pollutants emitted by industries, households, cars, and trucks. Of all of these pollutants, fine particulate matter has the greatest effect on human health. Most fine particulate matter comes from fuel combustion from vehicles, power plants, industry, households, or biomass burning. WHO estimates fine particulate matter causes 25% of lung cancer deaths, 8% of chronic obstructive pulmonary disease (COPD) deaths, and 15% of ischaemic heart disease and stroke.

Advanced technology is available to monitor particulates in ambient air. These instruments measure critical regulatory parameters including PM-10 and PM-2.5 mass concentration as it exists in ambient air

Outdoor Air pollution:

Outdoor air pollution is a complex mixture originating from different natural and anthropogenic sources and consisting of particles, chemicals and biogenic substances with well-known health effects. Although outdoor air is an important source of indoor particulate matter (PM), additional sources must be considered, leading to quite different compositions of particle mass and particle size distributions in the indoor environment.

Household Air pollution:

Sources of indoor pollution include

- Mold and pollen
- Tobacco smoke
- Household products and pesticides
- Gases such as radon and carbon monoxide
- Materials used in the building such as asbestos, formaldehyde and lead

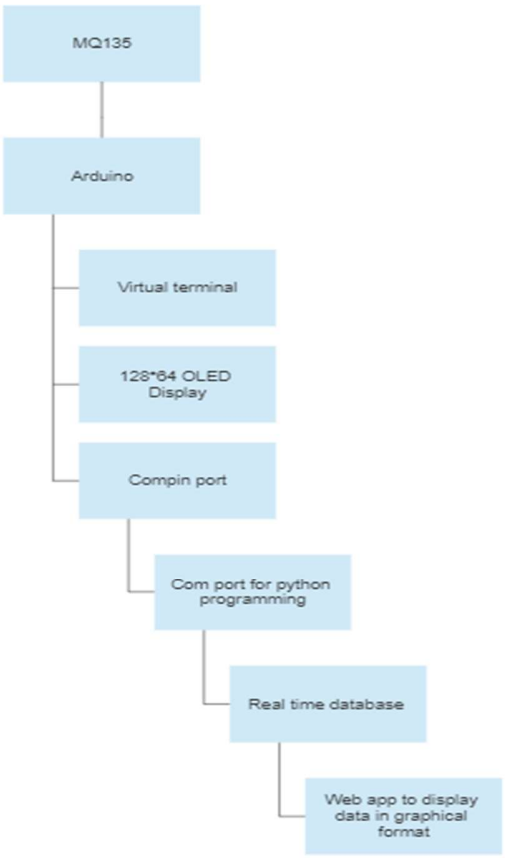
Sometimes a group of people have symptoms that seem to be linked to time spent in a certain building. There may be a specific cause, such as

Legionnaire's disease. Sometimes the cause of the illness cannot be found. This is known as sick building syndrome.

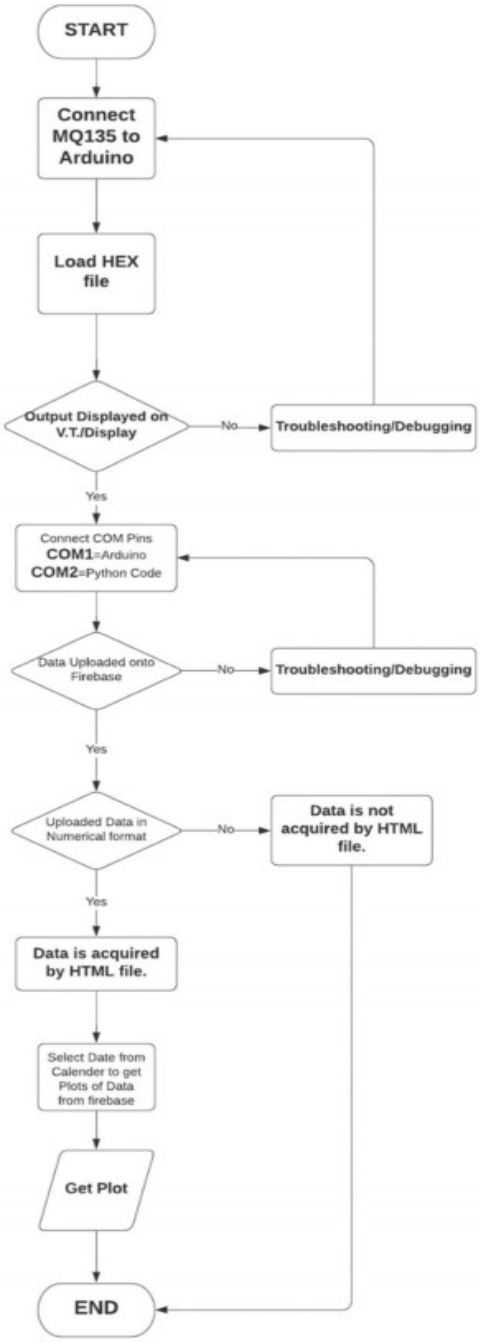
Usually indoor air quality problems only cause discomfort. Most people feel better as soon as they remove the source of the pollution. However, some pollutants can cause diseases that show up much later, such as respiratory diseases or cancer.

PROPOSED SOLUTION:

BLOCK DIAGRAM

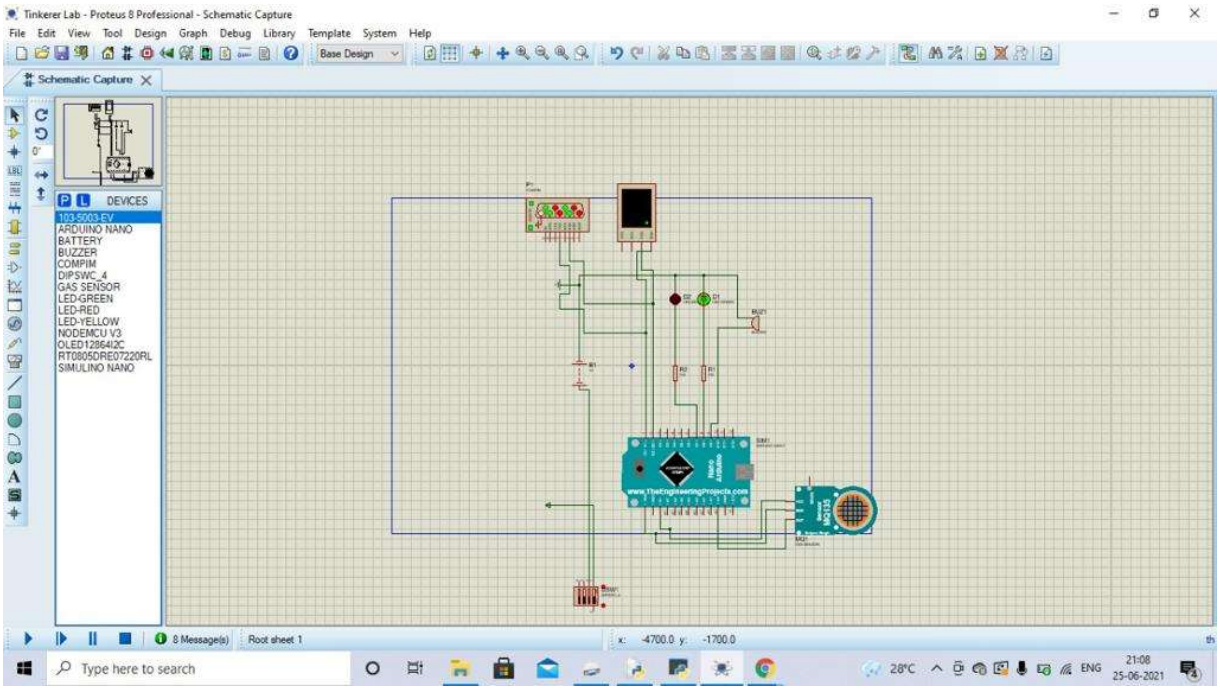


Flowchart:

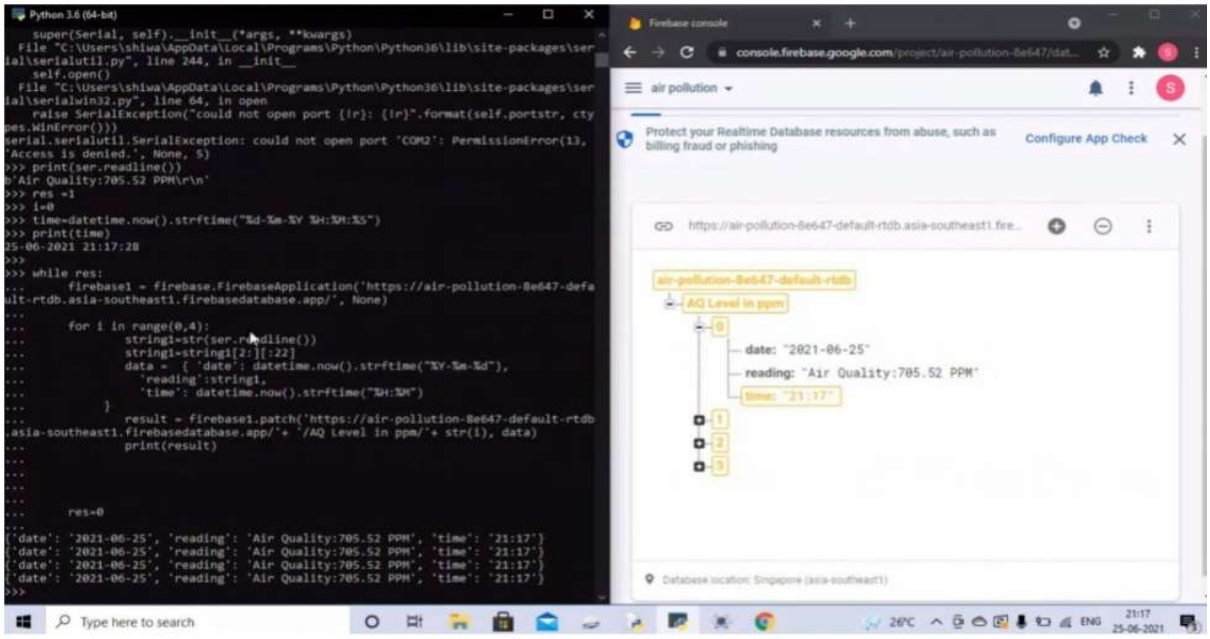

START
Connect MQ135 to Arduino
Load HEX file
Output Displayed on V.T./Display
No
Troubleshooting/Debugging
Yes
Connect COM Pins
COM1=Arduino
COM2=Python Code
Data Uploaded onto Firebase
No
Troubleshooting/Debugging
Yes
Uploaded Data in Numerical format
No
Data is not acquired by HTML file.
Yes
Data is acquired by HTML file.
Select Date from Calender to get Plots of Data from firebase
Get Plot
END

RESULT:

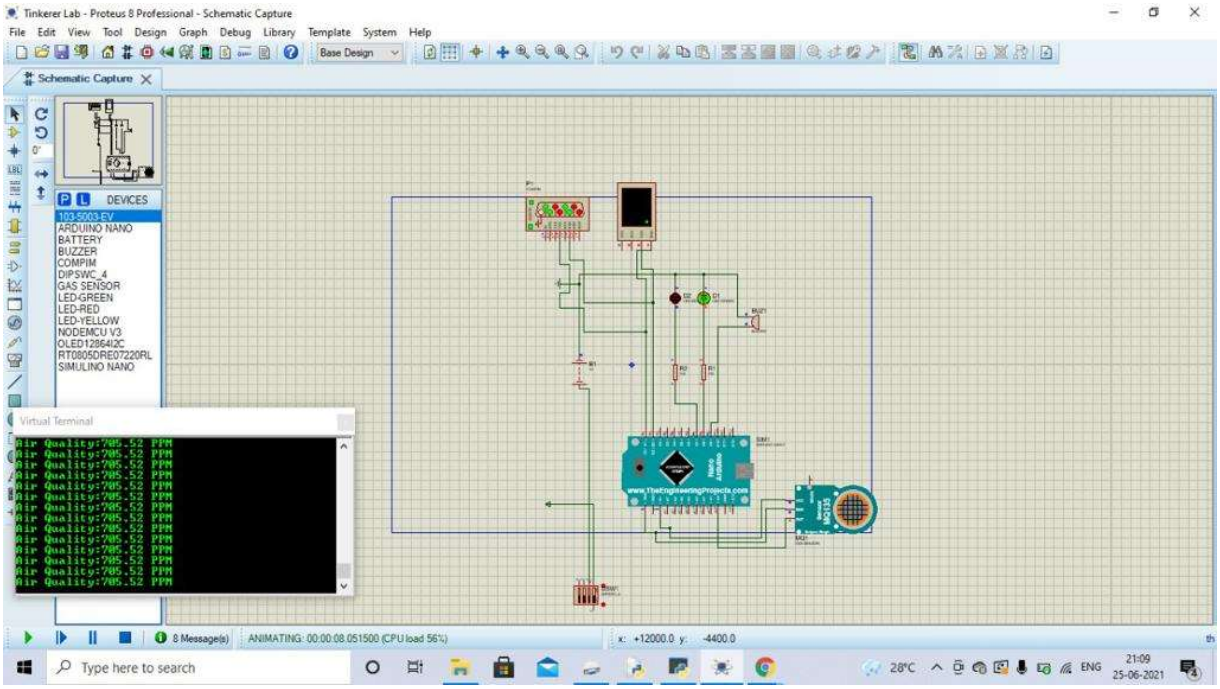
A. Fullscreen Screenshot of proteus.



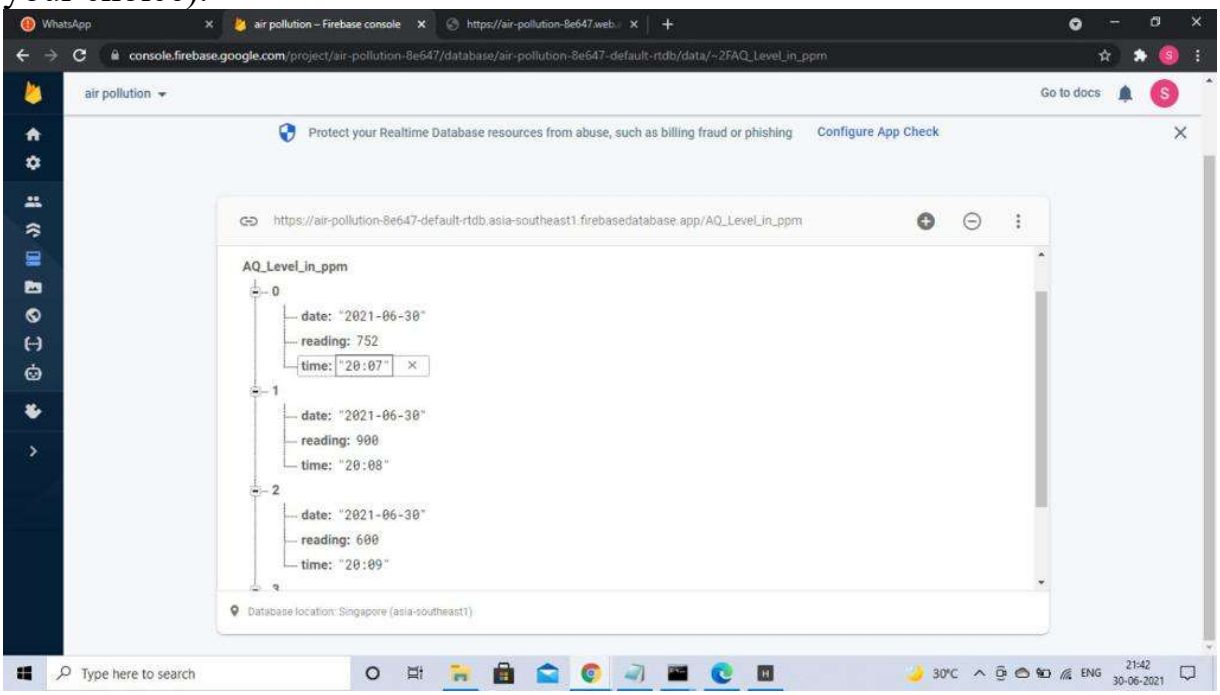
B. Data uploaded on firebase.(Firebase Window)



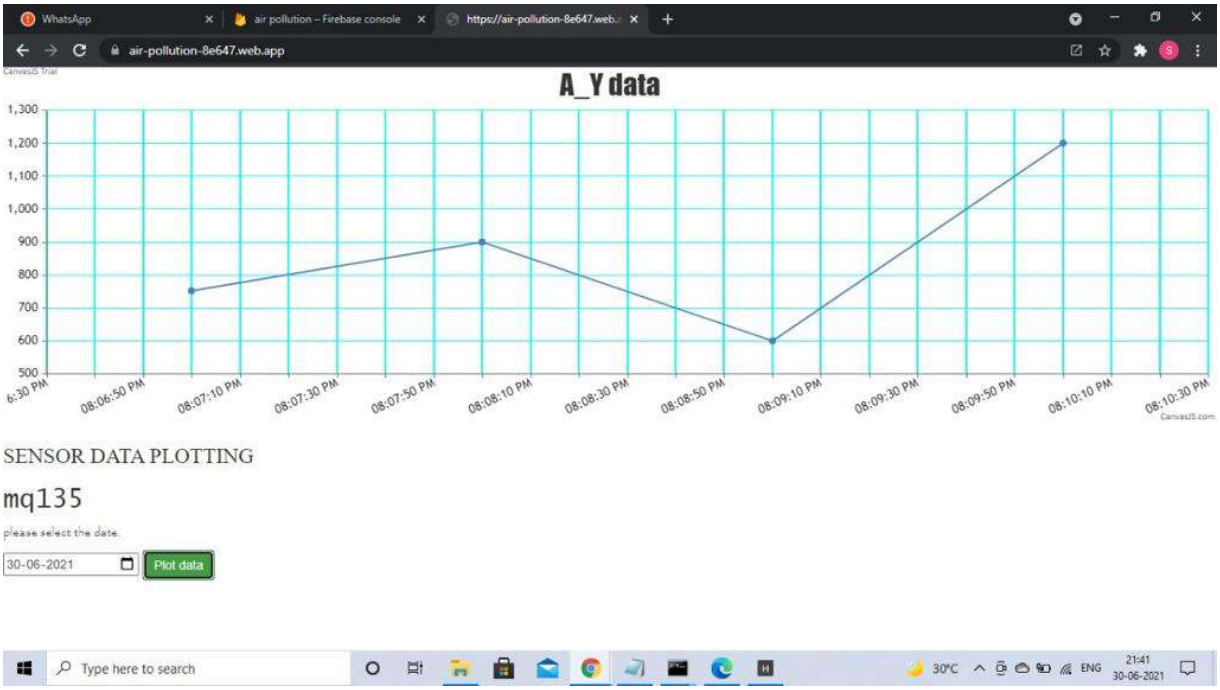
C. Screenshot of proteus while simulation.



D)Submit the Screenshot of the Firebase real-time database(data can be of your choice).



E)Submit the screenshot of the plotted graph in the HTML page.(The website url bar and chrome should be visible in the screenshot, to prove that you plotted it in HTML page)



F) Link of deployed Webapp

https://air-pollution-8e647.web.app

ADVANTAGES AND DISADVANTAGES

Advantages:

1) Worldwide monitoring
2) Real-time alerts
3) Sensors are easily available.
4) Detecting a wide range of gases like CO2, CO etc.
5) Simple, compact and easily handle.
6) Continuous update of change in percentage of quality
7) Reduced wiring
8) Reduce cost

9) Easy installation, easy maintenance and so on

Disadvantages:

1. Reliably detect and estimate small displacements
2. Determine column that moved
3. Estimate new locations of dislocated columns
4. Estimate location of slip surface
5. Faulty Readings

Challenges:

1. To be compelling, the areas of the checking stations need cautious position in light of the fact that the air contamination circumstance in metropolitan regions is profoundly identified with human exercises
2. Another issue is the large size of components.

APPLICATION

1. The system can be installed anywhere but mostly in industries and houses where gases are mostly to be found and gives an alertnmessage when the system crosses threshold limit.
2. The system will show temperature and humidity.
3. The system will show the air quality in PPM on the LCD and as well as on webpage so that it can be monitored very easily.

LEARNING OUTCOMES

1) Better Knowledge of proteus software, Arduino IDE and creation of Hex File.
2) Basic Understanding of Firebase – How data gets uploaded in real-time on it.
3) Practical experience with C programming for Arduino and Python programming for data upload.
4) Designing of Web App using HTML, CSS, JAVASCRIPT.
5) Linking HTML code with firebase to retrieve data from it.
6) Hosting, creation and deployment of WebApp.

CONCLUSION

The air pollution monitoring system is successfully implemented as a prototype. All the sensors and other stuff works as per the expectations. The sensors effectively sense the surrounding conditions and give the readings. The AQI readings are successfully acquired using MQ135 sensor. The system senses data and transmits it continuously. The data is successfully uploaded over firebase from where it is pushed to a machine learning code which then successfully displays the graph.

REFERENCES

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2) Akinbami, L.J., Lynch, C.D., Parker, J.D., Woodruff, T.J. (2010). The association between childhood asthma prevalence and monitored air pollutants in metropolitan areas, United States,2011-2004.EnvironmentalResearch. 110(3): 294-301.Available: http://www.aqmd.gov/docs/default-source/Agendas/STMPR-Advisory-Group/december-2015/3b_draft_gaseous.pdf?sfvrsn=4

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4) Poonam Paul, Ritik Gupta, Sanjana Tiwari, Ashutosh Sharma, “IoT based Air Pollution Monitoring System with Arduino”, IJART, May 2005. Available: https://www.ripublication.com/ijcse19/ijcsev9n1_01.pdf

5) Air Resource Management Centre, Vehicle-related air pollutants and public health, Ministry of Environment and Natural Resources, Sri Lanka, May 2003, pp. 611.
Available:http://ijariie.com/AdminUploadPdf/A_SURVEY_PAPER_ON_AIR_POLLUTION_MONITORING_USING_IOT_ijariie9341.pdf

APPENDIX

A. Source code (Web App)

https://github.com/Tinkerers-Lab-VESIT-ETRX/IoT-based-air-pollution-monitoring-system-11/blob/88dbe785603e13e8ea251603ef95e4a1fc5b901b/Index%20(2).html

```
<!DOCTYPE html>
<html lang="en">

<style>
   h3{font-family: "Times New Roman", Times, serif;}
   h2{font-family: "Lucida Console", "Courier New",
monospace;}
   p{font-family: "Papyrus";}
</style>
<body>


<h3>SENSOR DATA PLOTTING</h3>
<h2>mq135</h2>
<p>please select the date.</p>
<input type = "date"  id="demo">
<button class="btn btn-success" type="button"
onclick=myFunction()>Plot data</button>
```

```
<div id="chartContainer"></div>
   <canvas id="chart" width="400" height="400"></canvas>
<head>

   <link rel="stylesheet"
href="https://maxcdn.bootstrapcdn.com/bootstrap/3.3.7/css/bo
otstrap.min.css">
   <script
src="https://canvasjs.com/assets/script/canvasjs.min.js"></scri
pt>

  </head>


<script language = "javascript" type = "text/javascript">


function myFunction() {
   var
selectedDate=document.getElementById("demo").value;
   console.log(selectedDate);

   const Http = new XMLHttpRequest();
   const url='https://air-pollution-8e647-default-rtdb.asia-
southeast1.firebasedatabase.app/AQ_Level_in_ppm.json';
   Http.open("GET", url);
   Http.send();
   Http.onreadystatechange = () => {
      if (Http.readyState == 4 && Http.status == 200) {
         console.log(Http.responseText);
         var resData=JSON.parse(Http.responseText);
         console.log(resData);
```

```
        var i;
        var plotData=[];

        for(i=0;i<resData.length;i++) {
           var y=resData[i]['reading']
           if(resData[i]['date']==selectedDate){
           var temp1=resData[i]['date'].split('-');
           var temp2=resData[i]['time'].split(':');
           var x=new Date(temp1[0],temp1[1]-
1,temp1[2],temp2[0],temp2[1]);
           console.log(x,y);
           plotData.push({y:y,x:x});
           }

        }

        //console.log(plotData);
        if(plotData.length!=0){
           var chart = new CanvasJS.Chart("chartContainer",
           {
              title:{
                 text: "A_Y data"
              },
              axisX:{
                 gridColor: "cyan" ,
                 gridThickness: 2
              },
              axisY:{
                 gridColor: "cyan"
              },
              data: [
                 {
```

```
                    type: "bar",

                    dataPoints: plotData
                }

            ]
        });

        chart.render();
    }
    else{

document.getElementById("chartContainer").innerHTML="N
o data available for this date."
    }
  }
}
Http.open("GET", url);

Http.send();


}


</script>


</body>
</html>
```

B. <u>Source code(Arduino code)</u>

https://github.com/Tinkerers-Lab-VESIT-ETRX/IoT-based-air-pollution-monitoring-system-11/blob/88dbe785603e13e8ea251603ef95e4a1fc5b901b/Air%20pollution%20monitoring%20system.ino

```
#include "MQ135.h"
#include <SPI.h>
#include <Wire.h>
int RedLed = 9;
int GreenLed = 8;
int Buzzer = 7;

void setup()
{
pinMode(RedLed, OUTPUT);
pinMode(GreenLed, OUTPUT);
pinMode(Buzzer, OUTPUT);
Serial.begin(9600);
}
void loop()
{
MQ135 gasSensor = MQ135(A0);
float air_quality = gasSensor.getPPM();
Serial.print("Air Quality:");
Serial.print(air_quality);
Serial.println(" PPM");
if (air_quality<=1000)
{
digitalWrite(GreenLed, HIGH);
digitalWrite(RedLed,LOW);
noTone(Buzzer);
}
```

```
else if( air_quality>=1000 && air_quality<=2000 )
{
digitalWrite(GreenLed,LOW);
digitalWrite(RedLed, HIGH );
noTone(Buzzer);
}
else if (air_quality>=2000 )
{
digitalWrite(GreenLed,LOW);
digitalWrite(RedLed,HIGH);
tone(Buzzer, 1000, 200);
}
```

C. Source code (Python data upload)

https://github.com/Tinkerers-Lab-VESIT-ETRX/IoT-based-air-pollution-monitoring-system-11/blob/88dbe785603e13e8ea251603ef95e4a1fc5b901b/Air%20pollution%20monitoring%20system.py

```
import serial

from firebase import firebase

from time import sleep

from datetime import datetime

import serial.tools.list_ports



ports = serial.tools.list_ports.comports()
```

```
for port, desc, hwid in sorted(ports):
        print("{}: {} [{}]".format(port, desc, hwid))



ser = serial.Serial("COM2", 9600)
print(ser.readline())
res =1
i=0
time=datetime.now().strftime("%d-%m-%Y %H:%M:%S")
print(time)


while res:
    firebase1 = firebase.FirebaseApplication('https://air-
      pollution-8e647-default-rtdb.asia-
      southeast1.firebasedatabase.app/', None)


    for i in range(0,4):
            string1=str(ser.readline())
            string1=string1[2:][:22]
```

```
    data =  { 'date': datetime.now().strftime("%Y-%m-
%d"),

      'reading':string1,

      'time': datetime.now().strftime("%H:%M")

  }

    result = firebase1.patch('https://air-pollution-
8e647-default-rtdb.asia-
southeast1.firebasedatabase.app/'+
'/AQ_Level_in_ppm/'+ str(i), data)

    print(result)
```

```
res=0
```