***IOT-BASED WIRELESS SENSOR NETWORK FOR AIR POLLUTION MONITORING***

***A project report submitted in partial fulfillment of supervision for the award of a degree of***

**BACHELOR OF TECHNOLOGY IN**

## ELECTRONICS AND COMMUNICATION ENGINEERING

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# BONAFIDE CERTIFICATE

This is to certify that the project entitled “IOT-BASED WIRELESS SENSOR NETWORK FOR AIR POLLUTION MONITORING” is project work by **“S. KALYANI (20551A04H1), D. PAVAN KUMAR (20551A04E0), P. PRATHYUSHA (20551A04G7), Y. LAVANYA**

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# CERTIFICATE OF AUTHENTICATION

We solemnly declare that this project report **“IOT-BASED WIRELESS SENSOR NETWORK FOR AIR POLLUTION MONITORING”** is Bonafide work done purely by **“S. KALYANI (20551A04H1), D. PAVAN KUMAR (20551A04E0), P. PRATHYUSHA (20551A04G7), Y. LAVANYA (20551A04H8)”,** carried out under the supervision of

**Mr. M. LENIN BABU** (Asst. Professor) towards partial fulfillment of the requirements of the Degree of **Bachelor of Technology** in **Electronics & Communication Engineering** as administered under the Regulation of Godavari Institute of Engineering & Technology, Rajamahendravaram, A.P, India and award of the Degree from Jawaharlal Nehru Technological University, Kakinada during the year 2022 – 2023.

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# DECLARATION

We hereby declare that this submission is our work and that, to the best of our knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except were a due acknowledgment.

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# ABSTRACT

# Air is one of the essential elements of man’s surroundings. Pollution is the biggest challenge for the world present time. It may be air pollution, water pollution, soil pollution etc. It directly or indirectly affects the health of the individual. To overcome this problem, we are proposing a project named IOT-based wireless sensor network for air pollution monitoring. The project aims to measure the quality of air. Installing air quality monitor helps to monitor the presence of pollutants, resulting in better environmental conditions for humans to reside. For air quality monitoring, several heterogenous sensors are being used to measure several parameters like Sulphur oxides, Carbon oxides, ammonia and other harmful gases. the system is developing by using Node MCU(ESP8266) and the sensors mainly used in this system are the PM2.5/PM10 sensor, air quality sensor like MQ-135 and barometric pressure sensor (BME280). air quality measurements were taken based on the parts per million (PPM) metrics. PM55003 sensor measure particle concentration in PM1.0, PM2.5 &PM10. The sensors will gather the data of various environmental parameters and send it to the Things peak server which displays the data online after the interval of every 15 seconds. We can install this system anywhere and can also trigger some devices when pollution goes beyond some level like we can switch on the Exhaust fan.

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**LIST OF ABBREVIATIONS**

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1. VSN Virtual sensor network

1. MQTT MQ Telemetry Transport

1. IOT Internet of things

1. LAN Local area network

1. IP Internet protocol

1. PM Particulate matter

# INTRODUCTION

The causes of pollution measure carbonic acid gas, monoxide gas, pollutant, Lead, Ammonia, Particulate Matter, Ground Level gas. The Internet of things permits objects to be detected or in dominant. Things, in the IoT, refers to create of devices like heart observance implants, vehicles with intrinsic sensors, etc. Development of pollution observance system will facilitate to control and live pollution connected parameters. Variety of the ways that to controls pollution parameters measure. we have a tendency to measure reaching to implement pollution detection in vehicles is pollution is high or low owing to combustion of fuel in vehicle. I have a tendency to measure reaching to build it up and implement it using Node MCU and different elements. this methodology is turning into more and more important in pollution detection in vehicles. The Vehicles end up carbonic acid gas (CO2), monoxide gas (CO). I have a tendency to activity pattern electronic text Transfer protocol (HTTP)for act and transferring data and to boot assures that data is not manipulated and one hundred pc transmission of knowledge.

* 1. **DESCRIPTION:**

**A. Proposed system:**

The system to observe the air of setting using microcontroller, IOT Technology is projected to boost quality of the air. With the using of IOT technology enhances the method of watching numerous aspects of setting like air quality watching issue projected. Here, using the MQ135 it provides the sense of various style of dangerous gas and DHT11 it provides the Temperature and wetness vary and small controller is that the heart of this project. That management the whole method.

**B. Origin of the proposal:**

India being the fourth largest electrode of greenhouse gases little surroundings makes its time to create peoples attentive to matters Gas sensing and observation refers to the method of ceaselessly pursuit the a in concentration of various air part.

**C. Statement of the problem:**

Growing urbanization and no of business cities build it a demand to possess a detailed concern of the surroundings. exhausting to stay observation unendingly bound sites like industries, busy traffic signals, villages liable to wearing away & high ammonia concentration etc.

* 1. **MOTIVATION:**

As seen in the previous overview to the current IoT, most IoT applications in China were domain-specific or application specific solutions. The architectures of these IoT systems are split and cannot correlate and integrate the data from different storage tower; these isolated IoT keys use private protocols and cause much difficulties in information sharing, technology multiplexing, network managements, and advancement. All these problems are delaying the development of IoT. In order to decrease the total IoT cost and share information, I need to integrate multiple functions and capitals into a larger system. IoT thus needs to be intended with an open and generic IoT architecture with open borders and resources, considering different business scenarios, application-based requirements, and current technologies. I have thus seen the motivation to express a standard for IoT integration in order to reduce the total cost of money and time from devices, developments, and deployments. An open and basic IoT architecture is an integrated solution with interoperability. It has the following characteristics. Standard Interface and Protocol: By comparing various private IoT systems, a generic IoT structure has the same hardware and software interfaces, and protocols. Public and Operating: A general IoT architecture is organized to take over public IoT applications with open operating competence. A public IoT system integrate multiple IoT requests into one architecture. Open, Scalable, and Flexible: An open IoT architecture with open resources, open standards, and open interfaces easily extend its functionality and the scale of performance. It adapts to different requirements including technical growths flexibly.

* 1. **PROBLEM STATEMENT:**
* Air pollution is one of environmental issues that cannot be ignored.
* Inhaling pollutants for a long time causes damages in human health.
* Traditional air quality monitoring methods, such as building air quality monitoring stations, are typically expensive.
* This project is suitable for air quality monitoring in real time.
  1. **OBJECTIVES:**

The main objective of these Networks is to record the concentration levels of atmospheric pollutants in order to define air quality levels and establish action plans if high levels of contamination are detected. Other objectives are: Locating contamination problem areas and understanding their space- time changes.

* 1. **RELATED WORK**

IoT- primarily based pollution watching and prognostication System: This paper [1] introduces IoT with environmental protection and it puts forward a form of pollution watching and prognostication system. Wireless device network for period pollution monitoring this paper [2] presents the system which consists of many distributed watching stations that communicates wirelessly with a back-end server victimisation on machine-to-machine (M2M) communication.

Pollution watching victimisation wireless device network: the purpose of this paper [3] is to develop an occasional price multisensory node for pollution The Urban pollution watching system with prognostication Models this paper [4] presents the pollution watching System and its prognostication module. The Economical knowledge Gathering associate degreed Estimation for Metropolitan Air Quality watching by victimisation transport device Networks This paper [5] specializes in a transport device network (VSN) to watch cities air quality and develops an economical knowledge gathering and estimation (EDGE) mechanism on VSN. The Air quality watching in urban environments, the pollution is an associate degree environmental and a social drawback, because [6] it results an adverse effect on human health, ecosystems and climate.

The [7] has an occasional price geo-referenced air-pollution measuring system is used as early warning tool: the full system is Connected to an inexpensive board with inherent Wi-Fi permitting to send the info to the IoT cloud in period victimisation MQTT protocol, associate degreed so the georeferenced knowledge may be printed on an open access platform using IOT. In this paper [8] watching vehicles and pollution on road victimisation transport cloud setting the paper focuses on the transport cloud environments may be the long run technological dynamical model that gives economically attainable solutions by victimisation sensible transport networks with automatic traffic condition info, self-vehicle management on road associate degreed develop opinion systems to stop an accident further as analysis of quantity of deadly gases emitted from a vehicle on a road The paper [9] proposes, 2 number applied mathematics formulations supported real pollutants dispersion modelling to traumatize the minimum price WSN preparation for pollution watching.

**3. METHODOLOGY**

The model was designed using an Arduino Uno microcontroller, Wi-Fi module 8266, MQ135Gas Sensor and a 16 by 2 liquid crystal display (LCD) Screen. Figure 1 shows the proposed system overview and the functional block diagram is depicted in figure 2. The proposed flow chart is presented in figure 3.

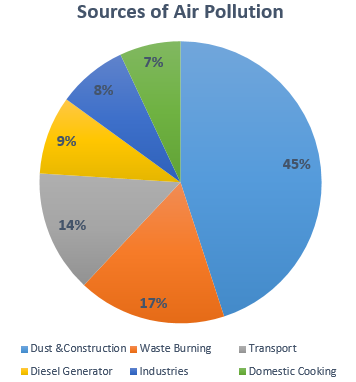
The system overview procedure was classified into Five (5) layers as shown in figure 1.

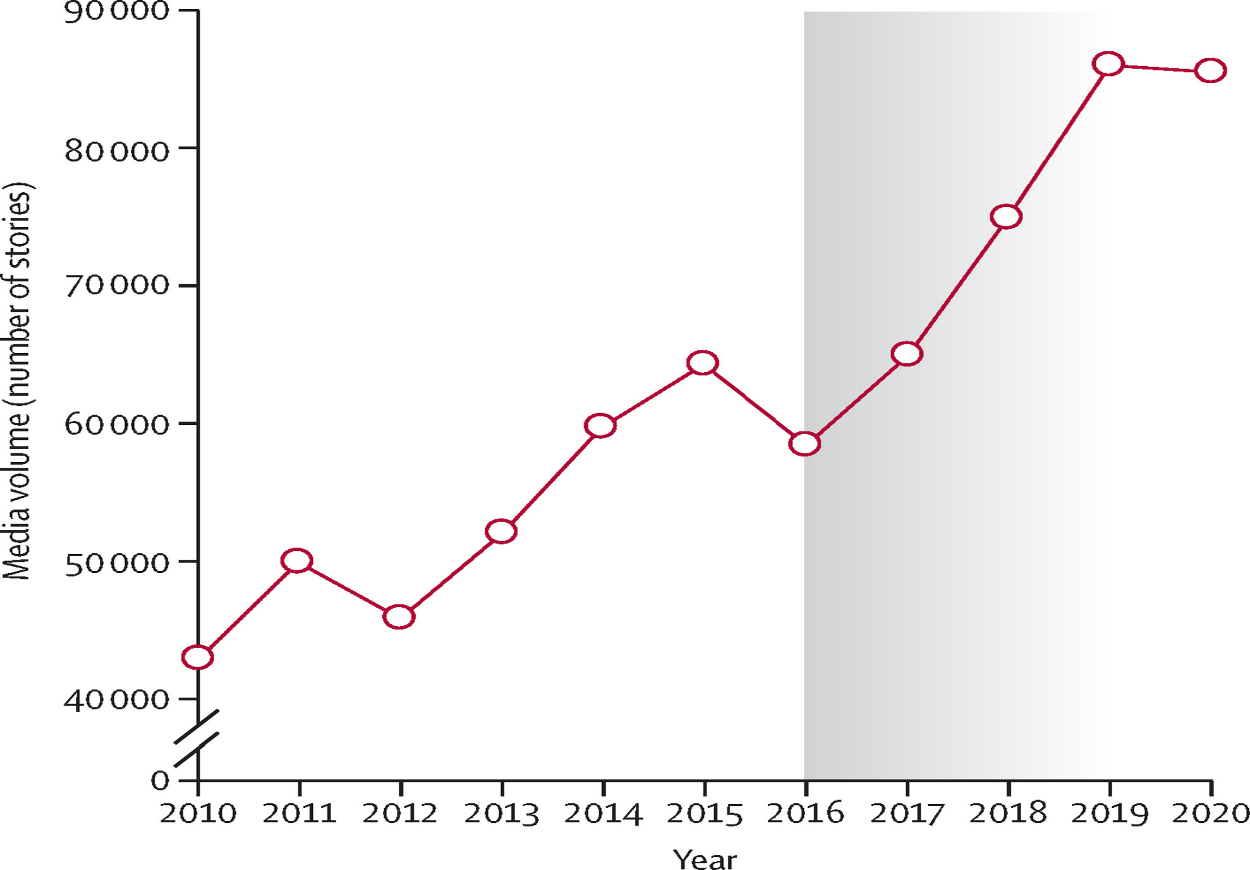
The first layer was the environmental parameters which are obtained by measurement. The second layer was the study of the characteristics and features of the sensors. The third layer was the decision making, sensing, measuring, fixing of the threshold valve, periodicity of sensitivity, timing and space. The fourth layer was the sensor data acquisition. The fifth layer was the ambient intelligence environment. The sensor collected data when operated by the microcontroller and forwarded it over the internet for analysis via the Wi-Fi module. Users were able to monitor measured parameters on their smartphones. The design specification of the proposed system is described in Table 1.

**TABLE 1** The Design Specification

|  |  |  |
| --- | --- | --- |
| **S:NO** | **COMPOUND REQUIRED** | **QUANTITY** |
| 1 | NODEMCU(ESP8266-12E) | 1 |
| 2 | MQ 135 Sensor | 1 |
| 3 | PMS5003 | 1 |
| 4 | BME280 | 1 |
| 5 | Bread Board | 1 |
| 6 | Jumper wires | As required |

**STATISTICS OF PROBLEMS CAUSED BY AIR POLLUTION**





**Fig 1.Statistics**

**4. LITERATURE REVIEW AND PROBLEM**

**IDENTIFICATION**

**4.1 LITERATURE REVIEW:**

Dias, M. J. et al proposed to monitor quality of air, a Wireless sensor network (WSN) based new framework is proposed which is based on data acquisition and transmission. The parameters of the environment to be monitored are chosen as temperature, humidity, volume of CO, volume of CO2, detection of leakage of any gas - smoke, alcohol, LPG. The values of these parameters are transmitted by using Zigbee Pro (S-2) to a base station where they are being monitored. The value of temperature and humidity are transmitted over Bluetooth also so that every person in the range of the system can check it over their smart phones and laptops as these parameters hold importance to everyone. CO, a dangerous parameter is monitored with an extra precaution. A text message is sent

to the base station through GSM module whenever its volume exceeds a particular safe limit intended for a particular application. In the research study proposed by Al-Haija, Q. A., Al-Qareeb, H., & Al-Waimi, A, we have used an innovative approach to using Can Sat to test the air quality, specifically, the presence of poisonous CO gas, at various urban locations across the city of Sharjah. A Can Sat is a simulation of a real satellite, integrated within the volume and shape of a soft drink can. The payload of the Can Sat used in this project consists of a GPS sensor, an Ardus at space board (which includes sensors for temperature, infrared, luminosity, magnetometer, accelerometer, and a gyroscope), an air quality sensor detection module and a carbon monoxide gas sensor module. The data collection has been performed in different areas considering the type of road vehicles associated with that particular area such as large trucks/trailers in an industrial area, school buses in schools, area, etc. Data collection may also vary from rush hours to regular traffic hours. Results show that the concentration of CO2/CO is significantly higher in rush hours. In general, the measured air quality near congested roads is much worse compared to an area away from main roads.

MONIKA SINGH Et al. In august 2019 proposed an Air pollution monitoring system using Arduino microcontroller, YAMUNATHANGAM Et al. in November 2018 used IOT by measuring the concentration of the gases by using various sensors. The data was collected in thing speak by means of ethernet. V.K.S.E. PHALA Et al. In November 2014 presented an air quality monitoring system that consists of air quality monitoring station, communication links, a sink node module and a data server. They developed the GSM module based on sink mode with data server pc.

**4.2 PROBLEM IDENTIFICATION:**

Air pollution is one of the most serious problems in the world. It refers to the contamination of the atmosphere by harmful chemicals or biological materials. According to the World's Worst Polluted Places by Blacksmith Institute in 2008, two of the worst pollution problems in the world are urban air quality and indoor air pollution. To solve the problem of air pollution, it's necessary to understand the issues and look for ways to counter it.

From smog hanging over cities to smoke inside the home, air pollution poses a major threat to health and climate. Ambient (outdoor) air pollution in both cities and rural areas is causing fine particulate matter which result in strokes, heart diseases, lung cancer, acute and chronic respiratory diseases.

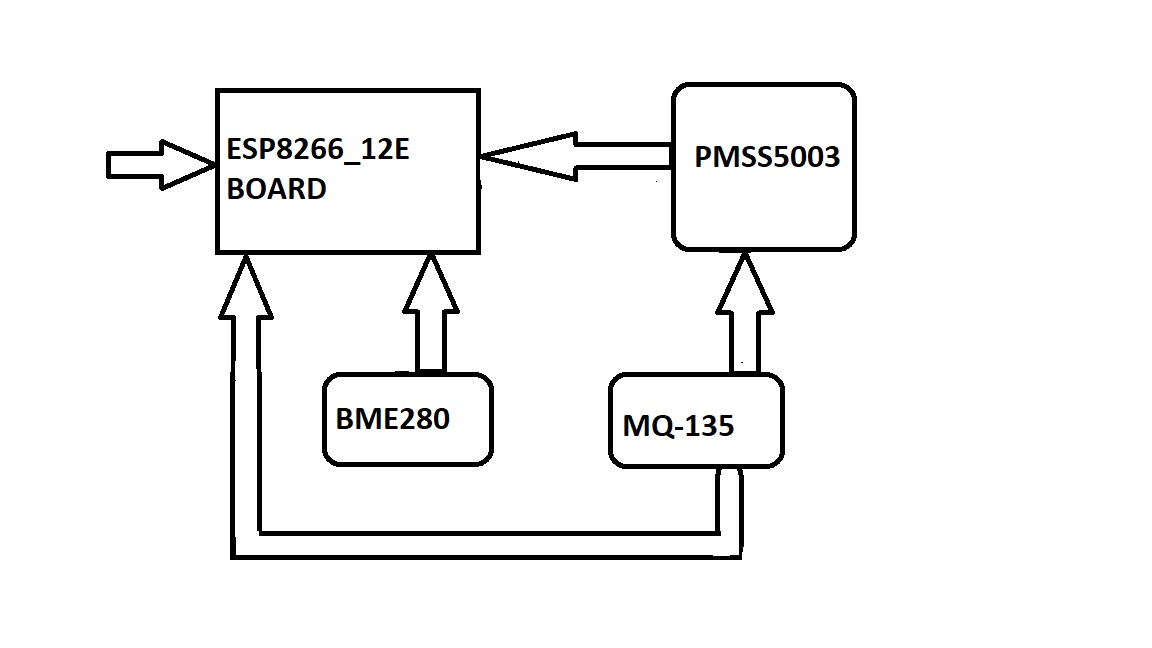
According to the recent survey, Dhaka, the capital of Bangladesh is the third in the list of most air polluted city. This air contamination makes disease, neurological, regenerative and respiratory framework. In extraordinary cases, it can likewise cause passing. As indicated by overview 50000 to 100000 unexpected losses occurred to us only because of air contamination. Along these lines, there is a requirement for checking air quality and to monitor it.

Other than human actions, air pollution is also caused by natural events. Biological decay and volcanoes release natural sulphur dioxides and nitrogen oxides, affecting air quality in negative ways. Most of the ozone around the ground level is formed when chemical reactions occur in the sunlight but there's also about 10 to 15 percent transported from the stratosphere. Other natural causes of air pollution are natural sources of particulate matters like volcanoes and dust storms, volatile organic compounds, pollen, forest fires, oceans, and forest fires.

* [Natural Air Pollution](http://www.ace.mmu.ac.uk/eae/air_quality/older/Natural_Air_Pollution.html): Highlights the main natural causes of air pollution.
* [Volcanic Gases](http://volcanoes.usgs.gov/hazards/gas/index.php): A look at volcanic gases and the effects on the Earth.
* [Mt. Sakurajima](http://gcmd.nasa.gov/records/GCMD_KADAI-OUKA-SAKURAJIMA-1992.html): A study on the air pollution brought about by the eruption of this volcano.
* [Forest Fires](http://www.env.gov.bc.ca/epd/bcairquality/topics/forest-fires-air-quality.html): Explains how forest fires can affect air quality.
* [Ground Level Ozone](http://www.k12science.org/curriculum/airproj/ozoneprimer.html): The primer explains how ground level ozone can cause air pollution.

**5. IMPLEMENTATION**

5.1 BLOCK DIAGRAM



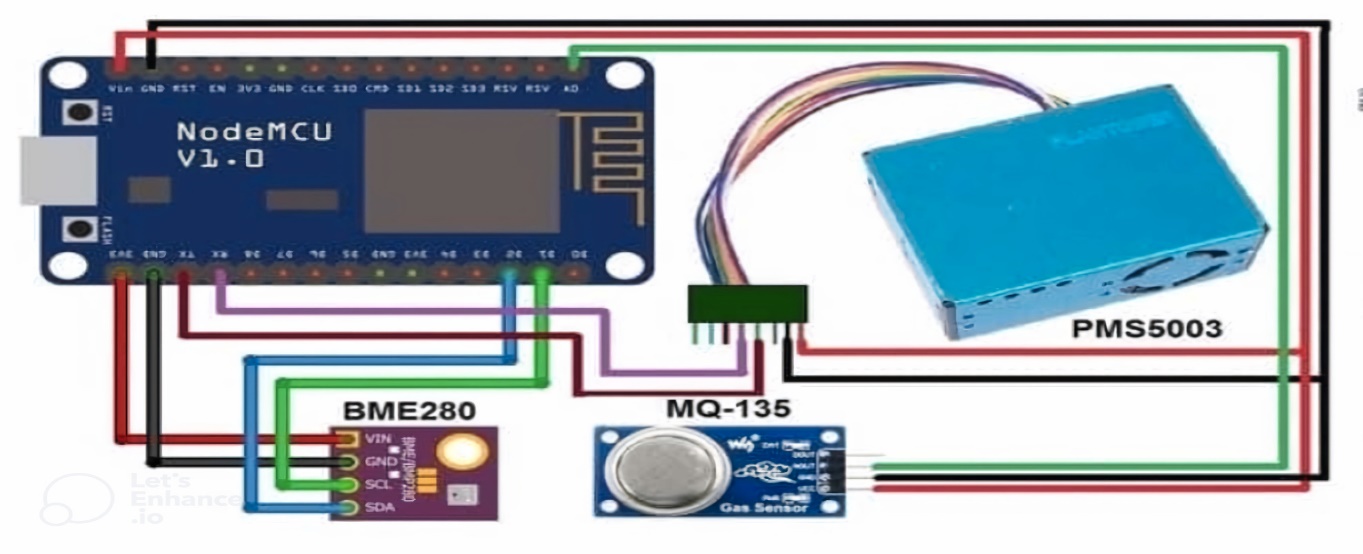
**Fig 2. block diagram**

**5.2 WORKING:**

In the beginning, the nodeMCU is operated in station mode and waits for an active LAN to connect. After connecting to a LAN, it will display the IP address by which we can visit the webpage and monitor the data. We display the IP address over the serial monitor. Note down the IP address and enter this IP address in your web browser to monitor the pollution content on the webpage. To check the working of the MQ sensor, you can just test it by providing any gas near to it. I just used a lighter to test the working of the MQ sensor. If the pollution content is more than 20% of the maximum value, then I considered it as normal. If the value is more than 20% and less than 70% of the maximum value, then it is medium, and if the value is more than 70% of the maximum value, then it is considered as dangerous level.

The sensors will gather the data of various environmental parameters and send it to the Thing speak server which displays the data online after the interval of every 15 seconds. We can install this system anywhere and can also trigger some devices when pollution goes beyond some level like we can switch on the Exhaust fan.

**5.3 CIRCUIT DIAGRAM:**



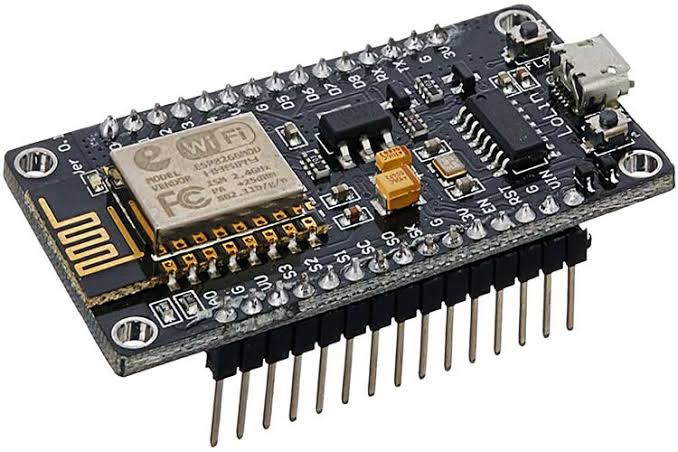
**Fig 3. Circuit diagram**

**5.4 COMPONENTS:**

**5.4.1 Node MCU:**

It is an open source Iot platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espress if Systems, and hardware which is predicted on the ESP-12 module. The term "NodeMCU" by default refers to the firmware rather than the development kits, and built on the Espress if Non-OS SDK for ESP8266.

The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware. The ESP8266 module is an extremely cost-effective board with a huge, and ever growing, community.



**Fig 4. NODEMCU**

**5.4.2 PMS5003 PM2.5 Particulate Matter Sensor:**

The Plan tower PMS5003 is a low-cost laser particle counter, one of a range of sensors by Plan tower that also include the PMS1003, PMS3003, and PMS7003. PMS5003 is a kind of digital and universal particle concentration sensor, which can be used to obtain the number of suspended particles in the air, i.e., the concentration of particles, and output them in the form of a digital interface. This sensor can be inserted into variable instruments related to the concentration of suspended particles in the air or other environmental improvement equipment to provide correct concentration data in time.



**Fig 5. PMS5003**

**5.4.3 MQ135 Gas sensor:**

The Sensitive material utilized in MQ135 gas sensor is SnO2. The conductivity of this material is lesser in clean air. The sensor conductivity goes up with hike in concentration of target pollution gas. MQ135 can monitor different kinds of toxic gases such as sulfide, ammonia gas, benzene series steam and CO2. The detection range varies between 10- 10,000 ppm along with voltage rate of about 5.0V±0.1V AC or DC.



**Fig 6. MQ135**

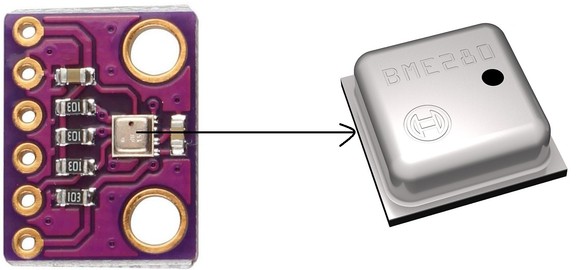
**5.4.4 BME280 Barometric Pressure Sensor:**

**BME280 Barometric Pressure Sensor:**

Bosch BME280 Humidity, Temperature & Pressure Sensor is an integrated environmental sensor which is very small-sized with low power consumption. This BME280 Atmospheric Sensor Breakout is the easy way to measure barometric pressure, humidity, and temperature readings all without taking up too much space. Basically, anything you need to know about atmospheric conditions you can find out from this tiny breakout.

**BME280 Chip:**

This module uses an environmental sensor manufactured by Bosch with temperature, barometric pressure sensor that is the next generation upgrade to the popular BMP085/BMP180/BMP183 Sensor. This sensor is great for all sorts of weather sensing and can even be used in both I2C and SPI! This precision sensor from Bosch is the best low-cost, precision sensing solution for measuring barometric pressure with ±1 hPa absolute accuracy, and temperature with ±1.0°C accuracy. Because pressure changes with altitude and the pressure measurements are so good, you can also use it as an altimeter with ±1 meter accuracy.



**Fig 7. BME280**

**5.4.5 JUMPER WIRES:**

Cabling RF jumper cables - Jumper cables are smaller and more bendable corrugated cable which is used to connect antennas and other components to the network.

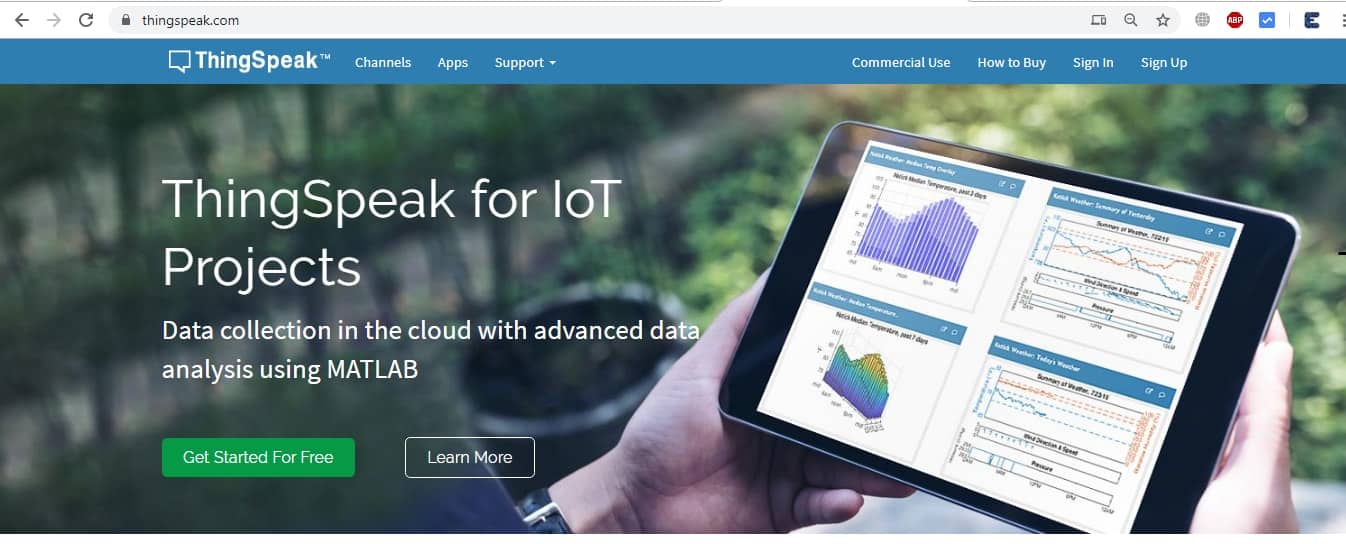


**Fig 8. Jumper wires**

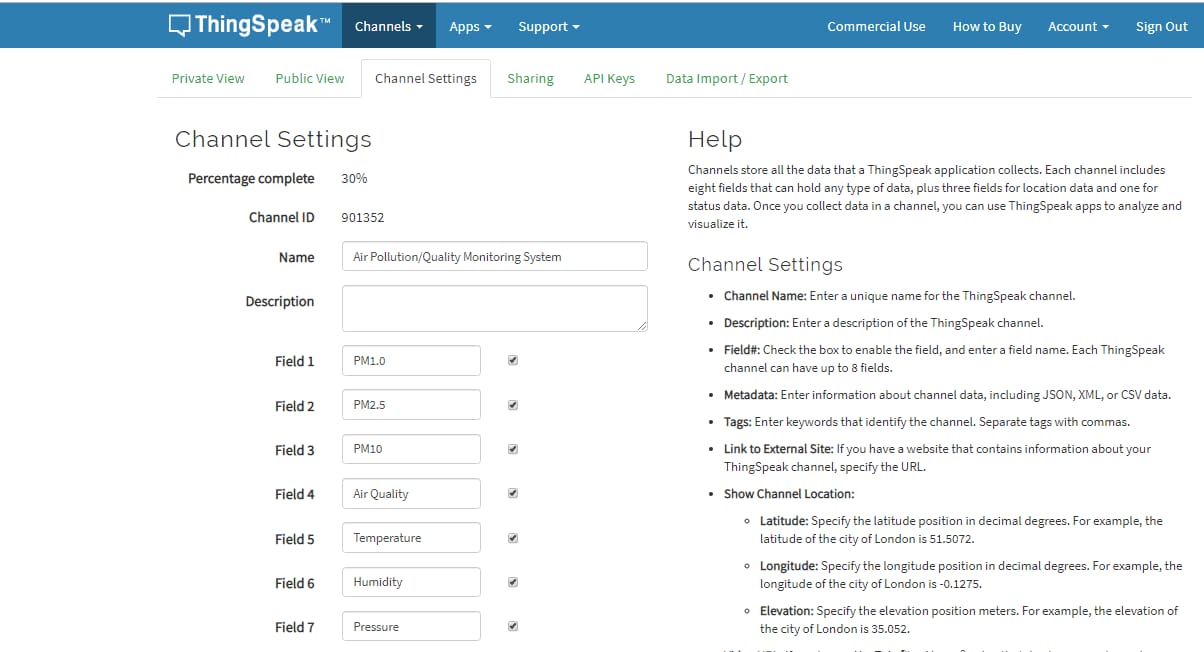
**6. SETTING UP THINGSPEAK**

We need to setup Thing speak account to monitor the data from Nodemcu ESP8266-12E online. To

setup thing speak visit https://thingspeak.com/. Here you need to create an account.

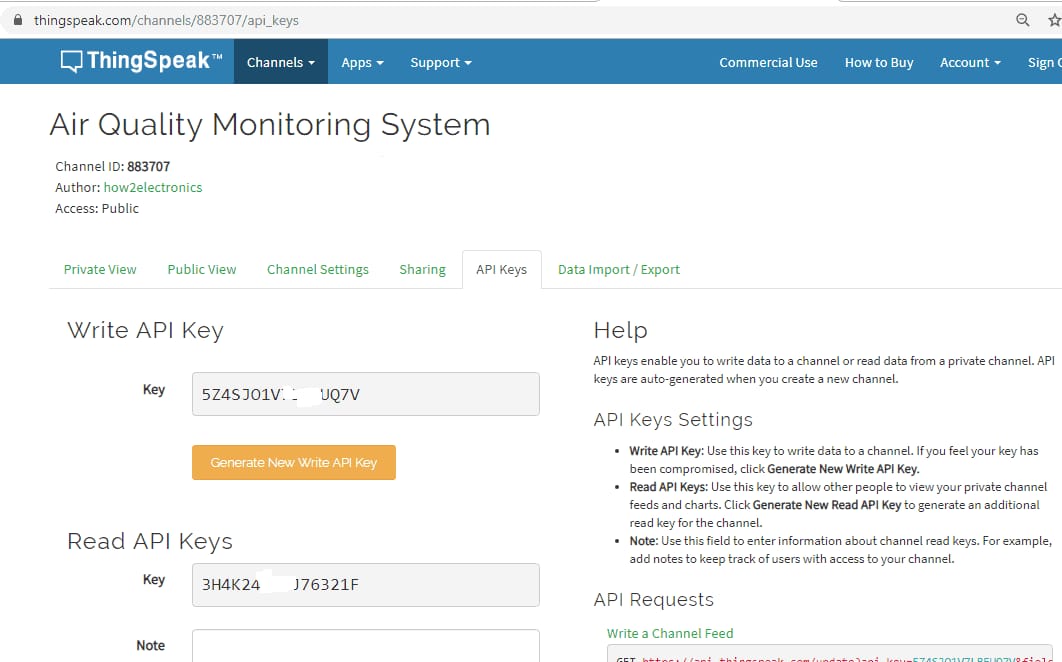


Once the account is created, you need to create a new channel by filling in the following details shown in the image below.



**Fig 9. Thing Speak**

Now copy the write API key and make a modification in the Arduino by replacing the API Key you copied.



**6.1 SOURCE CODE:**

#include <ESP8266WiFi.h>

#include <Wire.h>

#include <Adafruit\_Sensor.h>

#include <Adafruit\_BME280.h>

#include "MQ135.h"

#include <Arduino.h>

#define LENG 31 //0x42 + 31 bytes equal to 32 bytes

unsigned char buf[LENG];

int PM01Value=0 ; //define PM1.0 value of the air detector module

int PM2\_5Value=0 ; //define PM2.5 value of the air detector module

int PM10Value=0 ; //define PM10 value of the air detector module

float h, t, p, pin, dp ;

char temperatureFString[6];

char dpString[6];

char humidityString[6];

char pressureString[7];

char pressureInchString[6];

Adafruit\_BME280 bme; // I2C

String apiKey = "ILT5H176HEJ901OX";

// replace with your routers

const char\* ssid = "PAVAN";

// replace with your routers password

const char\* password = "PAVANPAVAN";

const char\* server = "api.thingspeak.com";

WiFiClient client;

void setup ()

{

Serial.begin(9600);

delay (10);

Serial.println();

Serial.print("Connecting to ");

Serial.println(ssid);

WiFi.begin(ssid, password);

while (WiFi.status()!= WL\_CONNECTED) {

delay (500);

Serial.print(".");

}

Serial.println("");

Serial.println("WiFi connected");

// Printing the ESP IP address

Serial.println(WiFi.localIP());

if (!bme.begin())

{

Serial.println("Could not find a valid BME280 sensor, check wiring!");

while (1);

}

}

void loop ()

{

if(Serial.find(0x42)){ //start to read when detect 0x42

Serial.readBytes(buf,LENG);

if(buf[0] == 0x4d){

if(checkValue(buf,LENG)){

PM01Value=transmitPM01(buf); //count PM1.0 value of the air detector module

PM2\_5Value=transmitPM2\_5(buf);//count PM2.5 value of the air detector module

PM10Value=transmitPM10(buf); //count PM10 value of the air detector module

}

}

}

static unsigned long OledTimer=millis();

if (millis() - OledTimer >=1000)

{

OledTimer=millis();

Serial.print("PM1.0: ");

Serial.print(PM01Value);

Serial.println(" ug/m3");

Serial.print("PM2.5: ");

Serial.print(PM2\_5Value);

Serial.println(" ug/m3");

Serial.print("PM10 : ");

Serial.print(PM10Value);

Serial.println(" ug/m3");

Serial.println();

MQ135 gasSensor = MQ135(A0);

float air\_quality = gasSensor.getPPM();

Serial.print("Air Quality: ");

Serial.print(air\_quality);

Serial.println(" PPM");

Serial.println();

h = bme.readHumidity();

t = bme.readTemperature();

t = t\*1.8+32.0;

dp = t-0.36\*(100.0-h);

p = bme.readPressure()/100.0F;

pin = 0.02953\*p;

dtostrf(t, 5, 1, temperatureFString);

dtostrf(h, 5, 1, humidityString);

dtostrf(p, 6, 1, pressureString);

dtostrf(pin, 5, 2, pressureInchString);

dtostrf(dp, 5, 1, dpString);

Serial.print("Temperature = ");

Serial.println(temperatureFString);

Serial.print("Humidity = ");

Serial.println(humidityString);

Serial.print("Pressure = ");

Serial.println(pressureString);

Serial.print("Pressure Inch = ");

Serial.println(pressureInchString);

Serial.print("Dew Point = ");

Serial.println(dpString);

Serial.println("...............................................");

if (client.connect(server,80)) // "184.106.153.149" or api.thingspeak.com

{

String postStr = apiKey;

postStr +="&field1=";

postStr += String (PM01Value);

postStr +="&field2=";

postStr += String (PM2\_5Value);

postStr +="&field3=";

postStr += String (PM10Value);

postStr +="&field4=";

postStr += String(air\_quality);

postStr +="&field5=";

postStr += String(temperatureFString);

postStr +="&field6=";

postStr += String(humidityString);

postStr +="&field7=";

postStr += String(pressureInchString);

postStr += "\r\n\r\n";

client.print("POST /update HTTP/1.1\n");

client.print("Host: api.thingspeak.com\n");

client.print("Connection: close\n");

client.print("X-THINGSPEAKAPIKEY: "+apiKey+"\n");

client.print("Content-Type: application/x-www-form-urlencoded\n");

client.print("Content-Length: ");

client.print(postStr.length());

client.print("\n\n");

client.print(postStr);

}

client.stop();

}

}

char checkValue(unsigned char \*thebuf, char leng)

{

char receiveflag=0;

int receiveSum=0;

for (int i=0; i<(leng-2); i++) {

receiveSum=receiveSum+thebuf[i];

}

receiveSum=receiveSum + 0x42;

if(receiveSum == ((thebuf[leng-2]<<8)+thebuf[leng-1])) //check the serial data

{

receiveSum = 0;

receiveflag = 1;

}

return receiveflag;

}

int transmitPM01(unsigned char \*thebuf)

{

int PM01Val;

PM01Val=((thebuf[3] <<8) + thebuf[4]); //count PM1.0 value of the air detector module

return PM01Val;

}

//transmit PM Value to PC

int transmitPM2\_5(unsigned char \*thebuf)

{

int PM2\_5Val;

PM2\_5Val=((thebuf[5]<<8) + thebuf[6]); //count PM2.5 value of the air detector module

return PM2\_5Val;

}

//transmit PM Value to PC

int transmitPM10(unsigned char \*thebuf)

{

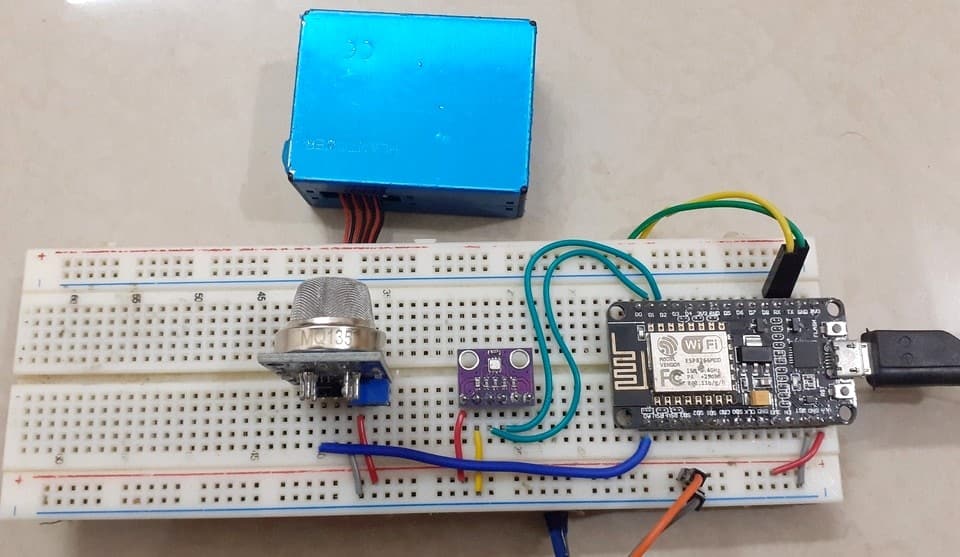
int PM10Val;

PM10Val=((thebuf[7]<<8) + thebuf[8]); //count PM10 value of the air detector module

return PM10Val;

}

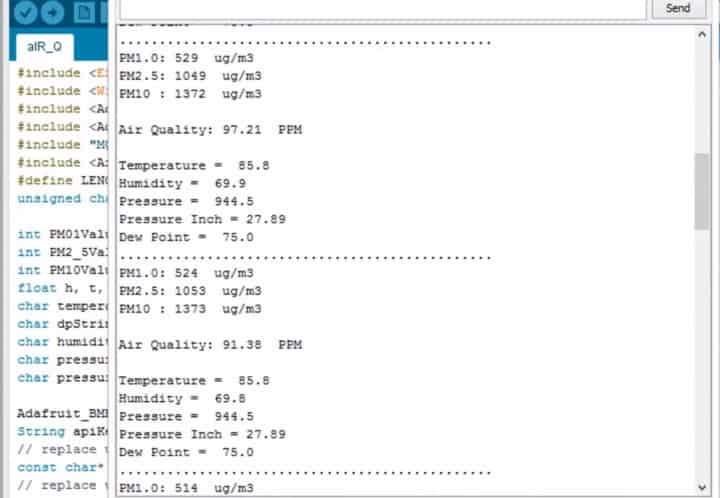
**7. OUTCOMES**



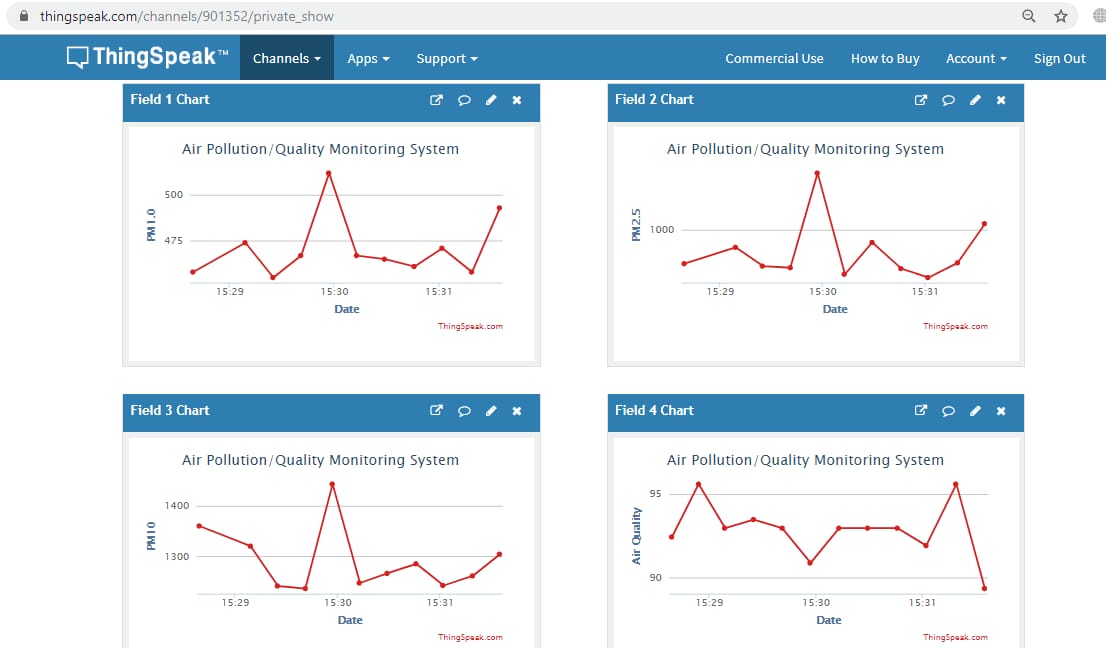
**Fig 10. Outcomes**

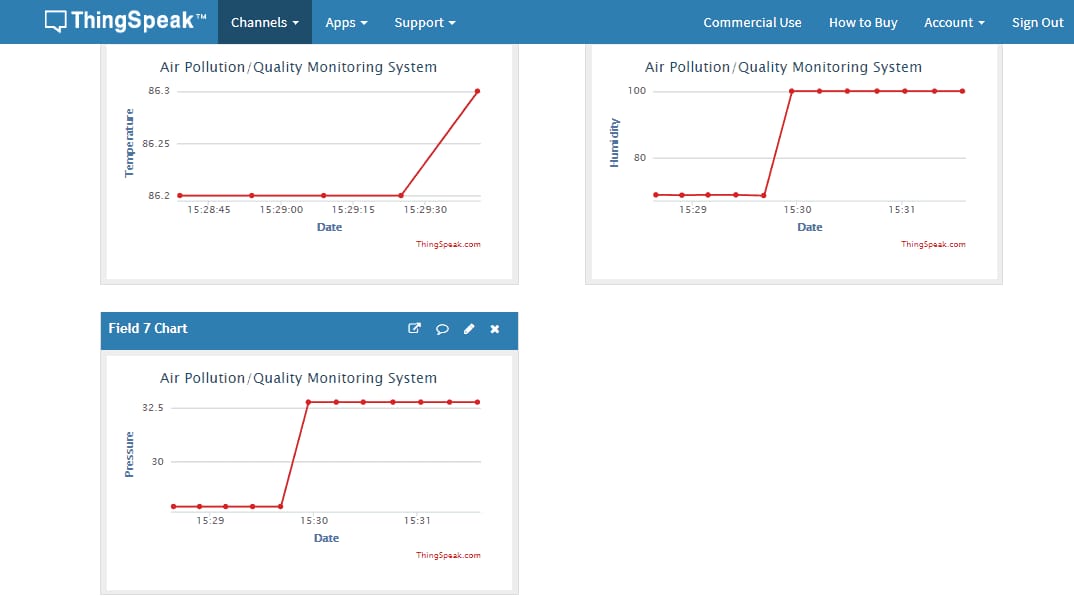
NODEMCU is connected to a device with the help of a USB, which will helppower up the system.

When we upload data to the NODEMCU, the system starts working and the measurement data will be shown. Once the code is uploaded to NodeMCU, you can click on the serial monitor and see the following results.



Similarly, you can go to Thing speak and check the private view to see the following graph below.





**8. CONCLUSION**

The System is integrated with other modern tools such as Air Quality Sensors, Gas Sensors, Node microcontroller unit Boards for making the process of automation more interactive. By placing our equipment in different locations, we can collect the readings of different gases present in the air and updated on cloud. This tool displays the details of polluted air in the developed mobile app and the same information is updated to the cloud. The data stored in the cloud can be further analyzed to know the air quality according to the recorded region. This helps in knowing the major cause and pollutants contributing to the polluted air and suitable precautionary measures can be taken to overcome and minimize the air pollution.

**10.1 FUTURE SCOPE OF THE PROJECT:**

Newly developing sensor technology could make air pollution monitoring more accessible and may be vital in accelerating much-needed reductions in air pollution. Below, we discuss new developments for detecting air pollution in cities with the use of sensors.

Many cities around the world have adopted the use of pollution sensors to address air pollution. It is likely that over the coming years, sensors will become more commonplace, with cities implementing innovative strategies such as installing sensors onto public transport to help protect residents from the harmful effects of air pollution exposure.

There is an upgraded version of BME280 Sensor called BME680 Sensor, that can also measure Index of Air Quality (IAQ) & can be used to measure Air Quality as well. So, the single sensor is enough to replace BME280 & MQ-135.

**10.2 REFERENCES:**

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