Air Pollution Prediction System by using IoT

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ABSTRACT
In this project we are going to describe about the "Air Pollution Prediction System", its usage and benefits in daily life. Air pollution and its harm has become a serious problem in many cities around the world. Now days the level of pollution is increasing rapidly due to factors like industries, urbanization increasing in population, vehicle use which can affect human health. To prevent or avoid these problems one of the preventive measures is to install an Air pollution prediction system at the crowd related area .The proposed idea of this project is to monitor the air quality, temperature and humidity over a cloud using internet. It will trigger a buzzer when the air quality goes high beyond a certain level; means when the total amount of harmful gasses like co2, smoke, alcohol, benzene & NH3 are high in air then the buzzer creates sounds. It will show the air quality, humidity & temperature on the LCD as well as on cloud, so that air pollution can be predicted very easily. The system use Esp8266, Dht11 (temp. and humidity sensor), MQ-135(gas sensor), buzzer, LCD lights, a bread board and some jumper wires to connect the components with each other. At the end, the objective of this project was achieved and the system worked effectively.

Keywords
IOT, Esp8266, MQ-123(gas sensor), Dht11 (temp. and humidity)

1. INTRODUCTION
1.1 An air pollution prediction system
An air pollution prediction system is designed to alert us to protect ourselves from the polluted air which is very harmful for our health. In this section we have discussed about the statistical data related to air and role of air and role of air pollution prediction system.

1.2 Air statistic in India
As per the national Crime record Bureau about over 60 people die every day in India due to air pollution. According to a survey, due to air pollution includes 50,000 to 1, 00,000 premature deaths per year occur in India. Health problem in India have been growing at faster rate especially in urban areas of developing countries where industrialization and growing number of vehicles leads to release of lots of gaseous pollutants. In India many cases in harmful effects of pollution include mild allergic reactions such as irritation of the throat, nose and eye as well as some serious problems like bronchitis, heart disease, pneumonia, lung and aggravated asthma. According to the state of Global Air 2020 report , air pollution in India killed more than 116,000 infants within a month of birth in 2019(and a total of 1.67 million Indians).In 2019,the central government launched the national clean AirProgram(NACP),the country's first-even pan-India air quality initiative. The programme aims to achieve a 20-30 percent reduction in particulate pollution by 2024.Many of these deaths could have been prevented, it we had been aware of and taken enough air protection measures.

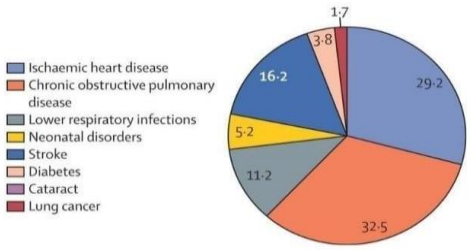

Figure 1: Statistics on of deaths caused due to air pollution

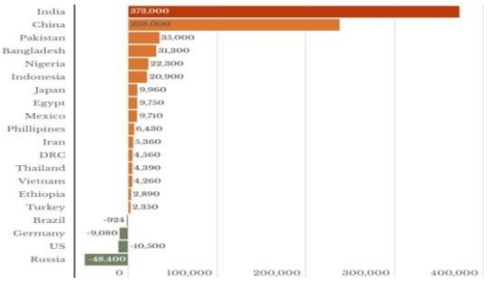

Figure 2: Pollution rate of India

1.3 Role of Air Pollution Prediction System
An air pollution prediction system is a system that receives data, assesses and then responds to events reported by various air predictors. Air prediction systems are permanently installed manual and automatic systems to detect air quality and warn those who may get affected and quickly inform about the current air quality, temperature and humidity .Air pollution prediction systems are mostly installed in anywhere such as industrial areas, urban areas on any crowded areas. Air predictors are important because they can predict/give you an early signal to protect from harmful gasses. An early prediction can get you out of a situation that would potentially turn into a big problem.

1.4 Need of an Air pollution prediction system
In air pollution prediction system we can monitor and control the air quality, temperatureand humidity via things peak in cloud. There is a gas sensor that detects air quality and things peak show the air quality rate and create sound if the harmful air quality rate is increased and we want to control or take some action. That's why we need a system that canwarn us anytime for which we can protect ourselves easily.

2. PROJECT OBJECTIVE
The main objective is of our project is to build an air pollution prediction system in order to overcome the limitations of air pollution. In this project, we are going to build an air pollution prediction system using ESP8266, DHT11 sensor to sense the temperature and humidity MQ-135 sensor to sense the gas or air quality.

3. STUDY ON INTERNET OF THINGS

3.1 Introduction to IoT

Imagine a world where billions of objects can sense, communicate and share information,all interconnected over public or private Internet Protocol (IP) networks. These interconnected objects have data regularly collected, analysed and used to initiate action, providing a wealth of intelligence for planning, management and decision making. This is the world of the internet of things (IoT).

Figure 3: IoT

The Internet of things refers to a type of network to connect anything with the Internet based on stipulated protocols through information sensing equipment to conduct information exchange and communications in order to achieve smart recognitions, online upgrade, detecting and administration.

Internet of things (IoT) is an ecosystem of connected physical objects that are accessible through the internet. The 'thing' in IoT could be a person with a heart monitor or an automobile with built-in sensors, i.e. objects that have been assigned an IP address and have the ability to collect and transfer data over a network without manual assistance or intervention [6]. The IoT concept was coined by a member of the Radio Frequency Identification (RFID) development community in 1999, and it has recently become more relevant to the practical world largely because of the growth of mobile devices, embedded and ubiquitous communication, cloud computing and data analytics

We define IoT into three categories as below: Internet of things is an internet of three things:

1. People to people
2. People to machine /things
3. Things /machine to things /machine, interacting through internet.

Internet of Things (IoT) is a concept and a paradigm that considers pervasive presence in the environment of a variety of things/objects that through wireless and wired connections and unique addressing schemes are able to interact with each other and cooperate with other things/objects to create new applications/services and reach common goals.

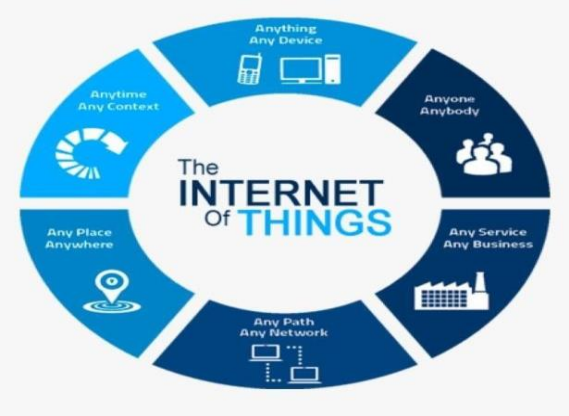

Figure 4: An overview of IoT

Internet of Things refers to the general idea of things ,especially everyday objects, that are readable, recognizable, locatable, addressable through information sensing device and/or controllable via the Internet, irrespective of the communication means (whether via RFID, wireless LAN, wide area networks, or other means). Internet of Things is a new revolution of the internet.

3.2 Major components of IoT

We all have heard about Internet of Things, IoT is a transformation process of connecting our smart devices and objects to network to perform efficiently and access remotely. The major components of Internet of Things are:

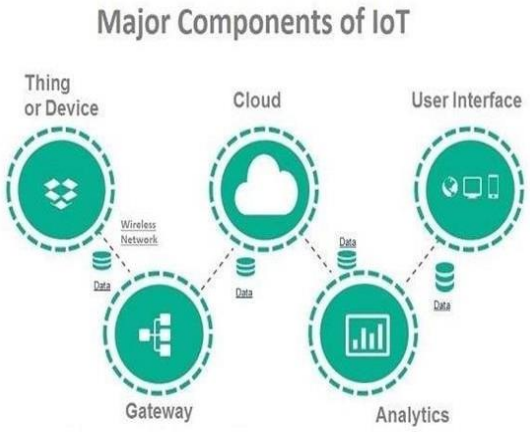

Figure 5: Components of IoT

3.2.1 Sensors

Sensors are the components of the device used for connectivity with the external world.These smart sensors are continiously collecting data from the enviornment and transmit the information to the next layer.Latest tecniques in the semiconductor technology are capable of producing micro smart sensors for various application.

Common sensors are:

- Temperature sensors and thermostats
- Pressure sensors
- Humidity/Moisture level
- Light intensity detectors

- Moisture sensors
- Proximity detection
- RFID tags

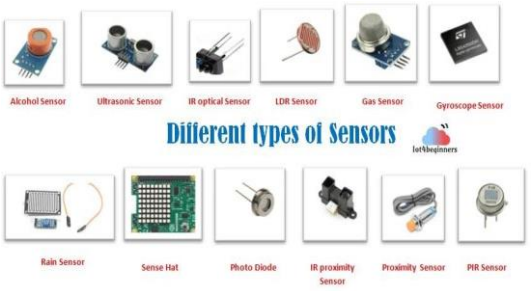

Figure 6: Diff, types of sensors

3.2.2 Gateway

IoT Gateway manages the bidirectional data traffic between different networks and protocols. Another function of gateway is to translate different network protocols and make sure interoperability of the connected devices and sensors. Gateways can be configured to perform preprocessing of the collected data from thousands of sensors locally before transmitting it to the next stage. In some scenarios, it would be necessary due to compatibility of TCP/IP protocol. IoT gateway offers certain level of security for the network and transmitted data with higher order encryption techniques. It acts as a middle layer between unauthorized access.

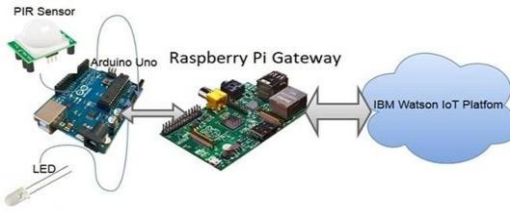

Figure 7: Gateway connection

3.2.3 Cloud

Internet of things creates massive data from devices, applications and users which has to be managed in an efficient way. IoT cloud offers tools to collect, process, manage and store huge amount of data in real time.

Industries and services can easily access these data remotely and make critical decisions when necessary. Basically,IoT cloud is a sophisticated high-performance network of servers optimized to perform high speed data processing of billions of device, traffic management and deliver accurate analytics. Distributed database managements systems are one of the most important components of IoT cloud.

Figure 8: IoT connection to cloud

3.2.4 Analytics

Analytics is the process of converting analog data from billons of smart sensors into usefulinsights which can be interpreted and used for detailed analysis .Smart analytics solutions are inevitable for IoT system for management and improvement of the entire system. One of the major advantages of an efficient IoT system is real time smart analytics which helps engineers to find out irregularities in the collected data and act fast to prevent an undesired scenario. Service providers can prepare for further steps if the information is collected accurately at the right time. Big enterprise use the massive data collected from IoT devices and utilize the insights for their future business opportunities. Careful analysis will help organisations to predict trends in the market and plan ahead for a successful implementation. Information is very significant in any business model and predictive analysis ensures success in concerned area of business line.

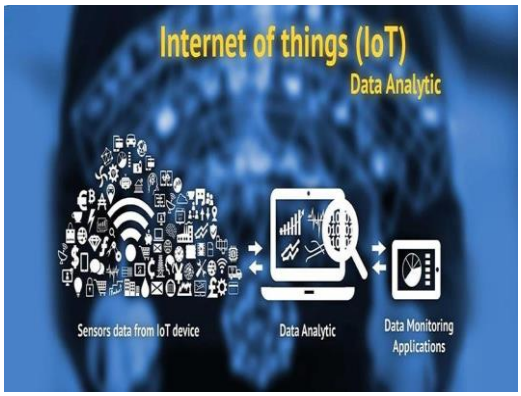

Figure 9: Data analysis of IoT

3.2.5 User interface

User interfaces are the visible, tangible part of the IoT system which can be accessible by users.

Designers will have to make sure a well-designed user interface for minimum effort for users and encourage more interactuins.Modern technology offers much interactive design to ease complex tasks into simple touch panels controls. Multicolour touch panels have replaced hard switches in our household appliances and the trend is increasing for almost every smart home devices. User will be interested to buy new devices or smart gadgets if it is very user friendly and compatible with common wireless standards.

3.2.6 Actuator

An actuator operates in the reverse direction of sensor. They are crucial as sensorsas once the sensor have detected a change in the environment; an actuator is required to make something happen based on the trigger. It takes an electrical input and turns

into physical actions. For example buzzer , sprinkler, electric motor.

3.3 Features of IoT

The fundamental characteristics of IoT are as follows:

a. Interconnectivity: With regard to the IoT, anything can be interconnected with the global information and communication infrastructure.

B: Things-related services: The IoT is capable of providing thing-related services within the constraints of things, such as privacy protection and semantic consistency between physical things and their associated virtual things, both the technologies in physical world and information world will change.

c. Heterogeneity: The device in IoT are heterogeneous as based on different hardware platforms and networks. They can interact with other devices or service platforms through different networks.

d. Dynamic changes: The state of devices change dynamically, e.g. sleeping and waking up, connected and/or disconnected as well as the context of devices including location and speed. Moreover, the number of devices can change dynamically.

e. Enormous scale: The number of devices that need to be managed and that communicate with each other will be at least an order of magnitude larger than the devices connected to the current Internet. Even more critical will be the management of the data generated and their interpretation for application purposes. This relates to semantics of data, as well as efficient data handling.

f. Safety: As we gain benefits from the IoT, we must not forget about safety. As both the creators and as we gain benefits from the IoT, we must not forget about safety. This includes the safety of our personal data and the safety of our physical well-being. Securing the end points, the networks, and the data moving across all of it means creating a security paradigm that will scale.

g. Connectivity: Connectivity enables network accessibility and compatibility. Accessibility is getting on a network while compatibility provides the common ability to consume and produce data.

Applications of IoT

Potential applications of the IoT are numerous and diverse, permeating into practically all areas of every-day life of individuals, enterprises, and society as a whole. The IoT application covers “smart” environments/spaces in domains such as: Transportation, Building, City, Lifestyle, Retail, Agriculture, Factory, Supply chain, Emergency, Healthcare, User interaction, Culture and tourism, Environment and Energy [10]. Below are some of the IoT applications:

a. Remote Control Appliances: Switching on and off remotely appliances to avoid accidents and save energy.

b. Smart Home Aplliance:Refrigeratorswith LCD screen telling what’s inside, food that’s about to expire, ingrediants you need to buy and with all the information available on a Smartphone app.Washing machines allowing you to monitor the laundry remortly,and kitchen ranges with interface to a smartphone app allowing remortly adjustable temperature control and monitoring the oven’s self-cleaning feature and many more.

c. Safety Monitoring : Cameras, and home alarm systems making people feel safe in their daily life at home.

K,d. Intrusion Detection Systems: Detection of fire and smoke in buildings, hospitals, shopping malls etc.

e. Lightning: Intelligent and weather adaptive lighting in street lights.

f. Transportation: Smart Roads and Intelligent High-ways with warning messages and diversions according to climate conditions and unexpected events like accidents or traffic jams.

g. Smart Parking: Real-time monitoring of parking spaces availability in the city making residents able to identify and reserve the closest available spaces.

h. Waste Management: Detection of rubbish levels in containers to optimize the trash collection routes. Garbage cans and recycle bins with RFID tags allow the sanitation staff to see when garbage has been put out.

i. Air Pollution monitoring: Control of CO2 emissions of factories, pollution emitted by cars and toxic gases generated in farms.

j. Forest Fire Detection: Monitoring of combustion gases and preemptive fire conditions to define alert zones.

k. Weather monitoring: Weather conditions monitoring such as humidity, temperature, pressure ,wind speed and rain , earthquake Early Detection etc.

l. River Floods: Monitoring of water level variations in rivers, dams and reservoirs during rainy days.

m. Patients Surveillance: Monitoring of conditions of patients inside hospitals and in old people’s home.

n. Medical Fridges: Control of conditions inside freezers storing vaccines, medicines and organic elements.

o. Fall Detection: Assistance for elderly or disabled people living independent.

p. Green Houses: Control micro-climate conditions to maximize the production of fruits and vegetables and it’s quality.

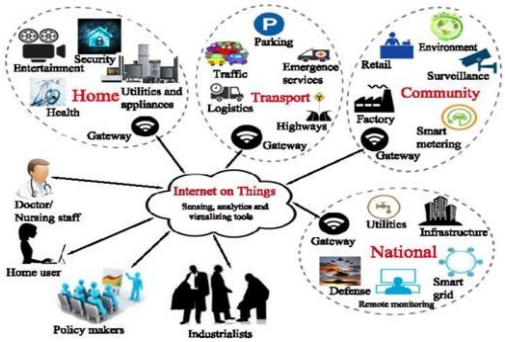

Figure 10: Applications of IoT

4. PROPOSED WORK

4.1 Methodology

Basically, the design and development of this project are divided into two main parts which are hardware specification and software specification. In the hardware architecture, the design of the circuit was constructed and the prototype of the project was built. While in the software development, the whole complete prototype was operated via programming codes.

4.1.1 Hardware Specification

The components that are used in the IoT based Fire Detection System are:

a) ESP8266

b) DHT11 (temperature humidity sensor)

c) LCD (display) for i2c communication

d) MQ-135 (gas sensor)

a) ESP8266

The ESP8266 WiFi Module is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. 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, meaning, you can simply hook this up to your Arduino device and get about as much WiFi-ability as a WiFi Shield offers (and that's just out of the box)! The ESP8266 module is an extremely cost-effective board with a huge, and ever growing, community.

Figure 11: ESP8266

b) DHT11

from it once every 2 seconds, so when using the library from Adafruit, sensor readings can be up to 2 seconds old.The DHT11 is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). Its fairly simple to use, but requires careful timing to grab data. You can get new dataComes with a 4.7K or 10K resistor, which you will want to use as a pullup from the data pin to VVC.

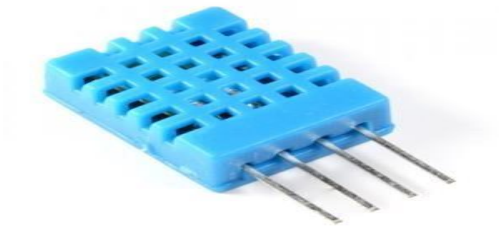

Figure 12:DHT11

c) LCD (display) for I2C Communication:-

This is a basic (16x2) 16 character by 2 line display. Black text on Green background. It is used to indicate the Air and Humidity in PPM. Fig. 6 shows LCD (16x2).

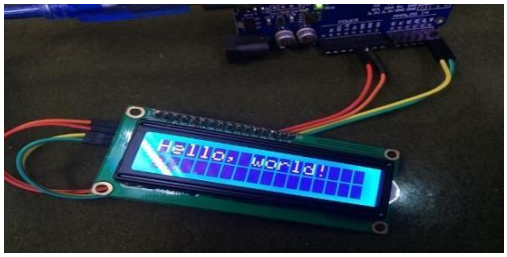

Figure 13: LCD Pannel

d) MQ135 Gas Sensor

MQ135 Gas Sensor is an air quality sensor for detecting a wide range of gases, including NH3, NOx, alcohol, benzene, smoke and CO2. Ideal for use in office or factory. MQ135 gas sensor has high sensitivity to Ammonia, Sulfide and Benzene steam, also sensitive to smoke and other harmful gases. It is with low cost & particularly suitable for Air quality monitoring application.

Features:

- High sensitivity to Ammonia, Sulfide and Benzene.
- Stable and Long Life.
- Detection Range: 10 - 300 ppm NH3, 10 - 1000 ppm Benzene, 10 - 300 ppm Alcohol.
- Heater Voltage: 5.0V.
- Dimensions: 18mm Diameter, 17mm High excluding pins, Pins - 6mm High.

Figure 14: MQ-135

The Arduino Integrated Development Environment or Arduino Software (IDE) contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

4.1.2 Software Specification

a) Arduino IDE

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate withthem.

Figure 14: Arduino IDE

b) ThingSpeak

"ThingSpeak" is an IoT analytics platform service that allows you to aggregate, visualize and analyze live data streams in the cloud. It provides instant visualizations of data posted by your devices to ThingSpeak. With the ability to execute MATLAB® code in ThingSpeak you can perform online analysis and processing of the data as it comes in. ThingSpeak is often used for prototyping and proof of concept IoT systems that require analytics.

What is IoT?

Internet of Things (IoT) describes an emerging trend where a large number of embedded devices (things) are connected to the Internet. These connected devices communicate with people and other things and often provide sensor data to cloud storage and cloud computing resources where the data is processed and analyzed to gain important insights. Cheap cloud computing power and increased device connectivity is enabling this trend.

IoT solutions are built for many vertical applications such as environmental monitoring and control, health monitoring, vehicle fleet monitoring, industrial monitoring and control, and home automation.

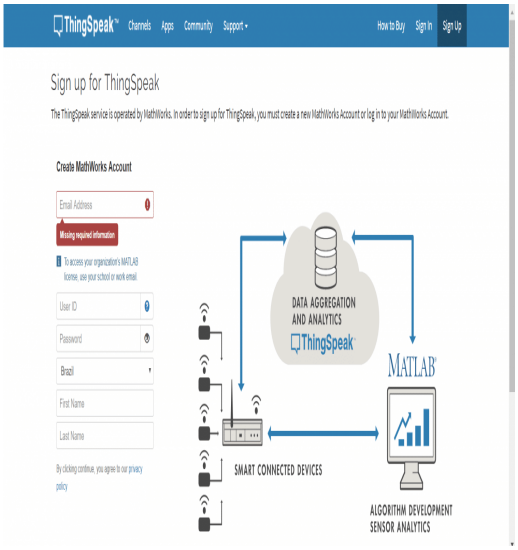

Figure 16: thingspeak monitoring

ThingSpeak Key Features:-

ThingSpeak allows you to aggregate, visualize and analyze live data streams in the cloud. Some of the key capabilities of ThingSpeak include the ability to:

- Easily configure devices to send data to ThingSpeak using popular IoT protocols.
- Visualize your sensor data in real-time.
- Aggregate data on-demand from third-party sources.
- Use the power of MATLAB to make sense of your IoT data.
- Run your IoT analytics automatically based on schedules or events.
- Prototype and build IoT systems without setting up servers or developing web software.
- Automatically act on your data and communicate using third-party service.

4.1.3 Schematic Diagram

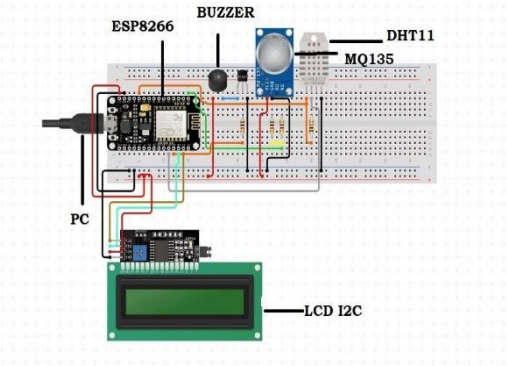

Figure 17: Schematic Diagram of Air Pollution Prediction System

4.1.4 Block Diagram

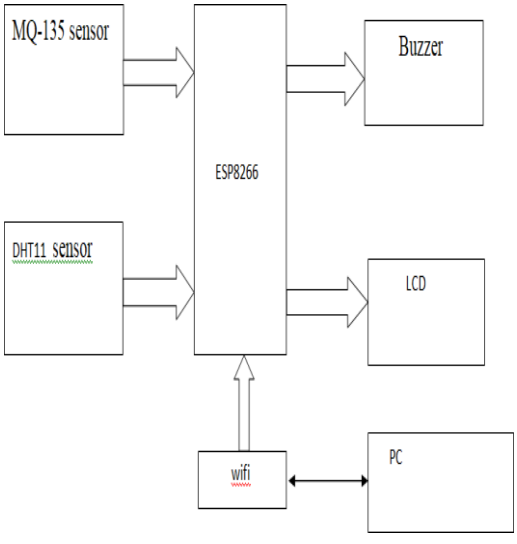

Figure 18: Block Diagram of Air Pollution Prediction System

4.1.5 Simulation Program

// Use this file to store all of the private credentials

// and connection details

```
#define SECRET_SSID "realme 2"  // replace MySSID with your WiFi network name

#define SECRET_PASS "12345678"  // replace MyPassword with your WiFi password

#define SECRET_CH_ID 1733211  // replace 0000000 with your channel number

#define SECRET_WRITE_APIKEY"XLY5DORD8G3TGDAV" // replace XYZ with your channel write API Key

#include <ESP8266WiFi.h> #include "secrets.h"

#include "ThingSpeak.h" // always include thingspeak header file after other header files and custom macros

#include "DHT.h" #include <Wire.h>

#include <LiquidCrystal_I2C.h> LiquidCrystal_I2C lcd(0x27, 16, 2);

char ssid[] = SECRET_SSID; // your network SSID (name)
char pass[] = SECRET_PASS; // your network password

int keyIndex = 0;  // your network key Index number (needed only for WEP) WiFiClient client;

#define DHTPIN D5 #define DHTTYPE DHT11

DHT dht(DHTPIN, DHTTYPE);unsigned long myChannelNumber = SECRET_CH_ID;

const char * myWriteAPIKey = SECRET_WRITE_APIKEY;
void setup() {

lcd.begin(); lcd.backlight(); Serial.begin(115200); WiFi.mode(WIFI_STA);

ThingSpeak.begin(client); // Initialize ThingSpeak
Serial.println(F("DHTxx test!"));

dht.begin(); pinMode(A0, INPUT);

}

void loop()

{

if(WiFi.status() != WL_CONNECTED)

{

Serial.print("Attempting to connect to SSID:");
Serial.println(SECRET_SSID);

while (WiFi.status() != WL_CONNECTED

 {

WiFi.begin(ssid, pass); // Connect to WPA/WPA2 network. Change this line if using open or WEP network

Serial.print("."); delay(5000);

}

Serial.println("\nConnected.");

}

float gas = analogRead(A0);

gas = map(gas, 0, 1023, 0, 100); float h = dht.readHumidity();
float t = dht.readTemperature(); lcd.setCursor(0, 0);
lcd.print("T:");

lcd.print(t); lcd.print((char)223); lcd.print("C");
lcd.setCursor(10, 0); lcd.print("H:"); lcd.print(h);
lcd.setCursor(0, 1); lcd.print("Air Quality: "); lcd.print(gas);

ThingSpeak.writeField(SECRET_CH_ID, 1, t, SECRET_WRITE_APIKEY);
ThingSpeak.writeField(SECRET_CH_ID, 2, h, SECRET_WRITE_APIKEY);
ThingSpeak.writeField(SECRET_CH_ID, 3, gas, SECRET_WRITE_APIKEY);

}
```

5. WORKING OF THE DEVICE

• First, we have to turn on wifi whose id-password is given in the program.

• After that the ESP8266module of device gets connected with the wifi.

• DHT11, is used in this device which sense the temperature, humidity.

• Another module LCD I2C where the temperature, humidity and the air quality are shown on LCD panel.

• MQ-135 gas sensor senses the harmful gases and when the air quality gets worsen and reaches to 60 or above then the buzzer will creates sound.

• Then program will connect with the device through USB port. Now we have to search ThingSpeak in any search engine.

• ThingSpeak is an open-source software written in Ruby which allows users to communicate with internet enabled devices.

• In facilitates data access, retrieval and logging of data by providing an API to both the devices and social network websites.

• ThingSpeak stores data in private channels by default, but public channels can be used to share data with others.

• Once data is in ThingSpeak channel, developer can analyze and visualize it, calculate new data or interact with social media, web services and other devices.

• Users can simply go to ThingSpeak and then sign in with ThingSpeak and search channel id or air pollution prediction system then they can seetemperature, humidity and air quality.

6. EXPERIMENTAL OUTPUTS

Few tests were done to observe the systems performance. The tests were completed by gas sensor i.e MQ135. Figure19 displays the temperature, air quality and humidity on LCD panel. Figure 20 and figure21 shows the graphical representation

of air quality, temperature and humidity thingspeak through cloud.

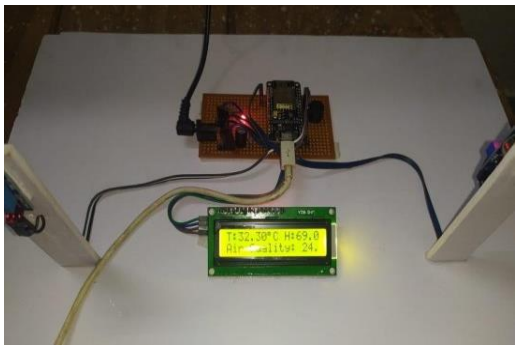

Figure:19(Experimental Outputs)

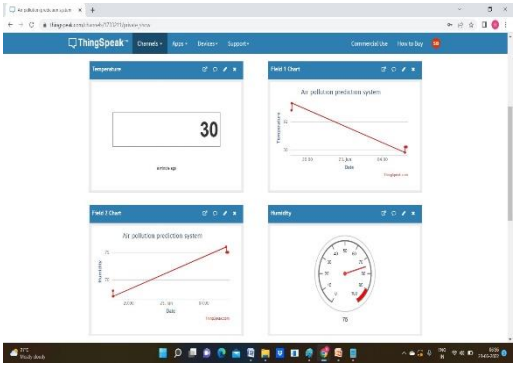

Figure:20(Graphical Representation)

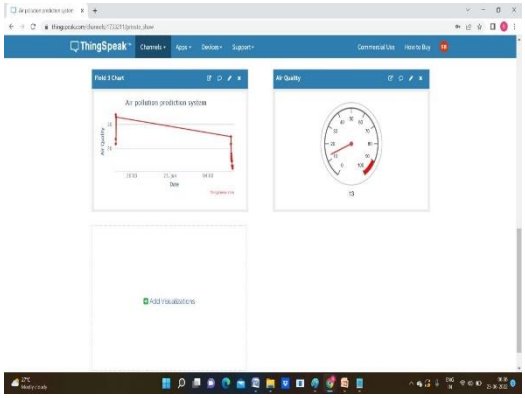

Figure:21(Graphical Rpresentation)

7. CONCLUSION & FUTURE WORK

7.1 Conclusion

This project has been made in order to help people to know about the pollution in air in their nearby surroundings. Based on the results obtained, by the air pollution predictor people can be altered and can take precautions. In fact, the system built is cheap in value compared to other existing alarm system in the market and easy to apply in buildings. The ability to detect the pollution is due to the use of gas sensor in the system. this device can be applied in several areas due to its flexibility and simplicity in handling; for instance, in hotels, factories, medicals, crowd areas etc. As the buzzer creates sound when air quality is worsened, people can easily get alerted, and they can take prevention like wear masks.

7.2 Future Work

This project gives us an idea about applications of IoT and smart device developmentwhich we can utilize in our future research work. The applications stated above are some demo applications that are absolutely possible with its future development. Initially for the limitation of time we were able to do develop just a flame detector alarm system. So, we have a big work scope in this sector. We hope that, we will be able to complete all features needed for its ultimate applications.

8. ACKNOWEDGEMENT

Our thanks to Dr. Tapaswini Nayak who have contribute towards development of the template.

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