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# Journal of Air Quality Monitoring System

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## Air Quality Monitoring System

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### Abstract

Nowadays cities specially like metropolitan cities are now facing one of the most serious problem i.e. Pollution. Indian cities are the one of the most polluted cities in the world. Air pollution causes a lot of harm to our surroundings and also causes a lot of health problems to people around us. These health problems include breathing diseases like asthma, chronic obstructive pulmonary disease, chronic bronchitis, emphysema etc. Neglecting air pollution may cause various kinds of problems to us which include more hospital admissions, premature death, lung problems which may even include lung cancer, breathing problems, wheezing, coughing, and worsening of existing cardiac conditions and respiratory conditions. Our motivation is to focus on serious problems like gas leaks and other hazards like explosion of flammable gases, chemical burns, cold burns and poisoning.

### 1.Introduction

#### 1.1 Big Domain

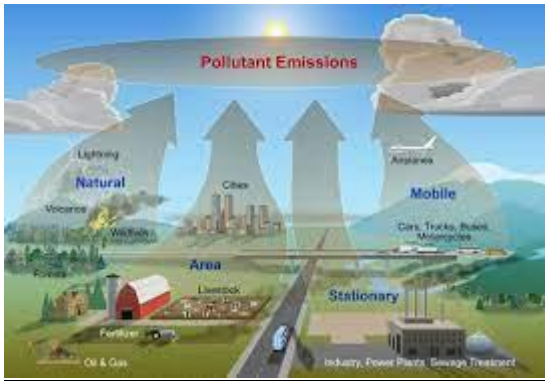
Air pollution refers to the introduction of harmful pollutants in the air that is very poor for the health of humans and other living organisms. It is mostly caused by production and energy use. Activities which increase the level of air pollution include burning of fossil fuels, burning of crops, etc. When gases like carbon-dioxide and methane are released into the air, it causes an increase in the Earth's temperature causing global warming. Another harmful air pollutant is smog which is a mixture of smoke and fog. It contains minute particles of dust, allergens,

smoke, etc. which can even cause heart attacks and hasten death.

#### 2.2 Problem Statement

Through this project we are trying to closely monitor the quality of air which is present around us. We are trying to monitor the quality of air in an accurate manner by analyzing the various constituents of air which play a major role towards polluting the air around us. Some of these constituents of air include carbon-di-oxide, carbon-monoxide, ammonia, PM 2.5,

temperature and humidity. We can find out the values of the mentioned constituents through the help of different sensors. We can display the values on an lcd screen and also send this data to a cloud based server and display the value through the help of a mobile app.



### 3.3 Motivation

Air pollution causes a lot of harm to our surroundings and also causes a lot of health problems to people around us. These health problems include breathing diseases like asthma, chronic obstructive pulmonary disease, chronic bronchitis, Emphysema etc. The three most common types of pollution are that of air, water and food, but air pollution is the most common of all the three. It is very necessary to monitor air quality. Neglecting air pollution may cause various kinds of problems to us which include more hospital admissions, premature death, lung problems which may even include lung cancer, breathing problems, wheezing, coughing, and worsening of existing cardiac conditions and respiratory conditions. This may even severely impact the financial conditions of a patient if excessive medication use and

more hospital admissions are required. Our motivation is to focus on serious problems like gas leaks and other hazards like explosion of flammable gases, chemical burns, cold burns and poisoning. These problems can be solved if we can measure the level of gases responsible for these hazards in our surroundings.



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### 4.4 Contribution Towards Society

This IOT based air quality monitoring system will make people more aware about their surroundings. People can avoid hazards, accidents and various types of illnesses by easily accessing the various air quality parameters in their nearby surroundings. Help can be provided to workers who are working in tough environmental conditions by the concerned authorities. This can be achieved by keeping real-time control on our IOT based solution. Air monitoring can be made easier through effective SMS alerts and Detection of toxic gases can be made much easier. The monitoring of temperature and humidity can be helpful in the analysis of required situation and can be helpful to keep a favorable environment, particularly in the field of mining.

## 2.Literature

The level of pollution has increased with times by lot of factors like the increase in population, increased vehicle use, industrialization and urbanization which results in harmful effects on human wellbeing by directly affecting health of population exposed to it. In order to monitor this, 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 webserver using internet and will trigger an alarm when the air quality goes down beyond a certain level. Due to flexibility and low-cost Internet of things (IoT) is getting popular day by day. With the urbanization and with the increase in the vehicles on road, environment conditions are getting affected. Some of the air quality parameters include CO<sub>2</sub> (colorless, odorless, non-combustible gas). Moreover, it is considered under the category of asphyxiate gases that have the capability of interfering the availability of oxygen for tissues. SO<sub>2</sub> (Sulphur Dioxide is a colorless gas, detected by a distinct odour and taste.) NO<sub>2</sub>. (Nitrogen Dioxide is easily detectable for its odour, it is brown in color and is highly corrosive). Other parameters include Smoke, LPG, temperature and humidity. The components needed are gas sensor, Arduino uno, resistors, Wi-Fi module, lcd, breadboard, buzzer. Arduino is a single-board microcontroller meant to make the application more accessible

which are interactive objects and its surroundings. The MQ-2 Smoke sensor can detect or measure gases like LPG, Alcohol, Propane, Hydrogen and even Methane. Wi-Fi connects the whole process to the internet and LCD is used for the visual output. The air monitoring system overcomes the problem of the highly-polluted areas which is a major issue. The buzzer is used to raise an alarm as soon as the air pollution level exceeds safety mark. This system has features for people to monitor amount of air pollution using this application. We have proposed an air quality and pollution monitoring system that allows us to monitor and check live air quality and pollution through IOT system, has used air sensors to sense presence of harmful gases and compounds in the air and constantly transmit this data. The sensors react with Arduino uno which processes the data and transmits it over application. This shows authorities to monitor air pollution in different areas and act against it. The instruments used in this conventional monitoring system have some drawbacks which are their large size, heavy weight and their extremely high cost. All these drawbacks lead to sparse deployment of the monitoring systems. Careful selection of locations are required to deploy these monitoring stations because air pollution situation in urban areas is highly related to human activities and is location dependent. (Areas with traffic choke points have higher air pollution).

This system can be installed anywhere and can also trigger some device when pollution goes

beyond some level, like we can send alert SMS to the user.

Air pollution can have a terrible impact on the environment and human health because of release

of lethal gases by vehicles emission, factories and elevated amount of inhale particulate matter

in the atmosphere. in this we are preparing Arduino micro controller - based air quality monitoring

system. Which can measure parameters likes temperature, humidity, and methane using various

sensors. the measurements are taken based on parts per millions (PPM) metrics and the data were collected through sensor-based LCD.

And these data are collected and analyzed numerically and graphically so that the civilians living in the area can a better idea of the pollution

level around them. in a recent study it is found that 40% of schoolchildren suffer from poor lungs

out of 2000 students. Arduino Uno is an open-source micro controller board that is based on a

microchip ATmega 328p. Sensors can be called as a bridge between digital data and external

environment here 5 sensors are used each sensor have different task. DHT22 is used to detect

the temperature and humidity. MQ-4 used to detect methane; MQ-9 used to detect the carbon

monoxide .MG811 is used for carbon dioxide.

The chemicals and pollutants are also responsible for various environmental calamities

like acid rain and depletion of ozone layer because of a number of anthropogenic actions,

air pollution is on the growth and its controlling is of significant importance to alleviate

particular actions to limit it. With the help of future technology, the sensor will become cheaper and more common, inexpensive, portable air quality sensor which can be

wearable by people to observe the air quality. These devices are linked to computer

through serial connection and data become documented and plotted in real time. The two

major sensor used are LM393 and MQ135 are gas sensing analysis [8,9,10] . We have

used cigarette smoke, coil burning smoke, vehicle smoke from streets etc. we analyzed data from the above sources and here is the result for that.

Time(second)	Value(ppm)	Distance(meter)
02	74(Fresh air)	0.5
04	123(Polluted air)	0.3
06	96(Polluted air)	0.4
08	170(Polluted air)	0.2
10	79(Fresh air)	0.6
12	80(Fresh air)	0.55
14	70(Fresh air)	0.8

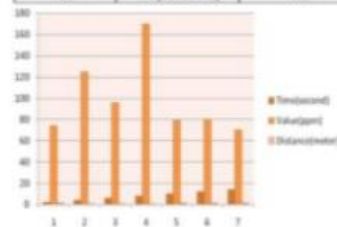
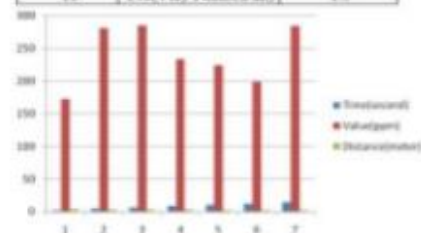


Table 3: Tabular representation of motorcycle smoke data

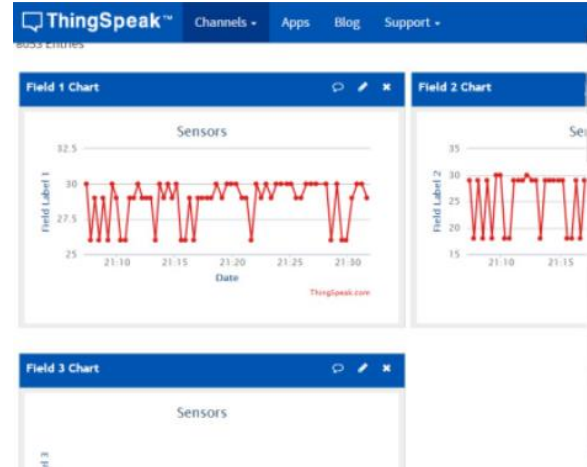
Time(second)	Value(ppm)	Distance(meter)
02	172(Polluted air)	3
04	283(Very Polluted air)	2.3
06	283(Very Polluted air)	2.2
08	233(Very Polluted air)	2.3
10	224(Very Polluted air)	2.1
12	199(Polluted air)	2.7
14	284(Very Polluted air)	1.9
16	246(Very Polluted air)	1.3



### 3. Background

#### Dataset and its description

There wasn't any inbuilt dataset present beforehand in our project. Since we just require to test our project's prototype in the sufficient air conditions, we are not dealing with an ML model thus, we are not directly dependent on training our model on datasets and then testing on other datasets like a typical machine learning model. We are sending data to the thinkspeak server through the help of our wifi module and the thinkspeak server has an inbuilt database which is storing all the required entries, hence neglecting the need of us needing a specific dataset to work upon. We can test our model under different conditions and store the corresponding observations in the database of our iot cloud based server – thinkspeak.



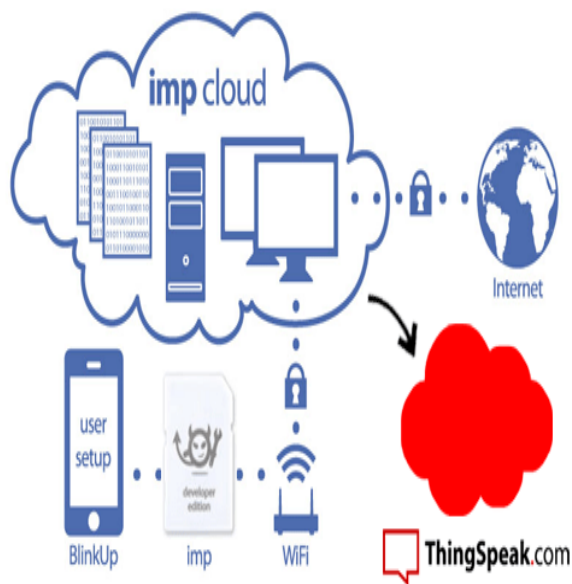
### 4. Methodology

#### 4.1 Approach

##### Hardware

##### (1) Arduino Uno:

Arduino is an open-source electronics platform based on easy-to-use hardware and software whose boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output or activating a motor, turning on an LED or publishing something online.





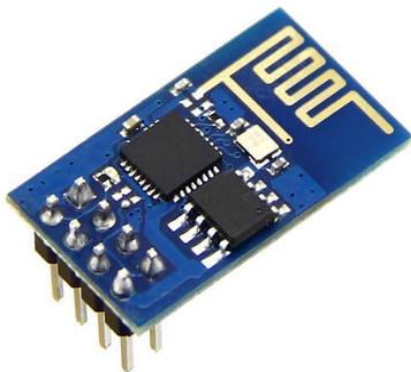
(2) 16x2 LCD Panel:



A 16x2 LCD has the capacity to display 16 characters per line and there are 2 such lines. Each character is displayed in 5x7 pixel matrix and the 16 x 2 intelligent alphanumeric dot matrix display is capable of showing 224 different characters and also symbols.

(3) Wi-Fi Module(ESP8266):

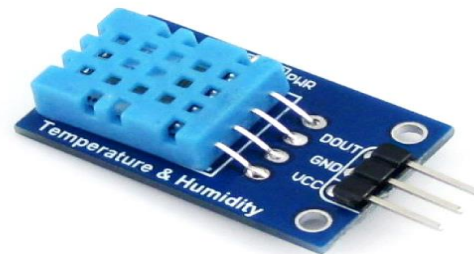
The ESP8266 WiFi Module is a self contained SOC which contains an integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network and is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor.



Sensors

We have used 4 important sensors in this project.

(4) **Temperature and Humidity sensor (DHT 11)**



The DHT11 is a basic and ultra low-cost digital temperature and humidity sensor. which uses a capacitive humidity sensor along with a thermistor to measure the surrounding air, and spits out a digital signal on the data pin without the need of analog inputs.

(5) **Air Quality Sensor PM 2.5 (MQ 135)**



MQ-135 Gas Sensor is an air quality sensor for detecting a wide range of

gases and also PM 2.5 which we measured in this project.

## (6) Carbon Monoxide Sensor(MQ 7)



MQ-7 is a Carbon Monoxide (CO) sensor which is best suitable for sensing Carbon Monoxide concentrations (PPM) in the air and also can measure CO concentrations ranging from 20 to 2000ppm.

## (7) MQ5 Sensor



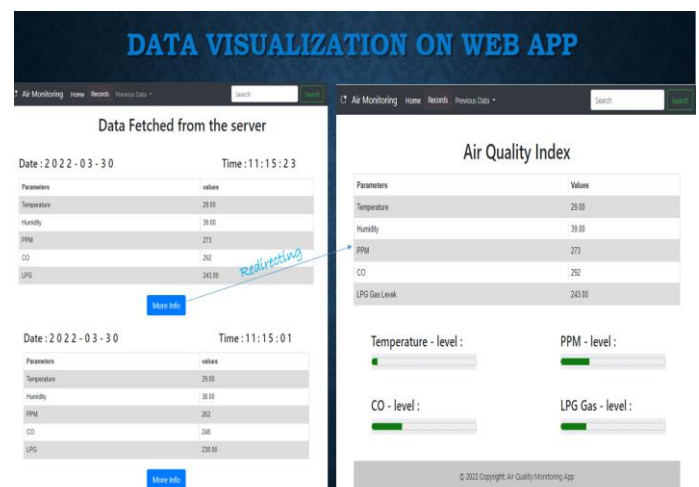
MQ-5 is a highly sensitive gas sensor which has the capability of detecting liquefied petroleum gas (LPG), methane, propane, butane, and other combustible gases which are present in the air.

## Software Implementation

The project has 2 software components

### 1. Website

It is built on bootstrap framework and the backend being built on the NodeJS using MongoDB atlas to fetch the data for the algorithm and uses EJS algorithm specifically built of the application. The application can run on laptops, PCs, smartphones etc.



### Tabular Representation of Data



*Graphical Representation of previous data*

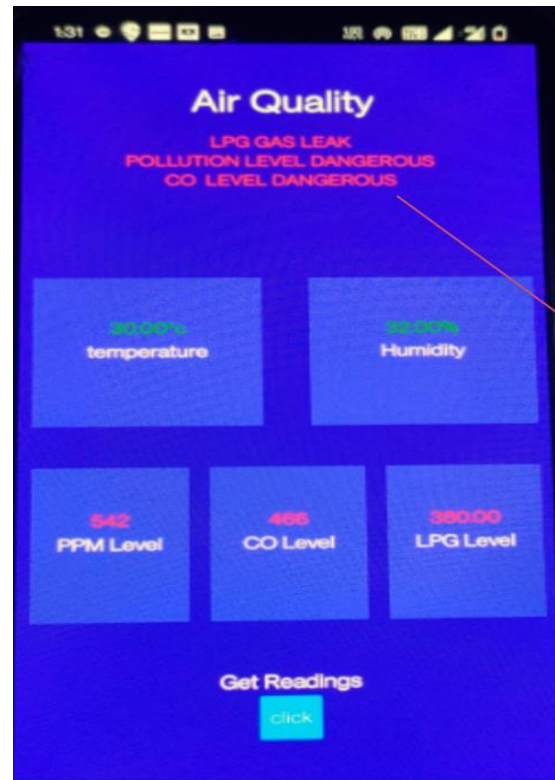
## 2. Mobile Application

We have also made a mobile application to cater to needs of the end users who find it easy to view the values of the data of their mobile phones.

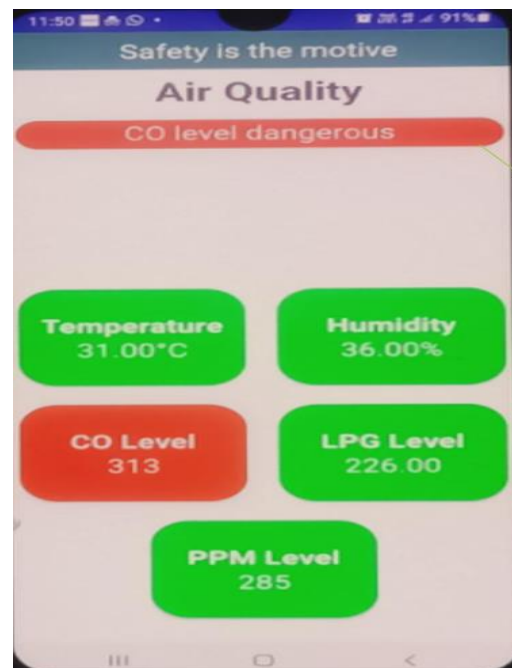
Two mobile applications have been made. The first one has been made with the help of MIT App Inventor.

The second app has been made with the help of firebase on Android Studio which also has the option of notifying the users in case of any hazard.

The app displays the values of all the parameters and gives a warning signal if any parameter exceeds its danger limit.



*App made using MIT app inventor, giving us the required warning signals.*



*App made with the help of firebase and Android Studio*



## 4.2 Mathematical Proofs

We have mathematically set the threshold values of the parameters of the air quality index as follows :-

Temperature:- 60 degree

CO :- 300ppm

PM 2.5 – 400ppm

LPG – 250ppm

PM 2.5 = (no. of micrograms of pollutant)/(cubic metre of air)

Temperature in degree celcius =  $1.8 * (\text{temperature in degree fahrenheit}) + 32$

## 4.3 Algorithm

Our project works on the basis of the following algorithm :-

We connect all the wires and the sensors along with the potentiometer and the wifi module and the 16x2 lcd with the help of the Arduino Uno microcontroller. All the sensors are analog sensors except the dht 11 sensor which is a digital sensor and has no analog input pins. We then set the dht 11 sensor in such a way so that we get different values for temperature and humidity and not a single combined ambiguous value. Similarly we set the pin configuration such that we receive separate values from all the given sensors and connect it accordingly with the 16x2 LCD to get the required values shown separately and keep the LCD connected with the potentiometer. We connect the whole system to the esp8266 Wifi module which helps to send all the data of the air quality parameters to the thinkspeak cloud server which has an inbuilt database from which data can be retrieved to the mobile application as well as the website.

## 5. Result Analysis

### Performance Parameter

This project provides a combination of process of sensing several gas levels in the air and also the ambient temperature and humidity, thus sensing the quality of the air.

The levels of the gases and the temperature is displayed in a LCD display panel as well as on the mobile and the laptop screen, which continuously shows the real time output values of all the gas sensors , temperature and humidity sensor.

Value(ppm)
172(Polluted air)
281(Very Polluted air)
285(Very Polluted air)
233(Very Polluted air)
224(Very Polluted air)
199(Polluted air)
284(Very Polluted air)
246(Very Polluted air)

```
COM1 (Arduino/Genuino Uno)
Air is poluted
Air quality= 72 PPM
Limit= 1
Fresh Air
Air quality= 124 PPM
Limit= 1
Air is poluted
Air quality= 80 PPM
Limit= 1
Air is very poluted.Leave the place
Air quality= 86 PPM
Limit= 1
Air is poluted
Air quality= 118 PPM
Limit= 1
Air is poluted
Air quality= 75 PPM
Limit= 1
Fresh Air
Air quality= 96 PPM
Limit= 1
```

## Experiment Setup

Arduino is a single-board microcontroller meant to make the application more accessible which are interactive objects and its surroundings.

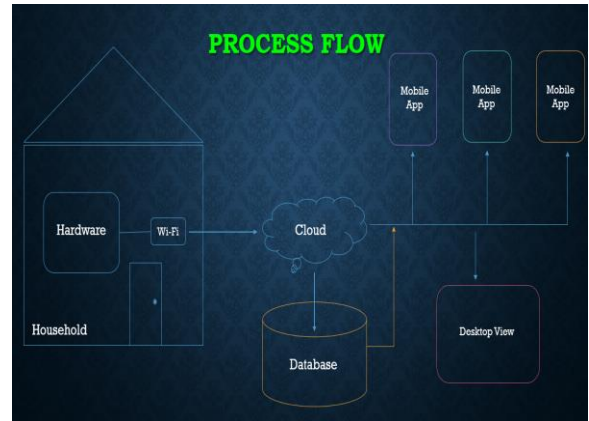
The MQ-5 sensor can detect or measure gases like LPG ,Alcohol, Propane, Hydrogen and even Methane.

Wi-Fi connects the whole process to the internet and LCD is used for the visual output. The air monitoring system overcomes the problem of the highly-polluted areas which is a major issue.

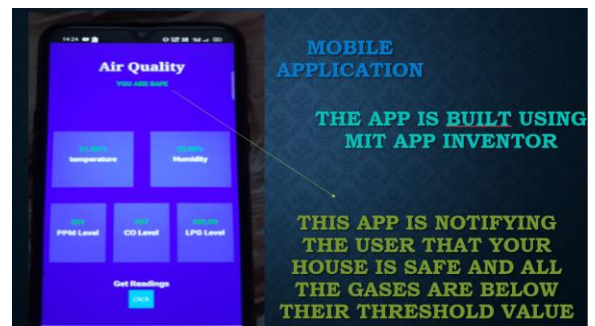
A danger signal is raised as soon as the air pollution level exceeds safety mark.

This system has features for people to monitor amount of air pollution using this application. We have proposed an air quality and pollution monitoring system that allows us to monitor and check live air quality and pollution through IOT system, has used air sensors to sense presence of harmful gases and compounds in the air and constantly transmit this data.

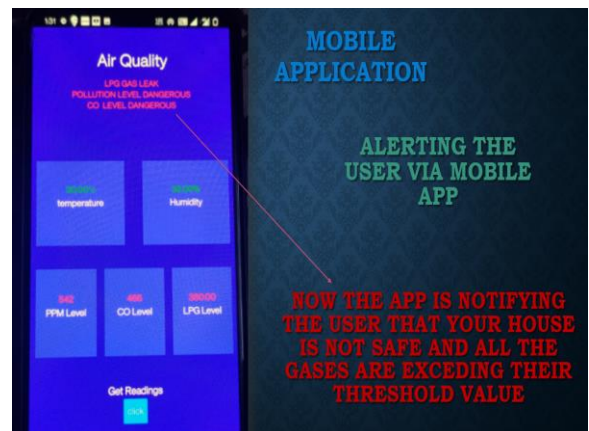
The sensors react with Arduino uno which processes the data and transmits it over application. This shows authorities to monitor air pollution in different areas and act against it.



## Experiment Result



All values below danger mark



LPG,PM 2.5, CO level above danger levels

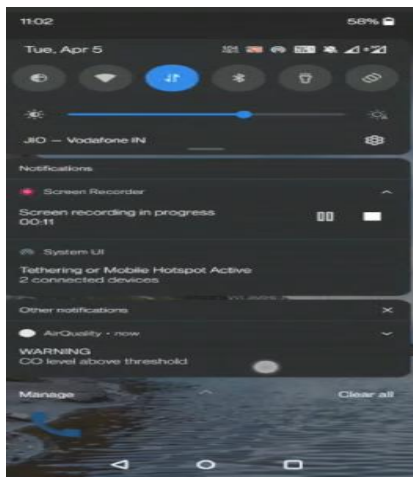
## 6. Observation

We observe that whenever a value of an air quality parameter is above the threshold level, it is indicated clearly in the website as well as the mobile app and notifications are also being send to the user.

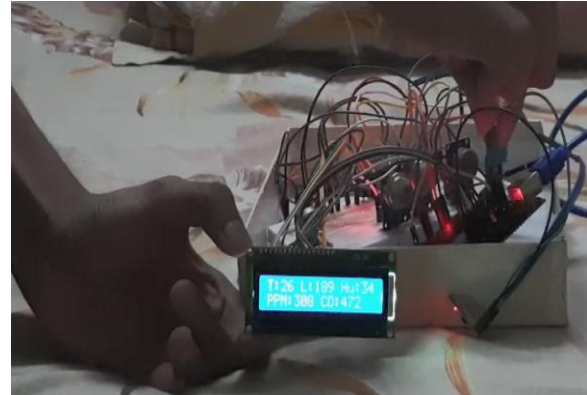
The following images illustrate some of the observations made by us in the process-



*CO level being dangerous is clearly being showed in the 16x2 lcd display as well as in the mobile app*



Notification showing that CO level is above threshold.



*Value of CO and PM 2.5 increased on placing it in front of incense stick.*

## 7. Conclusion and Future Scope

### Conclusion

We have developed an Air Quality Monitoring System which is Arduino based and very effective and based on the results, we can say that it is easy to use and its functionality is similar to that of the expensive air pollution detectors. It is a microcontroller based air quality detection system and it is easy to use and very user-friendly.

### Future Scope

Through the help of this prototype, our aim is to expand by planting various such prototypes in as many small localities in Delhi as possible that would help us to cover almost all the regions of Delhi and would help us to get more accurate air quality index results locality wise and help us to react to the extremities of the air quality better. Introducing login/logout system in

this project so that individual users can create their own account and log in if they want to use this product.

We can further provide this data for research work which would enable the researchers to perform an even more detailed analysis on air quality.



### **Acknowledgement**

We would like to express our gratitude to our mentor and professor in the project Dr Gaurav Singal who guided us in every step of the project and helped us with providing alternatives to the aspects where we were stuck.

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