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Multi - Conditional Analysis of Indian Ambient Air Quality Using MQ - 135 Sensor

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Abstract: ***In the present times, air quality is a major concern in whole world. Major parts of the world irrespective of developing or developed nations are a victim to Air Pollution; it is one of the biggest problems. Air quality is of significant concern because of its negative effect on the health of the region's living conditions, climate, and economy it is caused by harmful pollutants released from natural or man - made activities. [1] Such pollutants causing air Pollution are CO2, CO, SO2, NO2, O3, Suspended particulate Matter (SPM), Respirable particulate matter (RSPM), volatile organic compounds such as Alcohols, benzene, etc. and smoke. [2]. Therefore it is a bit challenging but necessary task to monitor air quality in real time looking towards the upcoming time. As a part of experiment monitoring of air Quality in real time using Arduino microcontroller unit with MQ - 135 air quality sensor is done. It measures NH3, NOx, alcohol, Benzene, smoke, CO2, etc. [3] which can be displayed in ppm And DHT11 humidity and temperature sensor which can be displayed in percentage and degree Celsius respectively and plotting of graphs showing variation in air quality with respect to time, temperature, humidity, different locations and seasonal variation in air quality. Also an alarm was connected with Arduino unit so that when air quality goes down and LCD shows value beyond certain permissible limit then alarm will start beeping to alert people about the severity of air. The benefits of sensor, having reliable stability, rapid response Recovery, having long life, affordable as cost and power consumption is minimum, Portable, light in weight, and user friendly. All the data's have been shown so that a fair variation could be observed in the air quality.***

Keywords: Air Quality Variations, Alarm

Abbreviations: AAP – Ambient air pollution, PM – Particulate matter, PM2.5 - Particulate matter of size 2.5**,** PM10 - Particulate matter of size 10

1. Introduction

Health problems have been growing at rapid rate especially in urban part of developing countries where industrialisation and increasing number of vehicles leads to release of lot of gaseous pollutants [**1].** Ambient air pollution (AAP) and particulate matters (PM) have basically been the major associates of adverse health effects such as respiratory diseases and cardiovascular diseases [**4].** The adverse health effects of exposure to particulate matter (PM), including particles with a median aerodynamic diameter < 2.5 μm (PM2.5) and < 10 μm (PM10), are of great concern to governments and health organisations worldwide. The primary effects of air pollution containing PM2.5 and PM10 include increased respiratory symptoms, decreased lung function, and increased incidence of chronic cough, bronchitis, and conjunctivitis which ultimately results in decreased average life span of people. [**5 - 9].**1·67 million (95% uncertainty interval 1·42–1·92) deaths were attributable to air pollution in India in 2019, accounting for 17·8% (15·8–19·5) of the total deaths in the country. The majority of these deaths were from ambient particulate matter pollution (0·98 million [0·77–1·19]) and household air pollution (0·61 million [0·39–0·86]). The death rate due to household air pollution decreased by 64·2% (52·2–74·2) from 1990 to 2019, while that due to ambient particulate matter pollution increased by 115·3% (28·3–344·4) and that due to ambient ozone pollution increased by 139·2% (96·5–195·8) [**10].** Why is it so important to monitor Air Quality has a confronting answer that We will be acknowledged when air quality is poor it is unhealthy, especially for people who are sensitive to it such as children, older adults, or people with heart disease, asthma, and other respiratory ailments. But it isn't the same everywhere. Pollution can build up in isolated pockets or possibly from local sources: for example near industry or a busy road can add to the overall poor air quality. Also the weather conditions in an area play a part in the quality of the air. Because different areas have different levels of air quality at different times it is important for us to monitor what is happening. IN that way we can identify trouble spots and ensure that we are taking the right steps to ensure we all enjoy the cleanest air possible. Aim of this study was real time air quality and pollution monitoring.

2. Methodology and Working

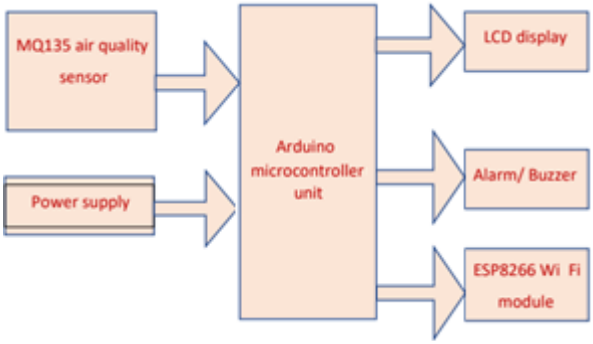


Figure 1: Block diagram

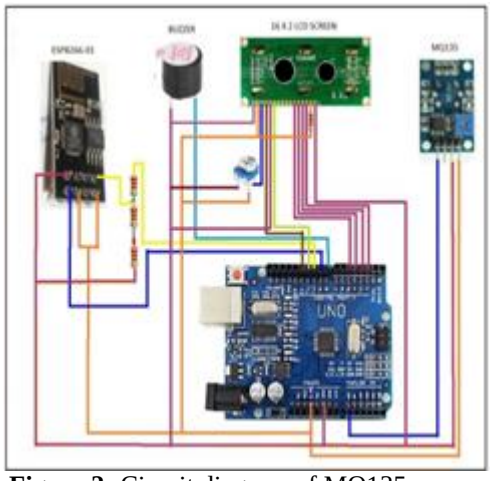


Figure 2: Circuit diagram of MQ135 sensor

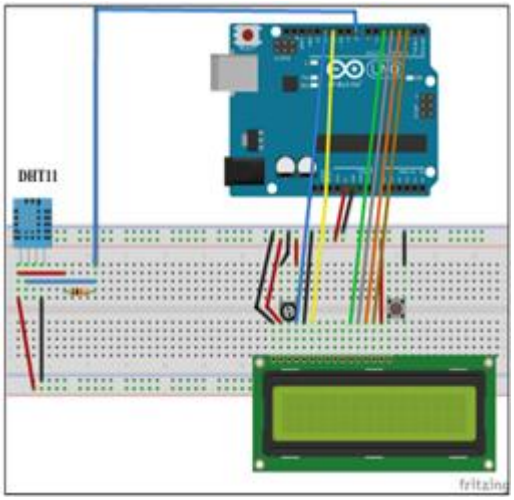


Figure 3: Circuit Diagram of DHT11 sensor

FIGURE 1 demonstrates the block diagram in which the experiment was designed. Hardware included wereArduino Uno board, MQ135 air quality gas sensor, 16*2 LCD display, Breadboard, Potentiometer, Wi - Fi module, DHT11 sensor, while Software included Arduino IDE software. **FIGURE 2** is the demonstration of the circuit setup of MQ 135 sensor in the system while **FIGURE 3** is demonstrates the circuit diagram of DHT 11 sensor.

3. Working Mechanism

MQ - 135 is a SnO2 semiconductor based gas sensor capable of MQ - 135 such as CO, CO2, Ethanol, NH4, Toluene and Acetone in the ambient air [**11].** The MQ - 135 air quality sensor has a basic design wherein a layer of Tin Dioxide (SnO2) is present inside the Aluminium oxide micro tubes and heating element inside a tubular casing**.** The sensor used SnO2 semiconductor, which has a higher resistance in clear air as a gas sensing material. When there is an increase in polluting gases, the resistance of gas sensor decreases along with the concentration. The analog output pin of the sensor is connected to the Ao pin of the Arduino. The MQ - 135 air quality sensor is calibrated so that when it comes in the contract with gaseous pollutants due to resistance difference analog output voltage is generated which is directly proportional to the concentration of polluting gases in ppm **[12].** And then analog voltage sensed at pin Ao of Arduino is converted to a digital value by using the in - built ADC channel of Arduino. The digital value is hence equal to the gas concentration in ppm. DHT11 module gives a calibrated digital output signal. It is a combined module for the for sensing humidity and temperature and gives precise value**. [13 - 14]** MQ - 135 gas sensor provide the system with data which is calculated to find the concentration of gases like CO, CO2, NH4, Acetone, Toluene and Ethanol **[15].**

4. Results

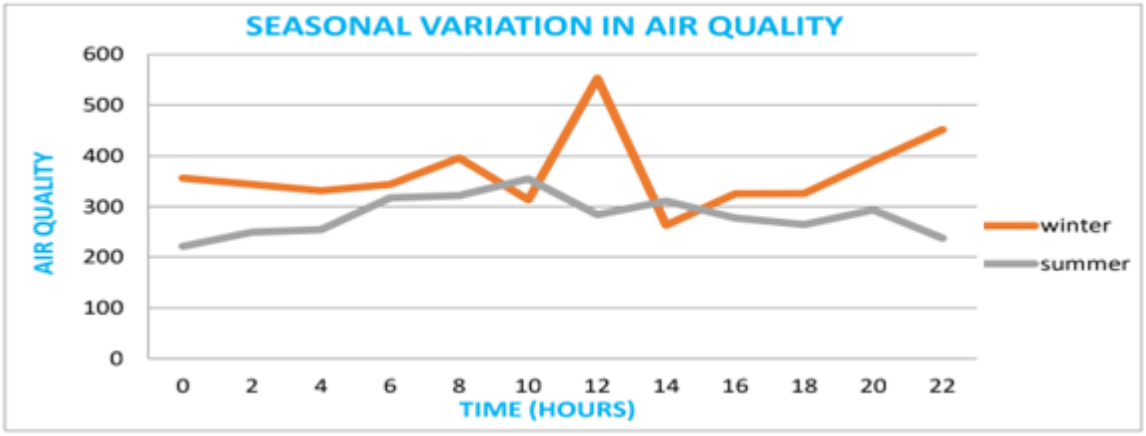
A study was carried out by me using the circuit to monitor real time variations in air quality and also to observe the changes with respect to temperature, humidity, location and seasons. Data's are provided which is the calculated mean of the datasets generated during the time period of study. Location of sample collection: traffic area, rural area, residential area.
Time span: Oct 2020 - March 2021.
Sample interval: 2 hours

4.1 Seasonal Variations in Air Quality in PPM

India observes season change from winter to summer from the month of October towards March. Data's of air quality was collected on timely basis using the system and analysis and interpretation was done to observe the change in the air quality that affects a common man.

Table 1: Average Air quality data's of summer and winter.

Time (hours)	Winter	Summer
0	356.11	221.43
2	343.46	249.43
4	331.11	254.67
6	343.46	317.34
8	395.81	321.39
10	313.14	354.47
12	552.78	283.88
14	263.13	310.89
16	325.05	277.39
18	325.46	264.63
20	389.09	293.16
22	451.63	237.64



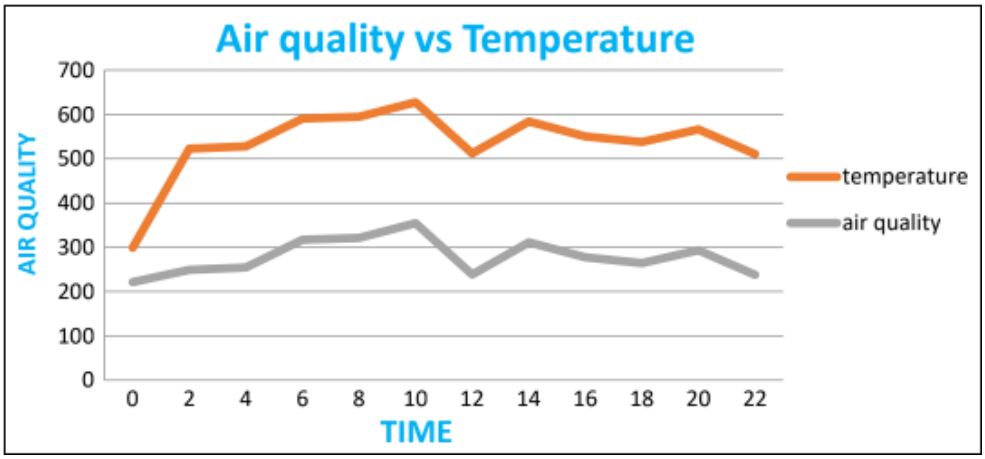
Graph 1: Graphical interpretation Air quality data's of summer and winter

Hereby we can observe that how change in season affects the air quality. The simple interpretation can be observed as winter the air is normally cold and steady which results in hindrance in mobility of air particles while In summer the air is light and fast moving thus particles can disperse better and the air quality levels observe a dip.

4.2 Air Quality Change with Reference to Temperature

Table 2: Average Air quality data's with respect to temperature.

Time (hours)	Temperature (K)	Air Quality (ppm)
0	299	221.43
2	522.43	249.43
4	527.67	254.67
6	590.34	317.34
8	594.39	321.39
10	627.47	354.47
12	511.88	238.88
14	583.89	310.89
16	550.33	277.39
18	537.63	264.63
20	566.16	293.16
22	510.64	237.64



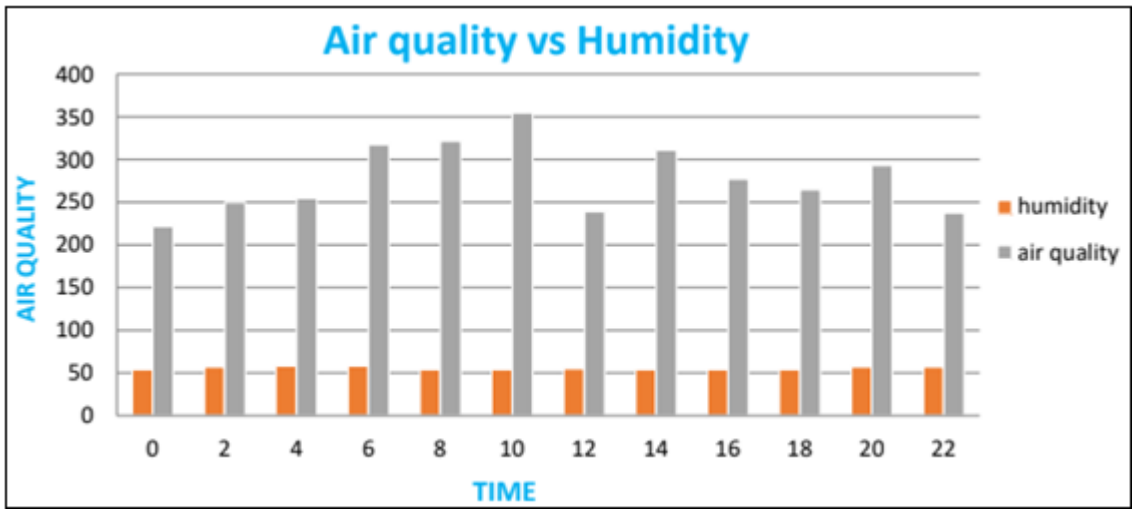
Graph 2: Graphical interpretation Air quality data's with respect to temperature

Results shows how air quality of any region is highly related with the temperature of that region. Temperature shows a direct proportional relation with air quality. We can relate how air quality is highly driven by the influence of temperature. Thus, we can observe how air quality changes during various hours of the day.

4.3 Air Quality Change with Reference to Humidity

Table 3: Average Air quality data's with respect to humidity

Time (hours)	Humidity (%)	Air Quality (ppm)
0	54	221.43
2	57	249.43
4	58	254.67
6	58	317.34
8	54	321.39
10	54	354.47
12	55	238.88
14	54	310.89
16	54	277.39
18	54	264.63
20	57	293.16
22	57	237.64



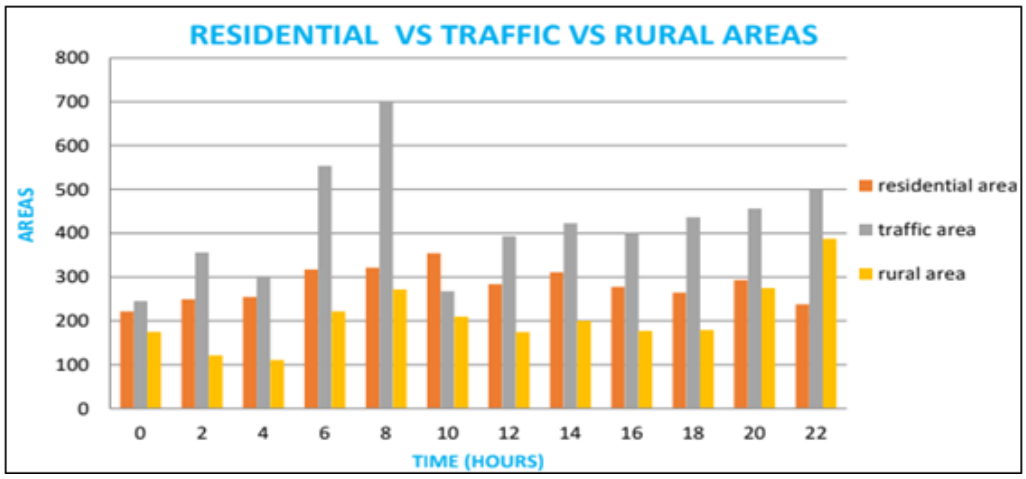
Graph 3: Graphical interpretation Air quality data's with respect to humidity

Results shows air quality of any region is considerably less affected with the variations in humidity. We can observe humidity have very low variations but at some level it is affecting the air quality.

4.4 Air Quality Change with Reference to Location

Table 4: Average Air quality data's with respect to location

Time (hours)	Residential Area	Traffic Area	Rural Area
0	221.43	245.05	175.3
2	249.43	356.21	121.03
4	254.67	301.69	111.02
6	317.34	553.62	221.4
8	321.39	700.46	271.61
10	354.47	267.85	209.82
12	238.88	393.85	174.66
14	310.89	423.11	199.97
16	277.39	402.22	177.13
18	264.63	436.48	179.42
20	293.16	456.33	274.88
22	237.64	500.49	387.38



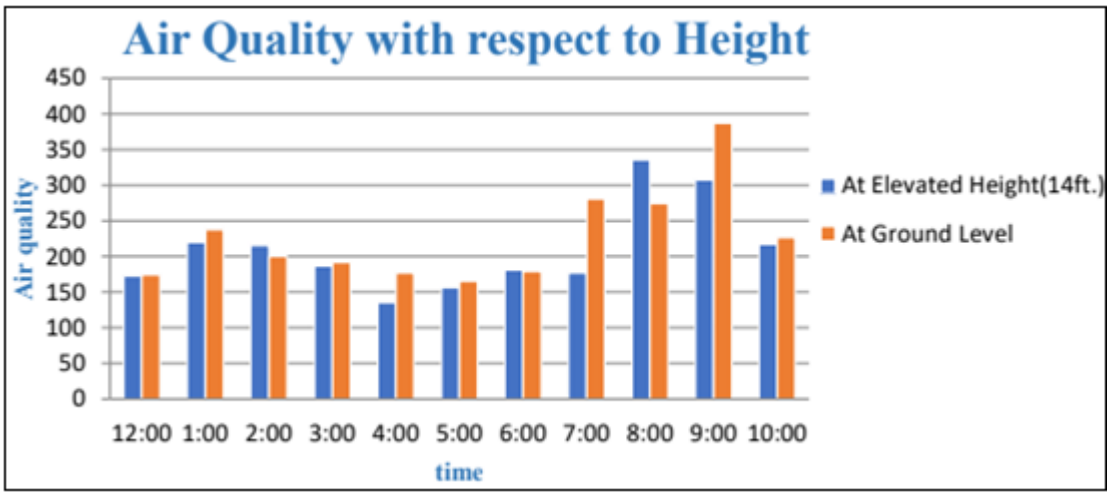
Graph 4: Graphical interpretation Air quality data's with respect to location

Results here show how air quality varies on the basis of location as well as the time duration. Sampling points fall under various categories of areas like Traffic area, residential area and rural area. Here from graph 4 we observe that the air quality is change due to peak hour traffic as well as daily activity. We can obviously relate the area which observes highest mobility of vehicles and human exposure results poor quality i. e. traffic area. Residential area and rural area are exposed to fewer activities thus they have relatively low air quality than traffic areas. The variation is also observed with respect to time as poor air quality is observed at peak and rush hours.

4.5 Air Quality Change with Reference to Height

Table 5: Average Air quality data's with respect to height

Time	At Elevated Height (14ft.)	At Ground Level
12:00 pm	172.68	174.66
1:00 pm	220.2	237.64
2:00 pm	215.5	199.97
3:00 pm	186.72	191.97
4:00 pm	135.56	177.13
5:00 pm	156.28	165.39
6:00 pm	181.27	179.42
7:00 pm	177.03	280.88
8:00 pm	335.82	274.18
9:00 pm	307.38	387.38
10:00 pm	217.23	226.44



Graph 5: Graphical interpretation Air quality data's with respect to height

Results help us to estimate the dispersion pattern of air particles with respect to height. We can observe the lag or time taken by air to disperse with increase in height. The dispersion of particle is also depends upon the density, wind velocity, Wind direction and wind speed plays a vital role in air quality variation patterns in nature. Nature of particles also plays a major role in air quality at different levels. Here in this graph 5 we shows that the with respect to time the dispersion of particle is increase at ground level and at the same dispersion of particle up to 14 ft height it will be decrees so the particle create a major effect on ground level atmosphere. Also during the afternoon time the dispersion of particle is slowly increase in ground level. Because of the temperature effect. But as we studied that altitude increase temperature decrease and its all related with height. So during a night time the dispersion of particle is increase at the height.

5. Conclusion

Ambient air quality highly affects human health and the environment we sustain in. Air quality shows difference with distinct parameter which we take into consideration. Time, temperature, humidity and location can be claimed as 4 dimensions in which quality of air changes. We can also provide one - dimensional, bi - dimensional or multidimensional study to analyze, monitor and interpret ambient air quality of any region at any given time with different conditions. Necessary steps can be taken into considerations after we observe how the situation of any point or location is, So that health and welfare of environment and humans can be sustained.

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Author Profile

Devesh N Rao is an ambitious and enthusiastic student. My domain of graduation study is environmental engineering. I tend to devote my time and efforts towards exploring ways to improve environment. I have completed this research under the mentorship of Prof. Khyati Modi. She has guided me in a great manner throughout my graduation program. I am currently pursuing my final year of B. E at government engineering college, Valsad

Prof. Khyati K Modi have 13 years of teaching experience. She is serving as Assistant Professor (G. E. S., CL - II), Environmental Engineering Department, Government Engineering College, Valsad, Gujarat. She is pursuing Ph. D. from Gujarat technological university on topic “Ambient Air Quality Status of Ahmedabad City after Switching Over to CNG as a Fuel for Automobiles”. She has published 6 research papers in different national and international journals.