Air Pollution Quality Monitoring System Using Internet of Things for Smart Cities

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Abstract - Internet of Things (IoT) Based Air Pollution Monitoring System is used to monitor the Air Quality over a web server using Internet. It will trigger an alarm when the air quality goes down beyond a certain level, means when there is sufficient amount of harmful gases present in the air like CO2, smoke, alcohol, benzene, NH3 and NOx.Pollution deaths are growing every year, and air pollutants is the primary contributor to those deaths. Occasionally, emission levels have risen due to several causes, such as the rise in population, increased use of automobiles, industrialization and urbanisation, which have a significant influence on the wellbeing of the people. To observe the situation this work includes anair pollution monitoring system which is an Internet of things using sensors based system,where we track quality of air through a web server on the Internet and generate warning about the air quality goes above a firm threshold, it implies when sufficient hazardous gas is present in the air such as benzene, NH3, smoke, CO2 and alcohol.The growth of business and Speedy human population urbanisation has horribleimpactupon worldwide air condition. in long-time period exposure to air pollution cause chronic heart and lung diseases, dangerously affecting human health. Thousands of factories and billions of cars launch large quantities of pollution into the air each day. so, tracking the air pollution has come to be important. In this paper, the development of an Internet of Things based air quality monitoring platform is presented and analize the performance of air quality monitoring system.
Keywords: Internet of things, Sensors,Arduino, Air quality.

1. Introduction

IOT Air Monitoring System mainly aims to raise an increasing problem of air pollution and sound pollution today. Air quality must be monitored and controlled for a healthier and better future for all.The Internet of Things (IoT) becomes popular everyday thanks to its flexibility and low cost. The urbanisation and the increase in road vehicles have significantly affected atmospheric conditions. Light sensitiveconsequences such as irritation of eyes pharynx, and nose and serious issues such as pneumonia, lungs, heart, bronchitisdisease,and worsened asthma include adverse effects ofcontamination [1][2].Monitoring measures, the concentrations of air contamination and sound contaminationthat Could be analysed and clarified. This data will then be used in several ways. A surveillance data analysis grants us to evaluate how bad air contamination and sound contamination are daily. We went through the region that we met with the latest technology every day. In the past it was very tedious and not very effective to check pollution in a particular region. Various new approaches have been implemented to keep an eye on the fast increase in emissions with rising emissions and advancing technology. The Internet of Things is one of the most recent works on this journey. IOT was brought about by increasing internet use and human interaction with the machine.

It enables information to be exchanged between different devices such as refrigerators, washing machines, cars, watches etc [3][4].

With the assistance of countless sensors this information exchange takes place. The success of IOT is driven by its effectiveness which makes it a viable low-cost technology. Air and sound pollution are two of the major components that affect people and the whole planet most negatively. Therefore, checking and controlling it is important. Traditional strategies include manual working, where data loggers used to visit the website to retrieve, interpret and compare data to ensure a long and time-consuming output, in addition to being inefficient.A sensor system that detects the level of sound and contaminant pollutants, such as carbon dioxide and sulphur dioxide, pollutes the air, is used in the monitoring system. In the cloud it is saved from remote access to everyone using the previously stored data in the database and output. This paper provides a system description that users can access and access the output of an Android application on their mobile telephones whenever they need. It is a practical tool to save valuable lives and property of individuals. The inhabitants are then led to a safe place to clear the area [5].

Air pollution is the most important problem in our country. Due to rapid growth of industry and vehicles it emits toxic gases like Sulphur dioxide, Hydrocarbons, Nitrogen Oxides, and Carbon Monoxide. Which increases breathing problems like lung cancer, asthma, chronic obstructive pulmonary diseaseetc in all living beings. Air of good quality is a basic requirement for all living things. 90 percent of people, according to estimates, breathe polluted air. Most people are dying as a result of air pollution. Lung cancer, respiratory disorders, heart disease, and other illnesses are all caused by air pollution.With the support of this planned system, we can monitor the intensity of air pollution. Using sensors, micro controller, computer, and buzzer we can inspect the quality of air.It gives us an alarm when the level of air goes to certain level. It will show the quality of air in ppm in webpage so we can examineclearly [6][7].

In this Proposed device different kinds of sensors are used. The most prominent sensors are gas and particulate matter sensors. In the busy urban environment, sensors for methane, nitrogen dioxide, carbon monoxide, sulphur dioxide, and particulate matter are utilized for the detection of gases such as sulphur dioxide, nitrogen dioxide, and methane as well as carbon monoxide as the particulate matter sensors. Thedevice comprises the component of these sensors. The aim behind building this can be we suggest a surveillance scheme for air quality that helps us to track and monitor the condition of living air along with the sound contamination in an IOT region.The system uses aerial sensors to detect and relay the data and report toxic gas/compounds in the air. The sensors communicate with Arduino uno which processes and transmits this data throughout the application. This enables governments to regulate and respond against air emissions in various regions.The primary motivation of the project is to avoid adverse effects on air pollution in order to ensure a safe environment by data analyses of the IoT cloud stored data. The thoughtlessly release by manufacturing, farming and other operations of human beings of hazardous chemicals and poisonous heavy metals into the atmosphere will have an effect upon the condition of our climate, water and food supplies.

Figure 1: Air pollution due to industries

2. Literature Review

Thomos Becnel at el. [1] Investigate correlation is having difficulty locating a spatio-temporal database that is suitable for research. Ted Van Kessel presents the theory of operation, equipment design, and data obtained during a two-month field deployment in Beijing at el. [2]. The MAPC performs similarly to previous low-cost optical counters, but with a substantially longer maintenance-free operational lifetime, according to the authors. Bardoutsos proposed a comprehensive, multi-dimensional approach to collecting, monitoring, and analysing diverse data sources of air pollutants and noise indicators into an integrated, intelligent computing system in el. [3]. Mokrani at el. [4] wants to address these needs by analysing existing work on IOT-based air quality monitoring, with an emphasis on recent trends and problems. Helton at el. [5] describes the hardware layer development of a device capable of measuring the amounts of the following pollutants: Particulate matter (PM2.5 and PM10), ozone, carbon monoxide, nitrogen dioxide, and ammonia are measured using three sensors, PMSA003, MICS-6814, and MQ-131, respectively.

The goal of this work, according to Ramagiri at el. [6], is to introduce a vehicular pollution monitoring system based on the Internet of Things (IoT), which is capable of detecting vehicles that pollute city roadways and measuring various types of pollutants and their levels in the air. This publication also informs environmental agencies about the current state of air quality as necessary. The proposed methods additionally guarantee the presence of wireless sensors for car pollution systems that specialise in easy accessof real time data through internet using IoT.

Walter Fuertes at el. [7] developed a low-cost wireless monitoring system based on a multilayer distributed model and an Arduino platform that permits air quality referential parameter measurements. This is an IoT application in which a physical object is implanted with electronics, software, sensors, and wireless connectivity to provide real-time monitoring of air pollution.

Pau Ferrer-Cid compares two structured data techniques, one based on statistical methods and the other on signal smoothness, with a baseline methodology based on node distance and without relying on measured signal data in el. [8]. The sensor signal is reconstructed with a supervised method based on linear regression and a semi-supervised method based on Laplacian interpolation, which permits reconstruction even when data is missing, to compare these techniques. The results, which were obtained using data sets measuring O3, NO2, and PM10, reveal that the signal smoothness-based strategy outperforms the other two, and that when combined with Laplacian interpolation, it is nearly as good as the linear regression method. Furthermore, the results reveal that in the situation of heterogeneous networks, the reconstruction accuracy is comparable to that of in-situ calibrated sensors. As a result, the utilisation of network data improves the network's resilience to possible sensor failures.

At el. [9], Swati Dhingra presented a method that is similar to Google traffic or the Google Maps navigation tool. Furthermore, data on air quality can be utilised to forecast future levels of the air quality index (AQI).

Identify and characterise IoT-based real-time monitoring systems that have adopted a measurement process to examine the influence of PM on human health, according to Mario J at el. [10].

At el. [11], Jaeseok Yun describes a PM-sensing system made out of off-the-shelf LoRa-based wireless hardware boards and low-cost PM sensors. PM data sets can be gathered and accessed in a standardised manner, i.e. via oneM2M defined representational state transfer application programmable interfaces, by employing software systems that are compliant with an IoT standard called oneM2M.

According to Rajib Saha, air pollution has a negative impact on the COVID-19 issue as well as human health. Cities such as Dhaka are under pressure to remain habitable. Because of the high density of transportation and population, the air quality index must be closely monitored, and the impact of the COVID-19 pandemic must be monitored. It is necessary to create an Internet of Things-based remote monitoring system to assess air quality in different locations of Dhaka and draw comparisons between before and after the COVID-19 Pandemic.

Dan Zhang at el. [13] shows that our approach can effectively measure and predict air quality using a variety of machine learning algorithms and real-world data. Our analysis reveals that good air quality monitoring and prediction for a smart city application is possible. In large cities, according to Yogesh Simmhan at el. [14], air pollution is a public health emergency. To help address this difficulty, cheap sensors and the Internet of Things (IoT) have enabled the deployment of a city-wide network of thousands of low-cost real-time air quality monitors. For dependable and scalable data collecting from the edge to the Cloud, an IoT cyber-infrastructure is required.

3. Pollution and the environment

One way that air pollution impacts the atmosphere is by its effect on human wellbeing. Contaminated air makes them sicker. Severe diseases happen to people. After all the dirty weather, people get asthma. Asthma is a disease that causes you to breathe with difficulty. If people have respiratory issues, they are able to die more easily because they have not enough blood in their bodies. If someone has a respiratory disorder, so the disease is diagnosed with asthma because the person has viruses such as influenza or pneumonia. That is how the air quality affects human health. The toxicity of the air is also affected by plants. Some of the species are birds, penguins, puppies, and all are threatened. Global heating, driven by air pollution, affects both aquatic and Terrestrial living conditions. It directly affects the environment when pollution increases. Danger's animal life, human life, layer of the ocean, climate, water life, etc. It also reduces the production and growth of eggs that lead to bird migration and affect birds' life (death). The effects on hatching are also caused [11]. It straightforwardly influences the climate when contamination increments. threats creature life layer of the sea, environment, water life, etc.it additionally lessens the creation and development of eggs that lead to bird relocation and influences birds life(death) the effects of incubating are likewise caused. The combustion of coal, oil and natural gas is responsible for air emissions. Fuel burning in plants, producing electricity and burning waste can cause air pollution. There are many respiratory viruses and pathogens. The primary causes of air emissions are motor vehicles and large industrial industries. Any of the toxins that poison the atmosphere are sulphur, lead, automotive waste, and plant gases. Smog could make you breath shortened, dizzy, watery and flushing. Corrosive rainfall,

ozone consumption and global environmental change are the most serious natural effects of air pollution. Ozone is increasingly depleted by air pollutions, including chlorofluorocarbons, hydro-chloro-fluorocarbons, and halons, that are known as ozone-depleting agents. These compounds were used and still are often used in coolants, spumes, fire extinguishers, solvents, pesticides, and sprays. The dilution of the protective ozone layer will contribute to a rise in UV radioactivitytouching the earth and guiding to more cases of cataracts, compromised immune system and skin cancer. Some crops can also be damage like soybeans are very sensitive to UV rays. In several ways, air pollution can exterminateyields and plants. Depletion of Ozone can diminishfarming and junglecrops, reduce bush seedlings' progress and existence, or enhance the exposure of plant life to infections, insects, and other ecological stress, such as roughclimate.

As discussed above, damage to plants and forests may also be caused by acid rain and the UV radiation due to deterioration of the ozone. Toxic air pollution on soils or surface waters may have a variety of consequences for wildlife. Like humans, animals are exposed to sufficient amounts of atmospheric toxics over time, causing health issues. Research has shown that air toxicity contributes to birth defects, reproductive insufficiency, and animal disease. Persistent harmful air emissions are of great concern in marine environments that break down steadily in the setting. These toxins settle in sediments and may magnify animal tissue at concentrations far higher at the top of the food chain than in water or air.Acid rain contains harmed nitric and sulfuric acid levels in precipitation. These acids mostly come from nitrogen oxides and sulphur oxides that are emitted into the atmosphere through the combustion of fossil fuels. Either rain, snow or fog fall upon the planet. Often hundreds of miles from the wind. Acid rain destroysplants in the jungle and allows earths and water resources to acidify, making water unsuitable for some fish and other fauna. It too speeds up the worsening of constructions, statues and monuments that make up our national legacy. Acid rain, causing disruption to streams, pools, waterways and soils, and damage to the trees and wildlife. So these are effects cause by Air pollution.

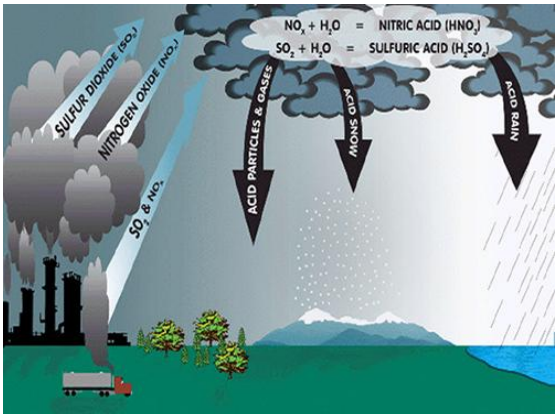


Figure 2: Pollution and Environment

4. Surveillance of air quality

The essential requirement for living creatures is good quality air. 90% of people breathe polluted air, according to the reports. Due to air pollution most populations are dying. Lung cancer, respiratory problems, heart disorders etc. are causing many diseases by air pollution. The problem of global warming is also caused by air pollution. As the temperature of the glaciers grows quickly due to global warming, the environment is not good. We must therefore preserve air quality. Air pollution must be reduced. Life is very painful without good air quality, so we have to monitor the air quality

[8][9] [10]. The fundamental necessity for living animals is acceptable quality air. 90% of individuals breath contaminated air as indicated by the reports. Because of the air contamination most populaces are kicking the bucket. cellular breakdown in the lungs, respiratory issues, heart issues and so on are causing numerous sicknesses via air contamination as the temperature of the ice sheets becomes rapidly because of a worldwide temperature alteration, the climate isn't acceptable. we should subsequently protect air quality. air contamination should be decreased life is exceptionally difficult without great air quality so we need to screen air quality. The world is concerned about air pollution. There is no question that emissions in our ecosystem can impair our quality of life and will also lead to health issues and other adverse consequences. We can see that every day the air we breathe gets poisoned more and more. Fossil fuels that contain nitric and sulphuric oxides contribute to the rise in air emissions. But people have taken this issue seriously and are committed to combating the problem they made. While the air quality level has come to a critical level. However, the amount of air pollution in the air should also be reduced.

Reforestation - It is possible to increase air quality by planting more and more trees, while purifying and filtering the air.

Industry policy- Strict gas filtering industry policy within the countries should be developed. Thus, the contaminants released by the plants can be minimised.

We have to use environmentally friendly combustion - we have to use eco-friendly fuels such as LPG, GNC, biogas, and other environmentally friendly fuels. We are also reducing the amount of poisonous gas that is dangerous. In the manufacturing and farming operations we should strive to employ more human labour than machinery. Instead of making more goods, we should reuse and recycle products produced by machinery like paper, glass, bottles or plastics products.

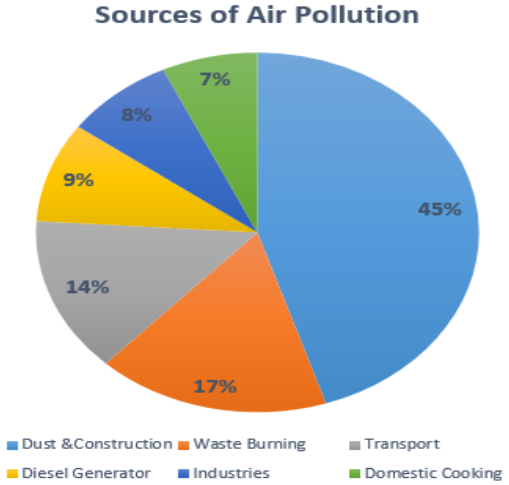


Figure 3: Sources of Air pollution

Air pollution control uses IoT based sensors for mapping and tracking air quality through vast geographic areas – allowing communities to help control air pollution and to make educated choices. Air tracking systems use stationary devices, such as handheld sensors, which can be fitted with motorcycles, or secure cell phone data, providing air quality data. IoT-Enabled Air Pollution Monitoring's key advantages would be better informing and monitoring of laws for the quality of air, planning to position susceptible facilities such as hospitals and schools in order to minimize childhood asthma, and improving patient outcomes; enabling customers to make better informed choices to minimise their vulnerability to unhealthy air pollution.

5. Gaps in Existing Work

We can easily use Internet of stuff devices to know air pollution, but we cannot resolve it instantly. It's not easy to motivate people to save our resources. It is extremely hard to get people to utilize public transportation, cycles and so on. Sensors in busy regions can have challenges with security. Data security and storage are the main challenge. Maintenance in devices can be difficult in unfavourable weather conditions. Energy consumption and air pollution monitoring equipment maintenance costs are high. The major challenge is to deal with the enormous quantity of information in real time. In present versions, the expense of the appliance is high. Device quality data measurement [14] [15]. We can without much of a stretch use Internet of stuff gadgets to know air contamination, however we can't tackle it right away. It is difficult to persuade individuals to save our assets. It is extremely difficult to get individuals to utilize public transportation, bikes, etc. Sensors in jam-packed regions can have issues with security. Information security and capacity are the principle challenge. Upkeep in gadgets can be troublesome in horrible climate conditions. Energy utilization and air contamination observing hardware support costs are high. The principle challenge is to handle the huge measure of information progressively. In existing models, the expense of the gadget is high. Gadget quality information estimation.

6. Internet of Things

The Internet of Things describes asphysical object network thingscombined with sensors, devices, apps and more technology that connect and exchange information throughout the internet with other computers and structures. These instruments vary from everyday items in the household to specialized industrial instruments. In future environmental protection, IoT has an important role to play. In almost all environmentally sustainable situations, IoT can be used. Sensor-enabled sensors can help track environmental impacts and capture air quality information. These instruments may also help to track forests, rivers, lakes and oceans. IoT environmental management systems typically use sensors for the monitoring of air quality and water, atmosphere or soil levels to provide a hand in environmental safety. In crowded areas, parks or fitness routes, the IoT can provide a means for quality monitoring. The execution of such a facility requires the distribution of air quality and contamination sensors throughout the town and the availability of sensor records in public to residents. Thanks to the substantialimprovements in technology around wireless communication, many sensors and wireless systems for pollution control and coverage have emerged. This has led to the emergence of pollution control.

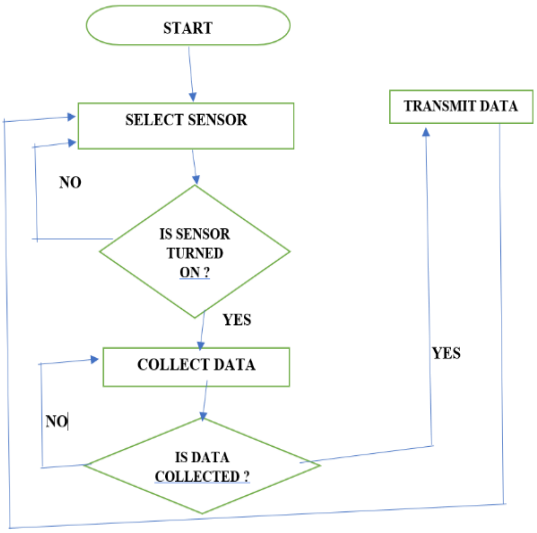


Figure 4: Flow Chart of IOT

Recently theInternetof Things, owing to its capacity to link thousands of real-world items, was highly attractive. In many areas, it can play a significant role in improving the quality of life in various industries, including healthcare, agriculture, military, transport, clever houses, cities of intelligence, and education. The Internet of Internet's is a majorfeature of the matter. The Internet of things is a technology for transferring data from one device to another. The different sensor type is applied to collect information such as sound, light, temperature, and heat, and forms an internet network. In many fields like agriculture, industry, environmental protection, etc., the Internet of things is currently used [12] [13]. Solutions to monitor air quality help to make cities connect their infrastructure more effectively, address health issues and link regulatory stakeholders with citizens to work together to enhance air quality. They can all work together. The data can be gained via sensors, either statically on a building or by taxi from a number of places across a city. The advantage of IoT devices that can operate on low power wide area networks is that they are able to handle data from every individual air monitor, reducing battery power during transmission and total costs. Projects can be run via solar cells, but they can be costly.

6. Hardware and Software Requirement

Minimum hardware requirement includes Arduino Uno, 16x2 LCD, MQ 6 LPG gas sensor, MQ135 Gas sensor, Wi-Fi module ESP8266, Buzzer, 10K potentiometer, Humidity sensor SY-H5220, 1K ohm resistors, Breadboard, 220-ohm resistor, and Temperature sensor LM35. In addition, minimum software requirement includes Embedded C Language, and Arduino 1.6.13 Software.

7. Proposed System

In this proposed system the MQ135 and MQ6 gas sensor will detect ait data, like ammonia, Carbon dioxide and smoke. All the sensors are connected to Arduino and Arduino is taking analog data converts it into digital. It should be displayed on 16*2 LCD Display. The MQ135 Sensors, LPG Sensors, Humidity Sensor and Temperature works an input data, transmitting information such as which gas is present as well as temperature and humidity. The output devices are an LCD and a

Buzzer. The data of the gases is shown on the LCD in ppm, and a Buzzer is activated when the ppm exceeds a threshold limit[16] [17].

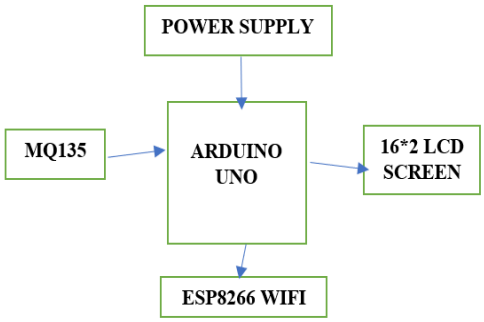


Figure 5: Flow Chart of proposed System

8. Components of Proposed System

The proposed system includes different types of sensors and other digital components. These components are mentioned in the Table-1 with their descriptions and related references. A Sample prototype can be depicted by Figure-6.

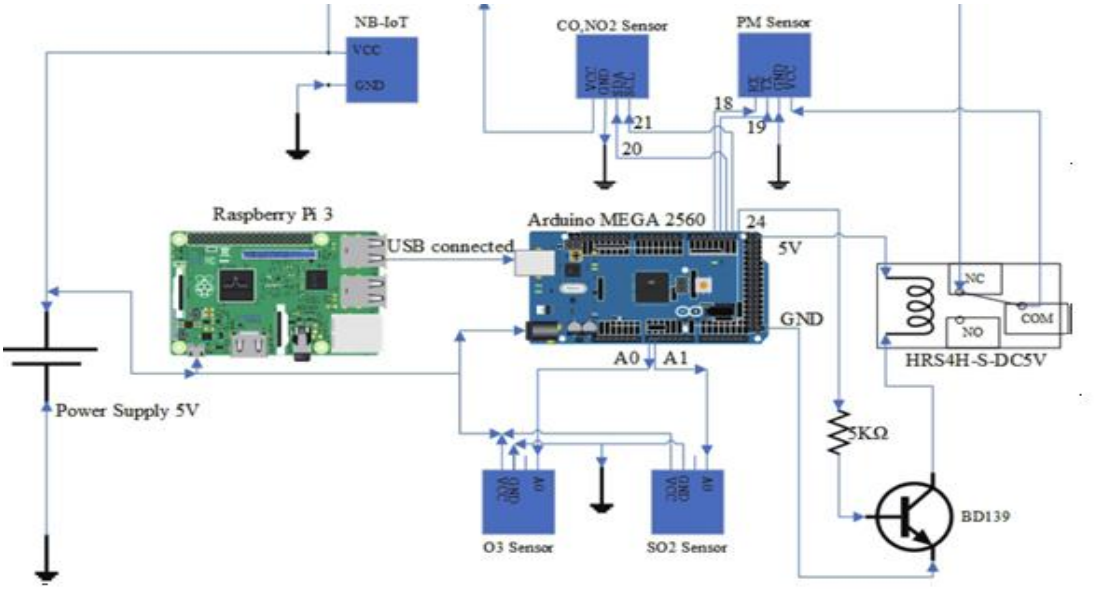


Figure-7: Sample prototype

Air pollution can be defined as the presence of toxic chemicals or compounds (including those of biological origin) in the air, at levels that pose a health risk. In an even broader sense, air pollution means the presence of chemicals or compounds in the air which are usually not present and which lower the quality of the air or cause detrimental changes to the quality of life (such as the damaging of the ozone layer or causing global warming). Air pollution is probably one of the most serious environmental problems confronting our civilization today. Figure 2 show the working of sensors for detecting air quality. There are some air quality sensors are connected with Arduino MEGA 2560 board that are detecting air quality and then users can take decision for solving problem of air

pollution. Sensor O3 and sensor SO3 are detecting Ozone and air quality. Sensor NO2 detect carbon monoxide.

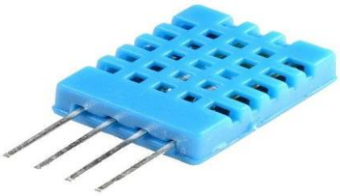
Table-1: Components used in proposed system

Sr. No.	Sensor/Device	Description
1	**Arduino UNO**	Arduino UNO is one of the leading prototype boards. It is compact and abundant in characteristics. The board comes with an Arduino boot loader integrated. It has fourteen GPIO pins, six PWM pins, six analogue inputs and UART, SPI or TWI interfaces onboards and is an Atmega 328-based controllers. Nine pins on the board are included in this IOT device. Six pins can normally interface the LCD character. Two pins are used for the Wi-Fi interface and an analogue control pin is used to connect to the MQ-135 [3].
2	**16X2 Character LCD**	The 16X2 LCD screen is utilized to exhibit the sensor values that are read by the Arduino MQ-135 module. The interface between the data pins D4 and D7 with the pins 6 up to three of the controller is interconnected with Arduino UNO respectively. The LCD RS and E pins are wired to 13 and 12 pins on each controller. The RW pin is attached to the base of the LCD module.
3	**ESP8266 WIFI**	ESP8266 is one Wi-Fi module for controlling device by using internet. It is cheap and easy to find. It is also worked on microcontroller. That is why we are using this module on Arduino. The ESP8266 comes with pre-installed firmware that allow you to control it with standard "AT commands". You can easily create and upload your own code. That's make it powerful and flexible.
4	**MQ135**	The MQ-135 is a sensor for air quality control. It detects dangerous gases such as NH3, NOx, smoke, and CO2 in air condition monitoring gear. The MQ-135 has a digital pin that allows this device work without the microcontroller and is effective in this project. This is how it tests the gas that is reliably damaging to us.
5	**MQ135 Sensors**	Air temperature sensors for a variety of gases such as CO2, NH3, alcohol, NOx, smoke, and benzene**.** The MQ135 gas sensor is also vulnerable to smoke and other noxious chemicals, such as ammonia, sulphide and benze steam.
6	**LPG Sensors**	This sensor is used to sense LPG in the air.
7	**Humidity Sensor**	The humidity sensor is an electronic device that is used to sense the humidity in the air and then react. after sensing he send the digital signal to the circuit.
8	**Temperature Sensor**	The temperature sensor is an electronic device that is used to sense the temperature of the surroundings and record the dets in the form of digital signal.
9	**Arduino**	The Arduino Uno is a microcontroller-powered open-source

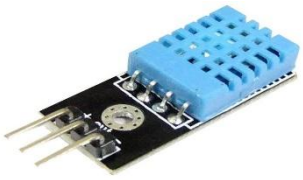
	UNO	board based on Arduino.cc's ATmega328P micro-controller.The board has optical and analogue input/output pins which are interfaced with different boards with expansion and other circuits**.**
10	**LCD**	An LCD is a fluid crystal display module that makes a transparent image. A very simple module widely used in DIYs and circuits is the 16 to2 LCD display. The 16 digits2 converts o into 2 such lines a showing of 16 signs per line.
11	**BUZZER**	A buzzer is like an alarm that send the audible signal. A snapshot for the different components is depicted in figure 6(a)-(g).

(a)MQ135 Sensors

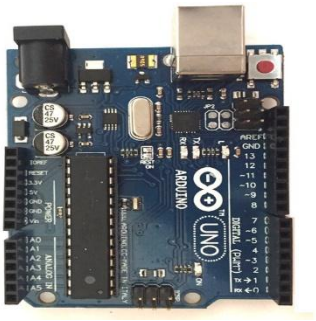
(b) LPG Sensors



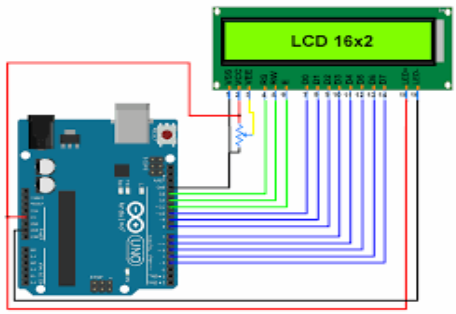
(c) Humidity sensor



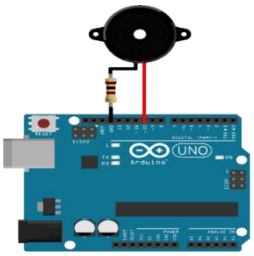
(d)Temperature Sensors



(e) Arduino UNO Circuit



(f)LCD 16x2



(g) Buzzer

Figure 6 Components used in the proposed system

9. Simulation Results and Analysis

Table-2 shows the different parameters measured by a particular sensor of the proposed datatype. We have used the Air Quality dataset available at kaggle for the training. Further table-3 depicts the structure of dataset collected at a particular time and deciding the level of air pollution.

Table-2: Parameters vs sensors

Sr. No.	Sensor	Parameter
1	MQ135 Sensors	NO, NO2, NOx, CO, SO2, O3
2	LPG Sensors	Presence of a hazardous LPG gas
3	Humidity Sensor	Humidity
4	Temperature Sensor	Temperature

Table-3: Possible training dataset collected on 01-02-2022

City	Time	PM2.5	PM10	NO	NO2	NOx	NH3	CO	SO2	O3	Benzene	Toluene	Xylene
DDN	01:00			1	40.01	36.37		1	122.07		0	0	0
DDN	02:00			0.02	27.75	19.73		0.02	85.9		0	0	0
DDN	03:00			0.08	19.32	11.08		0.08	52.83		0	0	0
DDN	04:00			0.3	16.45	9.2		0.3	39.53	153.58	0	0	0
DDN	05:00			0.12	14.9	7.85		0.12	32.63		0	0	0
DDN	06:00			0.33	15.95	10.82		0.33	29.87	64.25	0	0	0
DDN	07:00			0.45	15.94	12.47		0.45	27.41	191.96	0	0	0
DDN	08:00			1.03	16.66	16.48		1.03	20.92	177.21	0	0	0
DDN	09:00			1.47	16.25	18.02		1.47	16.45	122.08	0	0	0
DDN	10:00			2.05	13.78	16.08		2.05	15.14		0	0	0
DDN	11:00			2.27	13.87	16.73		2.27	14.12	99.17	0	0	0
DDN	12:00			1.73	12.87	14.63		1.73	13.26	91.67	0	0	0
DDN	13:00			1.72	14.15	15.55		1.72	17.2	95.92	0	0	0
DDN	14:00			1.85	15.74	17.62		1.85	18.78		0	0	0

DDN	15:00			0.95	15.94	16.18		0.95	19.16		0	0	0
DDN	16:00			0.87	17.28	18.32		0.87	17.83		0	0	0
DDN	17:00			0.8	19.04	20		0.8	16.14	187.62	0	0	0
DDN	18:00			0.47	21.24	22.7		0.47	11.93		0	0	0
DDN	19:00			0.53	25.63	27.42		0.53	14.99		0	0.33	0
DDN	20:00			0.47	16.22	16		0.47	13.66	187.42	0	0.23	0
DDN	21:00			0.83	16.5	17.52		0.83	13.28	96.08	0	0	0

10. Results

We have train the model by using the decision tree method and compute the performance with respect to Mean method, Naïve method and Seasonal naïve method. Figure-7 depicts the original value of AQI

versus predicted value of AQI.The performance metrics for themodel includes mean absolute error (MAE), root mean square error (RMSE), mean absolute percentage error (MAPE), and symmetric mean absolute percentage error (sMAPE). The different error can be defined as below-

Let

$$e_{T+h} = y_{T+h} - \hat{y}_{T+h|T}$$

then

Mean absolute error: $MAE = mean(|e_t|)$

Root mean squared error: $RMSE = \sqrt{mean(e_t^2)}$

Let

$$100e_t/y_t$$

then

Mean absolute percentage error:$MAPE = mean(|p_t|)$

Symmetric mean absolute percentage error: $sMAPE = mean(200|y_t - \hat{y}_t|/(|y_t + \hat{y}_t|))$

In our prediction these performance metrics are shown in table-4 and values are prominent to depict a good performance of the trained model.

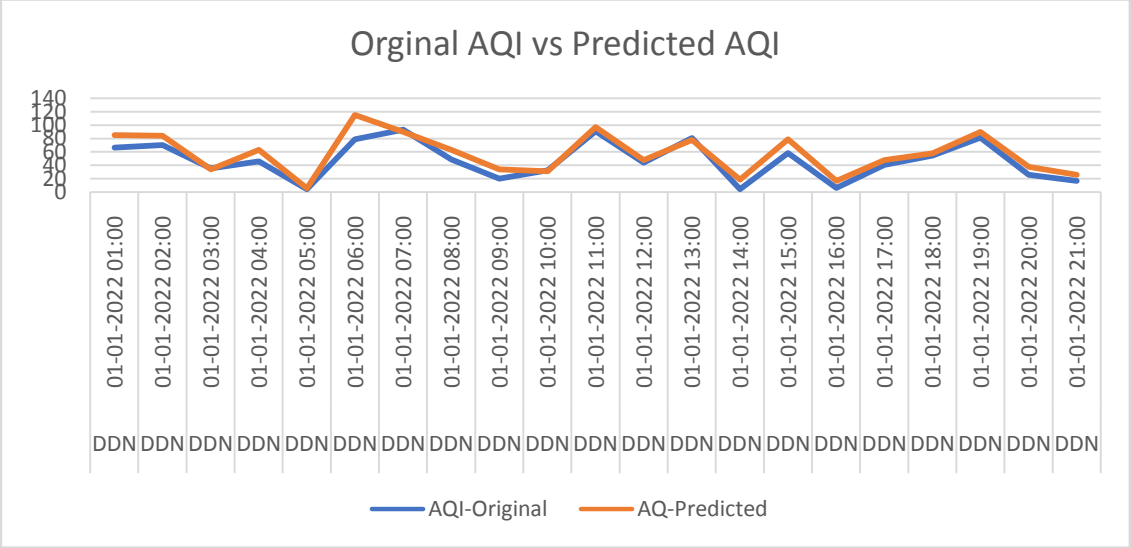


Figure 7. Original AQI vs Predicted AQI

Table-4.: Comparison of performance *wrt* Mean, Naïve, and Seasonal naïve method

	RMSE	**MAE**	**MAPE**	**MASE**
Mean method	38.45	34.83	8.28	2.44
Naïve method	62.69	57.4	14.18	4.01
Seasonal naïve method	14.31	13.4	3.17	0.94

11. Conclusion

IoT is saving life, setting aside cash and making treatment accessible to people groups in distant regions by foreseeing the illness through constant assortment of wellbeing related information utilizing brilliant gadgets and contraptions and preparing this gathered information to anticipate sickness in a patient and giving opportune therapy. Assumptions from IoT medical services are additionally explained in this part. Issues identified with IoT are likewise accessible dependent on logical examinations. Significant difficulties to IoT medical services like protection security and ID are likewise talked about. Web of things is humming all over. IoT has set up its need in numerous zones of our day by day life including-medical care, shrewd urban areas, brilliant homes, savvy farming, coordination's, transportation, schooling and different assembling enterprises. Yet, it is seen that security is a significant hindrance in adaption of IOT. Security is required at IOT gadget level, where information is gathered, at network level, where information is sent and toward the end at the cloud level, where information is put away. This paper has introduced a survey of different security and protection answers for IOT applications in medical services, brilliant urban areas and savvy homes.To enhance air quality, a device to track the environment's air using an Arduino microcontroller and IOT Technology is suggested. The use of Internet of Things technology improves the process of monitoring different aspects of the environment, such asthe air quality observing problem discussed in this paper. The MQ135 and MQ6 gas sensors are applied to identifyseveral types of dangerous gases.Finally, we have validated the values received from our model with respect to the values predicted by a trained model and found that the values are perfectly acceptable.

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