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## Remote Monitoring Real Time Air Pollution – IoT Cloud Based

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**Abstract—** Air pollution nowadays, is one of the major concerns especially in metropolitan cities, primarily due to pernicious effects on the well-being of the common people, and thus in the long run affecting global economy. Monitoring of air quality started from the traditional ways and has come a long way to the most sophisticated technology being used today. Fresh air is the basic necessity of human being and hence it is becoming important to come up with real time air quality deets by using modern yet affordable technologies. In this paper we are analyzing and studying about the technology which has been used till date in monitoring the air quality index and its efficacy. In the proposed prototype we will be using internet of things (IoT), wireless sensor network and the cost-effective circumambient sensors and an app which will give the real time information about the quality of index at various regions.

**Keywords—** pollution, wireless sensors, app, quality of air.

### I. INTRODUCTION

Air pollution can be defined as the existence of particles and few gases whose concentration when increases become toxic in nature to human beings. These presences of substances are deleterious to the health of human beings and other living beings as well as cause destruction to the climate. It affects the normal functioning and well-being of person. Pollutants in air can be in the form of gases, solid particles and liquid. Pollutants can be primary or secondary. The pollutants that are directly released in air are called primary pollutants. When chemicals react with primary pollutants then the pollutants produced are secondary pollutants [1]. Quality index of air is decreasing day by day and it is becoming a matter of concern for everyone. It is increasing the health risks such as accelerated aging of the lungs, asthma, bronchitis, emphysema, and possibly cancer. It has become a matter of worry over the globe. Air polluting gases such as carbon dioxide (CO<sub>2</sub>), nitrogen dioxide (NO<sub>2</sub>), sulphur

dioxide (SO<sub>2</sub>), particulate matter (PM) and ozone (O<sub>3</sub>). The AQM (Air Quality Monitoring) stations are used to measure the wide range of pollutants and environmental conditions.

According to WHO study, air pollution is a major reason of deaths and major disease spread globally. The health effects can be estimated by increasing rate of hospital admissions and emergency room visits, to an escalated imperil of premature death. Suspended Particulate Matter have the potential of penetrating deep into lungs passageway thereby entering the bloodstream hence contributing to major ill health symptoms and diseases like cardiovascular, cerebrovascular and respiratory impacts. In 2013, it was declared as a significantly contributing factor for lung cancer by World Health Organization's International Agency for Research on Cancer (WHO-IARC).

So, for monitoring the quality index of air a need of air monitoring system came into existence. This can be implemented by making usage of sensors, microcontroller and internet of thing. With the help of sensors levels of various gases such as carbon dioxide, nitrogen dioxide and sulphur as well as level of suspended particles can be monitored. Further, this data collected with the help of sensors could be made available to the common public via smart phones wherein the app serves the user with real time data collection of the present quality of air in the area. With the execution of this in the proposed prototype, quality of life can be changed in a better manner for the betterment of the society and therefore contributing in the betterment for a better tomorrow for the entire mankind.

Now an important thing is to know about the need of monitoring. Fresh and clean air is a necessity for every living organism. Polluted air is the reason for various health hazards and befouling of the environment. Hence controlling is the air pollution is a major concern. But before taking any step for

controlling the air pollution we first need to have a measure of the air quality in an area and then the right strategy can be discussed and formed which will help to take the necessary steps for controlling the air pollution. The factors contributing towards the air pollution is innumerable. Some of the major factors of air pollution include untreated waste from factories, smoke from the exhaust of automobiles, radioactive elements, smoke from various industries, forest fires, etc.

These factors are the reason for the day by day ever decreasing air quality. Although a large number of gases are harmful to health of human beings but few gases like carbon monoxide (CO), hydrogen sulphide (H<sub>2</sub>S), sulphur dioxide (SO<sub>2</sub>), nitrogen dioxide (NO<sub>2</sub>) have a major impact. The affinity of hemoglobin present in our blood is more to carbon monoxide (CO) than to the oxygen (O<sub>2</sub>). This creates a problem since when the level of CO increases in our surroundings, our blood increases the level of CO in it thereby reducing the oxygen levels in the blood and body. This decrease in the level of oxygen level can prove to be fatal. The major contribution in the rise of carbon monoxide levels is the increasing traffic emissions. To improve the air quality huge amount of efforts are required in indoor as well as outdoor environment.

Sources of Air Pollution

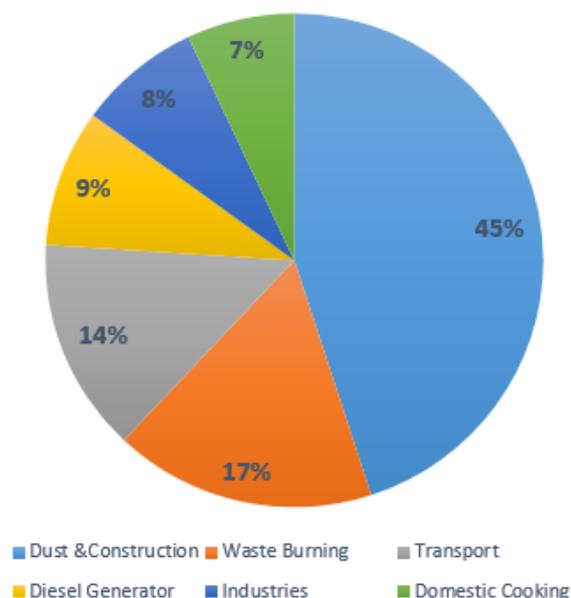


Fig. 1. Percentage of contribution of various sources in Air Pollution

In Fig.1 represents the contribution of each sector towards air pollution. The major chunk of air pollution is caused by the dust and construction work going on in the towns and cities in the name of urbanization and development. Second factor which contributes in a major manor is waste burning. Waste burning can be in many forms like industries and factories burning their waste so as to discard them which causes air pollution and affects the health of workers as well as nearby cities. Other waste burning forms may include crop stubble to coal used in stoves. Burn barrel air emissions include carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>), and various oxides of nitrogen like nitrogen oxide (NO), nitrogen dioxide (NO<sub>2</sub>) etc.

Transportation is yet another contributor in the rising air pollution problem. With the outgrowing of population people more and more prefer to use their own transportation system instead of using public systems transport. Although it may be easier and convenient to travel by one's own transport but it is creating a major of air pollution by contributing more and more towards it.

The other prominent factors which contribute to the air pollution are diesel generators, industries and domestic cooking.

## II. LITERATURE REVIEW

In installing the sensors and then collecting the data from them, it uses multiple sensors for different locations to coordinate, AQI LED indicator is activated as per level of air pollution and according to real time level of air pollution using graphs [2]. For different sensors data computing, the author has used different intelligence for the sensor nodes and uses databases for locations [3]. For Arduino, the author has used sensors for data collection, uses ESP8266 Wi-Fi module for connecting the data from sensor to server [4]. The microcontroller communicates with ESP8266 Wi-Fi module with the help of AT commands. Also, ZigBee transmitters and receivers are used and GPS is used for finding out the locations of air pollution on map [5].

Several research projects have been done to monitor the air pollution using IOT or wireless sensor networks. An environment is provided by Iot in which the different objects can work together and interact with each other. GPRS system used in a distributed wireless system monitoring air pollution by mobile was described in [6]. Paradigms used in monitoring system of air pollution has been changing quickly as there is progress in sensor and wireless communication technology[7].

A distributed wireless network system is a system in which the sensors are distributed in the environment at the different locations. Wireless sensor network at placed at different places in the form of various nodes. These nodes are called "motes". Each node (mote) has number of gas sensors that collects the various gases concentration in the air and send it for the analyses. It has a centralized design in which there is a central node [8]. The distributed system of sensors gives the information to the main location i.e. central node. Different sensors placed at the different locations and each sensor sends the information collected by them to the main location (central node).

There are different sensors which are used for measuring the various things such as temperature, humidity, rain, gases, pressure etc. [9]. The gas sensors used to measure the gases in the air such as carbon dioxide, carbon monoxide, Sulphur dioxide, nitrogen dioxide etc. Sensors are placed on different locations. The sensors placed on the different locations measures the different gas concentration in the area and provide the information on the basis of it. The information from the sensors at different places is given to a central location which processes the data further. The parameters such as temperature and humidity can also be measured along with the gases. The information is collected from different sensors at different locations via microcontroller. The information is then uploaded to the cloud so that it can be analyzed and viewed in the future [10]. The whole data collected is placed in the database management system present in the cloud. The various mobile applications and websites are developed to provide real time data and the previously collected data for the measurement of level of pollution in the particular area. The pollution level in the different areas can be viewed also by using the Google maps. The different level of pollutants in different areas can be viewed on the Google maps using the internet connection [11]. The different technologies are combined in air monitoring system to achieve wireless transmission of data.

The IoT based air monitoring system was also designed by researchers [12] over the web servers which triggers an alarm when the pollution increases in an area over the threshold value. In this the data was shown on the liquid crystal display (LCD) and on the web page. The quality of air was shown in

parts per million. The technique used by the Iot based air pollution monitoring system integrates the wireless sensors with the Iot on a Single Board Computers (SBC) which is a computer made on single circuit board with the required functional features of a computer. SBC helped in reducing the complexity and the alerting process was made real time and smart[13].The gas sensors used to measure the level of harmful gases and the microcontroller which is Iot based is used for controlling the process. Image processing a software technology can also be used for real time automated monitoring for the increasing the output. The Iot based large number of sensors is used to provide real time monitoring of pollution in the air [14]. The areas in which their is less accessibility in those areas system based on unmanned aerial vehicle was used for monitoring air pollution[15] . Autopilot Pixhawk was equipped in system for unmanned aerial vehicle control and for collecting and sensing the data Raspberry Pi was used .To analyze the data gathered algorithm used was adaptive.

collect the data from various resources (buildings, factories) where the author deployed the sensors. After this the data is transmitted with the help of IoT gateway such as zigbee protocol. Also the data is stored in the cloud database for the future use and proper monitoring of air pollution using graphs. After that the data is monitored and analyzed with the help of computer centers and smart phone application.

Fig. 2 shows the pictorial representation of how the data will be collected from various sources and then given to the microcontroller.

PROPOSED METHOD

The basic problem in existing research is to install air quality sensors in the industrial area, traffic and residential areas. All these wireless sensors are connected to a microcontroller (here, to an arduino) which is used and programmed in a manner so as to control the multiple sensors and collect the data from these multiple sensors. The data which is collected by the microcontroller is transmitted to Cloud for analysis. After analysis, the data is shared with the common man with the help of an app which is available on their smart phone and hence they can thus take required precautions

As shown in block diagram Fig.3 the first step is to sense the parameters of air pollutants or gases present in the air such as O<sub>2</sub>, CO<sub>2</sub>, and SO<sub>2</sub> etc. Now the microcontrollers will

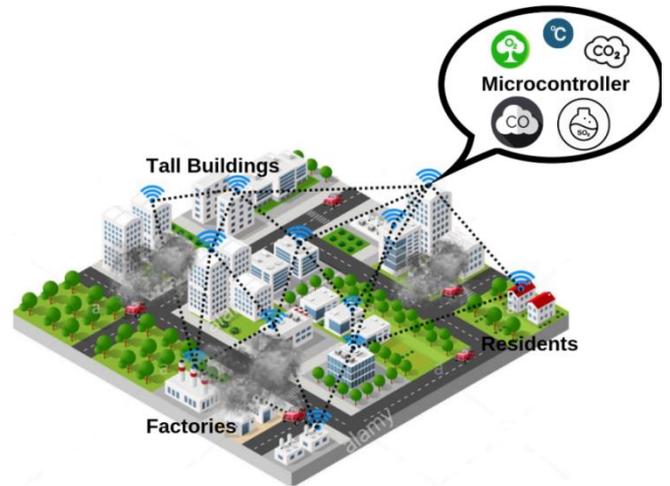


Fig. 2. Air pollution Monitoring System Layout

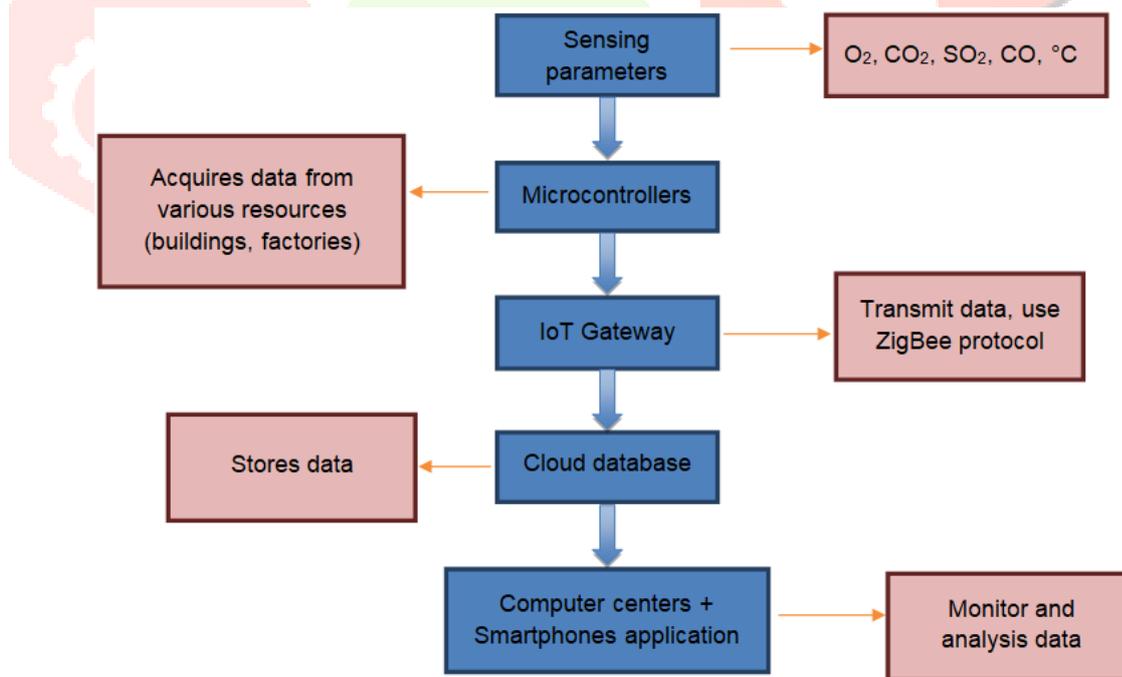


Fig. 3. Block diagram of the proposed prototype

## COMPONENTS USED

**Arduino Uno:** is a microcontroller board based on the ATmega328P. The board has multiple digital and analog input/output pins that can be interfaced with other expansion boards and circuits.



Fig. 4. Arduino Uno

**Wi-Fi:** is a wireless network protocol which are commonly used for local area networking of devices and Internet access. It allows devices like laptops, desktop, smart phones, smart watches and other equipment like printers and cameras to interface with Internet.

Esp8266 module is a wireless hardware which can operate without any other software or hardware for receiving and transmitting information. It is available at low cost. AT commands are used by microcontroller to communicate with esp8266 module.

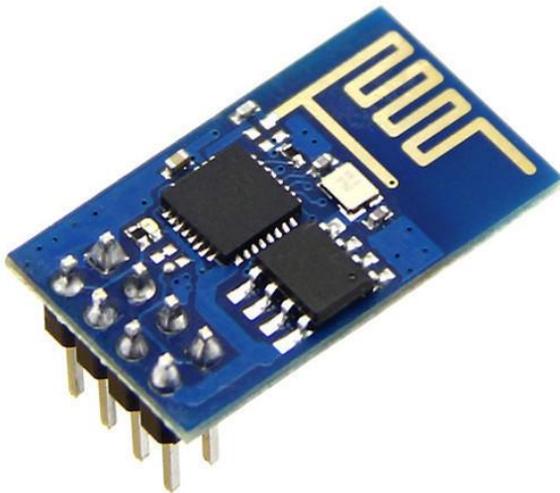


Fig. 5. Wi-Fi Module

**Gas sensor:** The amount in which the gases are present in our environment is measured by a device called gas sensors. Depending upon the amount of gas concentration in our surroundings the sensor makes a difference in potential which is called as output voltage. The amount of gas in the environment and the type of gas can be known by the value of voltage. Gas detectors (sensors) are used mainly to determine the harmful gases. They are placed in factories to know when there is any gas leak.



Fig. 6. Gas Sensor (MQ135)

**Liquid Crystal Display (LCD):** It is a flat-panel display or optical device which is modulated electronically that uses polarizes combined with liquid crystal that has light modulating property. Light is not directly emitted by the LCDs, rather it uses a reflector or backlight for producing the color images. Depending on the arrangement of polarizer the LCDs can be on (positive) or off (negative). It will be used to display the content on screen and will be interfaced with arduino and other sensors.

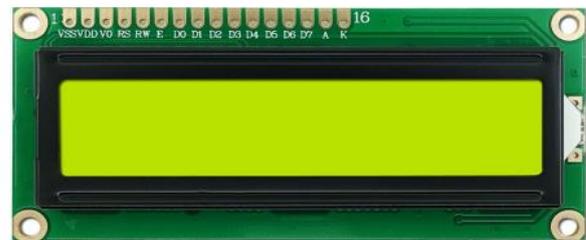


Fig. 7. LCD Module

## WORKING METHOD

Air Graded Detectors are located at the selected region on the building's peak, industrial regions, apartments and traffic locations. Extents of dirt particles, sulphur dioxide, carbon monoxide, nitrogen dioxide, carbon dioxide in the located environment are sensed by wireless detectors. Each sensor

nodes as shown in Fig. 9 has different gas sensors from which it collects the data of various gas concentrations. In parts per million the concentration of pollutants is shown that can also be converted in percentage. These sensors are connected to the microcontroller. The detected networks are controlled by Microcontrollers connected to these detectors (sensors). The Microcontroller programming is done in arduino in which detectors (sensors) are taken as input and pass on the data to the cloud. The facts collected by a microcontroller pass on the doorway that is IoT gateway which further goes to the cloud database via Wi-Fi transmission. So, the data is transferred to the cloud by an IoT gateway. Air Grade details come up by inspected record in the cloud. The cloud gets the data and then data is processed as shown in the Fig. 3. A program is developed to analyze the data present in the cloud. The data can also be stored in the cloud for the future references. On the cloud server, data will be present according to the locations. After the data processing and analyses the information is transmitted to the smart phone application. The people can have access to these online smart phone applications via any device which has connection to the internet. Thus, then the examined information is passed to the people via smart phone applications. These smart phone applications provide people with the real time data.

The pollutants level of concentration is measured in parts per million (PPM) or percentage.

$$1 \text{ PPM} = 1/1000000$$

$$1\% = 1/100$$

$$1 \text{ PPM} = 0.0001\%$$

TABLE I. CONVERSION OF PPM TO PERCENTAGE

Parts per Million (PPM)	Percentage (%)
0	0%
1	0.0001%
10	0.001%
100	0.01%
1000	0.1%

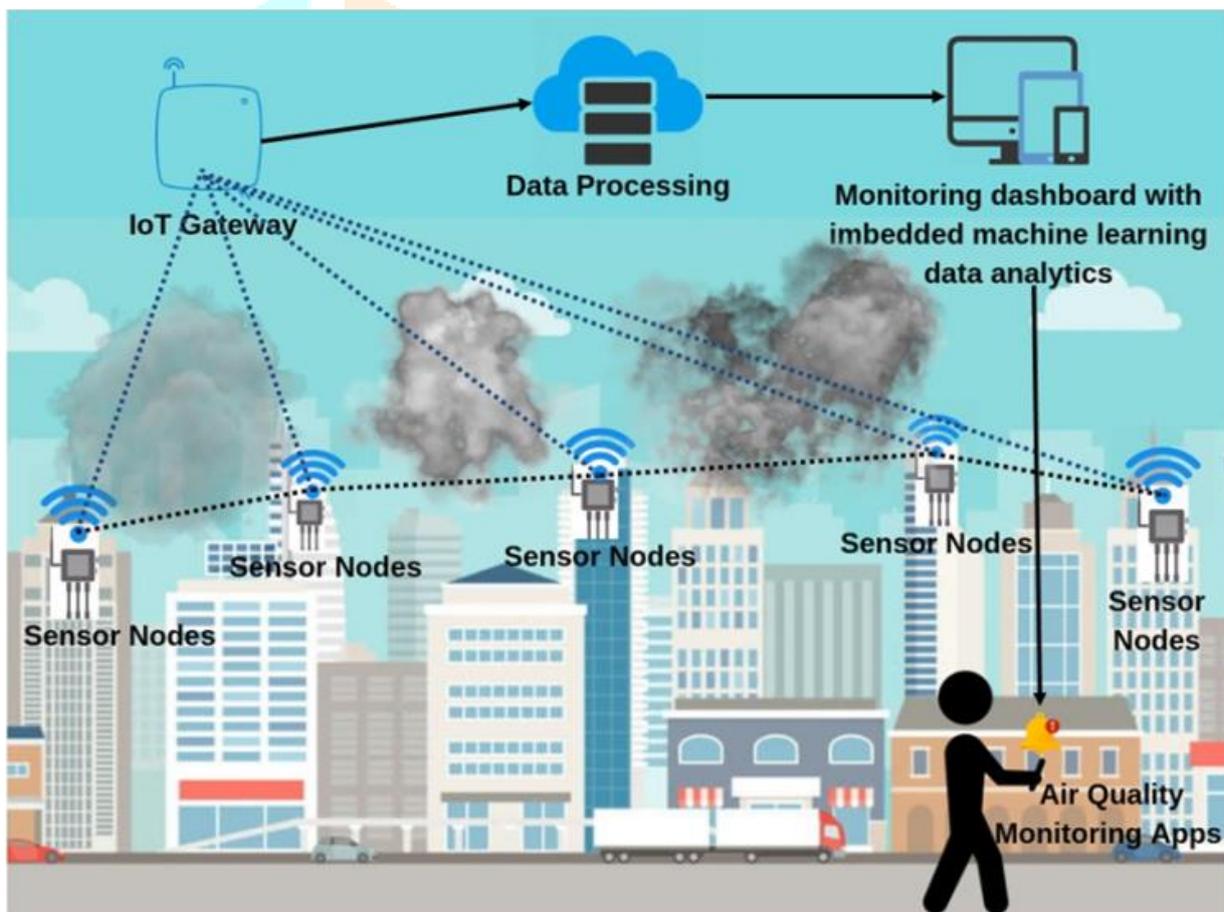


Fig. 8. Visual Representation of Remote Monitoring Real Time Air Pollution

The above Fig. 8 gives us a pictorial representation of how this remote monitoring real time air pollution will be implemented. Few advantages of this are: sensors are easily available, detects a wide range of gases like NH<sub>3</sub>, SO<sub>2</sub>, etc., simple, compact and easy to handle. On the other hand, the disadvantages are: accurate measurement of gases cannot be detected, more sensors are required for accurate results. Applications include roadside pollution monitoring, industrial perimeter monitoring, indoor air quality

measurement and to make this data available on smart phones of a common person.

#### CONCLUSION

This Paper suggest a proper remote monitored real time air pollution system that is cloud based and which persistently provide traces of air grade in a locality and present the air grade calculated on a LCD display. Calculated Data is also addressed to the cloud platform and hence to an app. It also generates perception of the air grade that one can respire regularly. This appliance observes actual calculated air grade.

### III. ACKNOWLEDGMENT

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