# IOT Based Air Pollution Monitoring and Controlling System Using Raspberry Pi

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## ABSTRACT

In a country like India, air pollution is increasing day by day. The main reason for increasing of pollution level are crop's remaining burning, emission from the motor vehicle, open defecation of smoke in atmosphere from the industries and burning of garbage. These lead to the adverse effects of the society that may lead to loss of living creatures. The level of pollution has increased with times by lot of factors which results in harmful effects on human wellbeing. To keep in control and provide a better quality of life for all, air quality should be monitor and control An IOT Based Air pollution Monitoring and Controlling System is proposed. Sensors can be distributed at various locations which can sense and collect the data. The presence of harmful gases like CO2, smoke, carbon monoxide above a particular limit may turn disastrous which can lead to severe accidents. The pollution level can be monitored from anywhere using computer or mobiles.In this system we can also control the quality of air pollution by using exhausting fan. Pollution is major issue in the nowadays. Atmospheric conditions continue to deteriorate each year due to increase of civilization and increasing unclean emissions from industries and automobiles. Among various types of pollutants such as water, soil, thermal, and noise, air pollution is the most dangerous and severe, it causes climate change and life-threatening diseases. According to the World Health Organization (WHO), 90 percent of the population now breathes polluted air, and air pollution is the cause of death for 7.5 million people every year [2]. These pollutions lead to the harmful effects of the society that may lead to loss of living creatures [3]. Air pollution, climate change and its consequences are of a great concern to the environmentalists and climate change scientists. As the world's population becoming increasingly urban, the cities are under pressure to remain liveable. In recent years, the air quality of the cities has become one of the causes of concern around the world [4].

With the tremendous increase in the level of population and industrialization pollution has increased rapidly. This expansion in the level of contamination brings about destructive consequences for living things. This project explains the implementation and execution of an Air Pollution detection system. The innovation grasped here, is the hands-on execution of the idea of Internet of Things. This detailed work is an exploration of the possibilities of consumption of this innovation, in this world, where living-being is turning into a genuine risk. The work is actualized utilizing Raspberry pi. In this project we used 5 sensors CO sensor, Dust sensor,

Temperature sensor, Humidity sensor and LD. We made an IoT based Air Pollution Detection Monitoring System in which we will monitor the Air Quality over a web server using ESP8266 Wi-Fi device and will a trigger alarm when the air quality goes down a certain level means when there is a number of harmful gases is present in the air like CO. These sensors continuously sense the data and store the data in the internet It will show the air quality in PPM on the LCD and as well as on the webpage so that we can monitor it very easily. The system will also show temperature and humidity. It also detects the amount of dust particle in the air. The system can be installed anywhere but mostly in industries and houses where gases are mostly to be found and gives an

*alarm when the system crosses threshold limit and the exhaust fan turns on and it will turn off when the pollution level goes below the threshold level [5].*

## 1. INTRODUCTION

Air pollution is the biggest problem of every nation, whether it is developed or developing country. Health problems have been growing at faster rate especially in urban areas of developing countries where industrialization and growing number of vehicles leads to release of lot of harmful gaseous pollutants. Harmful effects of pollution include mild allergic reactions such as irritation of the throat and nose as well as some serious problems like bronchitis, heart diseases, pneumonia, lung and aggravated asthma.

CO is released when something is burned. The greatest sources of CO to outdoor air are vehicles or machinery that burn fossil fuels. Unvented kerosene, gas space heaters, leaking chimneys and furnaces, and gas stoves also release Co.

Also, exposure to dust in workplaces and inside homes can have adverse health outcomes, such as respiratory problems, asthma, allergic reactions. There is no proper system for minimizing the CO and clear dust from the air.

### Objectives

• Develop a system which can detect pollution in the atmosphere and analyses the data.

• Monitor and store the data in the webpage

• The system gives an alert when the values go high.

• Reduce the pollution automatically with an exhausting fan.

This project can be implemented at industries to monitor the level of pollutants. The project offers a solution towards continuously monitoring level of CO in the atmosphere and also dust particle in the air. The project also detects other parameters like temperature, humidity and light intensity from anywhere anytime using mobile or computer. It also promises a solution to minimize the pollution in indoors by using an exhausting fan. It can be employed to reduce the man power in data collecting & analysis. Pollution board can monitor the real time pollution level on the industries or at any particular area. At the same time the system also helps to reduce the pollution and can also be used to take direct action on the people responsible for pollution and take preventive actions. The system also has a data base of all the tracked pollution history which can be visualized at any time.

So, this project can be considered as a multi-benefactor project for government, public and environment.If air pollution is not controlled, by 2030 the air will become so poisonous that it will be necessary to use an oxygen kit to breath. Rising air pollution will also lead to premature aging.

## 2. PROCEDURE AND PAPER SUBMISSION

Harsha N. Shah et.al, Zishan Khan, Abbas Ali Merchant, Moin Moghal, Aamir Shaikh, Priti Rane, "IOT Based Air Pollution Monitoring System", 2018, Monitor the air quality over a web server using internet, continuously monitoring the data with less human interactions. Harsha Gupta, Dhananjay Bhardwaj, Himanshu Agarwal, Vinay Anand Tikkiwal, Arun Kumar, "An IOT Based Air Pollution Monitoring System for Smart Cities",2019, Raspberry Pi based system, Processor with a high processing speed and an inbuilt WI-FImodule.S. Sanjay Kumar, P. Ramchandar Rao, Ch. Rajendra Prasad, "Internet of Things Based Pollution Tracking and Alerting System", 2019, Monitoring environment in real time at diverse application. Tracks all kinds of pollution very easily.Kgoputjo Simon, Elvis Phala, Anuj Kumar, Gerhard P. Hancke, Senior Member,IEEE, "Air Quality Monitoring System Based on ISO/IEC/IEEE 21451 Standards"2016, Monitoring real time measurement of air polluted gases such as CO2, CO, Consume little power.

Junho Jo, Byung Wan Jo, Junghoon Kim, Sung Jun Kim, WoonYong Han, "Development of an IOT Based Indoor Air Quality Monitoring Platform" 2020, IOT based indoor air quality monitoring platform. Monitoring efficiency.

F.N Setiawan, I Kustiawan, "IOT Based Air Quality Monitoring"2018, User can monitor the air quality using smart phone connected through esp8266. Air condition can be monitored every time.Lalit Mohan Joshi, "Research Paper on IOT Based Air and Sound Pollution Monitoring System"2015, Monitor the air and noise pollution using wireless embedded computing system. Simplified hardware which reduces cost.Manikannan.G,Vijalakshmi.T,Prabhakaran,"Mobile -Air Pollution Monitoring System Using Internet of Things(IOT)" 2019,Wireless sensor network. Monitor low frequency data at remote locations. Ali, J.K. Soe,

Steven. R. Weller, "A Real-Time Ambient Air Quality Monitoring Wireless Sensor Network for Schools in Smart Cities", 2015. Wireless sensor network (WSNs). A solar powered low-cost real time ZigBee based wireless air quality monitoring system that can be easily deployed in outdoor environments in areas surroundings schools in smart cities.Ali AbaasAbooddee Al-Zaheiree,Yasir Ahmed Taha Al-Zubaidi, S.S. Gaikwad, R.K. Kamat, "Advanced Air Pollution Detection Using IOT and Raspberry Pi", 2020, MQ2,MQ135,MQ7, Fast reaction and high affectability.

The proposed solution of our system which monitoring as well as controlling the pollution by using sensors and air filter. In earlier days monitoring system is done by using Arduino, and there is no any controlling elements to control the pollution. Here we using different sensors connected to a Raspberry Pi module, and the sensors frequently measures the environmental parameters like humidity, temperature, carbon monoxide, light density, observed and recorded it for further applications.

The system can monitor the leakage of toxic gases and hence the level of pollution using Raspberry Pi and IOT is proposed which can prevent fatal accidents. By the use of sensor MQ135, MQ6, MQ7 gas sensors which sensed the poisonous gases and save the human life and health. Raspberry Pi is the heart of the system which control the entire process of the system. WIFI module connects the whole process to internet and LCD is used for visual output.

The air pollution monitoring system can help in the innovation of new practices to overcome the problems of highly-polluted areas, which is a major issue. It supports the new technology and effectively supports the healthy life concept. By the use of wearable technology is also a mile stone which can ensure the safety of workers in the industrial areas. In this project we can also control the quality of air pollution by using air filters which absorb the carbon in the polluted air and provide fresh air as the output. Air quality monitoring and controlling system is proposed in our project which enable us to monitor and check real time quality of the air temperature, humidity, in particular region through Internet of Things. We can check level of pollution on mobile / laptop through fire base platform where data is stored.
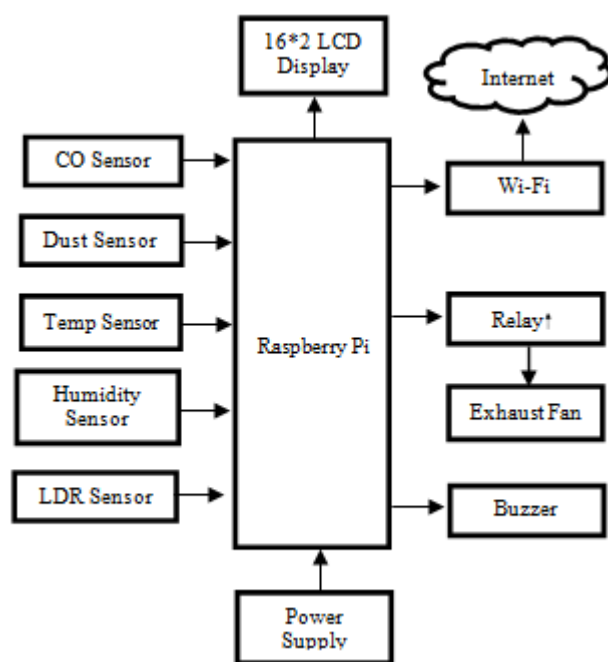


*Fig.*

Proposed Air Pollution Monitoring System is based on the block diagram as shown in the Fig.An IOT Based Air pollution Monitoring and Controlling System is proposed. Sensors can be distributed at various locations which can sense and collect the data. The presence of harmful gases like $CO_2$, smoke, carbon monoxide above a particular limit may turn disastrous which can lead to severe accidents. The pollution level can be monitored from anywhere using computer or mobiles.In this system we can also control the quality of air pollution by using exhausting fan. In this project we used Raspberry Pi 1B. A 5 V power source with a micro-USB connector is used to supply 5v.

CO is released when something is burned. The greatest sources of CO to outdoor air are vehicles or machinery that burn fossil fuels. Unvented kerosene, gas space heaters, leaking chimneys and furnaces, and gas stoves also release Co. The data of air is recognized by MQ7 gas sensor. The MQ7 sensor can sense, CO in the range of 10-500 PPM [1]. Output pin of MQ7 is connected to A4 pin of Arduino nano, and it will give the Pollution level in PPM (Parts Per Million). MQ7 gas sensor will give the output in form of voltage levels and we have to convert it into PPM. So, for converting the output in PPM, we have used a library for MQ7 gas sensor. Exposure to dust inside homes can have adverse health outcomes, such as respiratory problems, asthma, allergic reactions. To monitor dust in the air we are used dust sensor GP2Y1010AU0F. GP2Y1010AU0F Module is used to

Sense Dust Particles in air and also called as an optical air quality sensor. The output of the sensor is an analogue voltage proportional to the measured dust density and is connected to A7.

For measuring the intensity of light LDR (Light Depended Resister) is connected to A6. Temperature sensor (LM35) is connected to A0 for measuring the temperature in indoor and outdoor.it can sense -55 to 155 $^0$C. DHT22 is connected to A3.it measures the humidity in the air. Output of these sensors are connected to Arduino nano; it converts the analogue data to digital and send to raspberry pi through serial communication. To monitor the sensed data in real time we used a 16*2 LCD display connected to Raspberry Pi (rs-D7, en-D8, d4-D25, d5-D24, d6-D23, d7-D18). ESP8266 Wi-Fi Module is a self-contained System on Chip (SOC) that can give any microcontroller access to Wi-Fi network, The sensed data in Raspberry Pi is uploaded to internet (Ubidots). An exhausting fan is connected to raspberry Pi through relay. When the data exceed the threshold limit exhausting fan turns on and turn off when the value become less than the threshold value. A Buzzer is connected as an alarm system whenever the data exceed the limit it turns on. Data's are continuously uploaded and store the data in ubidots and can monitor the data from anywhere anytime using mobile or a computer.
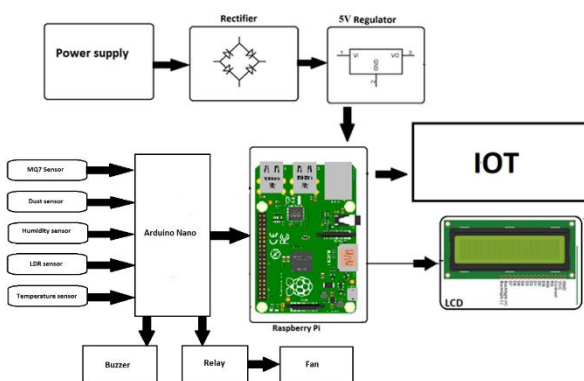


Environmental pollution problem has become a great threat to the development of society and humans' life. IOT technology provides an effective method for solving the environmental pollution problems. This project is for detecting the harmful toxic gas like CO, Dust and smoke and shows the real time monitoring of the concentration of the gases in the industrial floor and houses. The idea of this project is to sense the level of various gases in the industrial floor and houses and upload these data to the cloud. Also, it provides the warning alarm if the level of gases exceeds the threshold limit [5]. MQ-7 GAS Sensor is one of the series of semiconductor Gas Sensor that can be employed for detection of gases mainly employed for workshops and commercial buildings. It has many features such as: High sensitivity, Fast response, Wide detection range, Stable performance and long life and a Simple drive circuit. Resistance values of the sensor differ with various concentrations gases. The system uses a gas sensor MQ7 which detect Carbon monoxide in the atmosphere. A GP2Y1010AU0F module is used to detect dust particles in the air and also called as an optical air quality sensor. It detects fine particles larger than 0.8µm in diameter, even like the cigarette smoke. Also use LM35 sensor and DHT22 sensor for detecting temperature and humidity in the atmosphere. These sensors are deployed at the industrial floor and houses, they detect CO, Dust, temperature and humidity continuously and send data to Arduino nano. Arduino nano convert the analogue data into digital data. After the conversion these digital data is send to Raspberry Pi through serial communication. A 16*2 LCD display is connected to raspberry Pi for monitoring the level of pollution in real time. Serial/parallel pins are defined so it's easy to interface them with many microcontrollers. ESP8266 (Wi-Fi Module) connects the Raspberry Pi and the cloud. The ESP8266 is a low-cost Wi-Fi chip with full TCP/IP stack and MCU capability. It runs on 3.3V and gives our system to access to internet.

Ubidots is used as a cloud service to receive and process sensor data. The sensed data is then sent to the Ubidots (cloud Storage), it stores the data in the cloud and displayed on the webpage. We can monitor the pollution level in Ubidots anytime from anywhere using mobile or a computer. To upload sensor data on the internet, two items are needed: a place that can be used to access and store data and a way to communicate with it. Typically, these consist of a web application (place) and an API (way of communicating). A web application, like other applications (programs), runs locally on computers but is located on the web. In this project, Ubidots was selected as the webpage. In this work, Ubidots was used to exchange sensor data from Raspberry Pi to the webpage.

The presence of harmful gases like CO2, smoke, carbon monoxide above a particular limit may turn disastrous which can lead to severe accidents.

| Sensor | Description | Threshold limit |
|---|---|---|
| MQ7 | CO Sensor | 175 |
| GP2Y1010AU0F | Dust Sensor | 50 |
| LM35 | Temperature Sensor | 40 |

Table above shows the threshold limit of the sensors. Above this limit CO is harmful to health. When the sensors detect the pollution level above the threshold limit the buzzer starts alarming and the exhausting fan turns on.it continues the process till the value of these sensors drop below the threshold limit. There by we can reduce the pollution level in indoors.

## 4. FLOWCHART
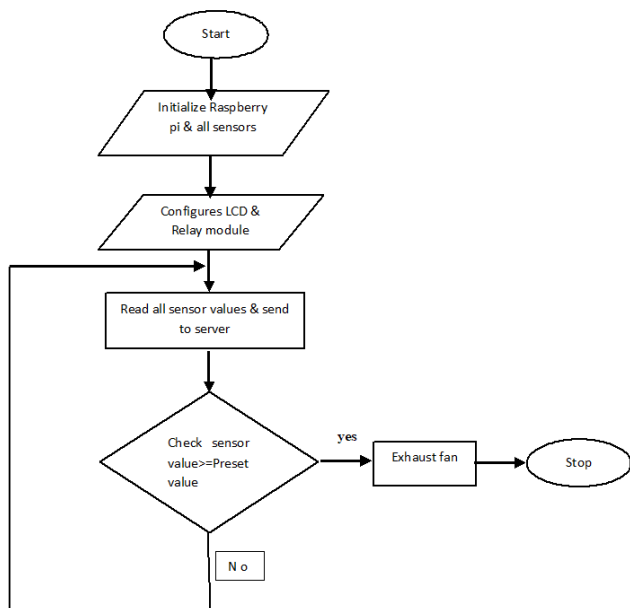


In IOT based air pollution monitoring and controlling system, the first step that we initialize all the libraries and header files such as software, LM35, DHT. In this program set up function that only one time execution. And the loop function executed at infinite times. We add all the programs so we can easily access the software. The next step was adding all the values of sensors and also we can add the date and time. These all values are displayed in a LCD screen, here we use a 16/2 LCD display. It has 16 characters per line and there are two such lines. In an LCD screen is and electronic display module and has a wide range of applications. It has 14 pins, 8 are the data pins and 3 LCD control pins,2 LCD power pins and 1 LCD contrast pin.Read all the values of the sensors, here we mainly used five sensors, MQ 7, Dust Sensor, LDR, Temperature Sensor, Humidity Sensor, Here we are using MQ7 as CO sensor the value that the sensor sense range 10-500 ppm. The CO sensor is connected to Arduino NANO, In has total 8 pins, the CO sensor is connected to Arduino NANO by analog pin (pin no:4). Dust sensor GP2Y1010AU0F. The sensor connected to Arduino NANO by Analog 7. The LDR sensor means that light dependent resistor and this sensor is connected by Analog 6. The fourth sensor is Temperature sensor that is LM35 and is connected by 1 pin A0. The final sensor is humidity sensor, that is DHT22 and It is connected by Analog 3 pin. In this step read all the value of sensor. The next step is the value of the sensor, here check all the values of the sensor. In this project we add a pre-set value and this priest value is fixed. This project the sensors monitor all values and here there are two conditions. That is it's a yes or no condition. In yes condition the sensors monitoring all the values and this value is higher than the pre-set value then it is yes condition. In this yes condition means that the pollution is high at this same time the sensors start monitoring and control the pollution. In no condition state means that the pollution is at normal condition at this state the sensors continuously monitor until the value at yes condition, otherwise the sensors monitoring like a chain. In this paper we use a alert mechanism, here we use a fan and buzzer. Here the buzzer is connected at Arduino NANO at ninth pin and the relay is connected at eleventh pin. The buzzer is an Arduino signalling device, which may be mechanical or electrical. The relay is used to convert small electrical stimuli into large currents. This project at the normal condition the pollution is low at this time the buzzer is off state. If the pollution is very high at this moment the buzzer will turn on and indicating the pollution is high, at this time the fan is also turn on and start working. This high pollution state the fan and buzzer act as a alerting devices. So, we can easily understand and control pollution. This project the relay is set at opposite of buzzer that is in high condition at off state and low condition at on state.
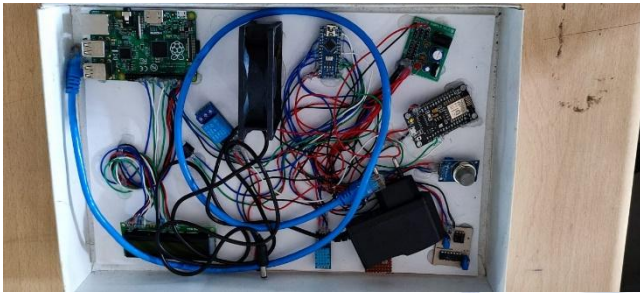
Fig.(a)

The goal of the project was to perform an initial implementation of the platform to monitor the air quality and reduce the pollution. This circuit connections are made and whole setup is placed into a small box, to be resistant of all whether conditions. Now the whole setup is placed in an industry or any workplaces to trace the concentration of CO gas, dust and smoke. The sensors recorded the value of pollutants in the air. All monitoring values are detected and stored in the Ubidots Cloud an online platform. The system is very easy to handle and it has accurate readings. So, it can easily monitor the pollutants. In Ubidots we can see the current pollution levels as well as previous levels of Carbon monoxide, dust, temperature and humidity.
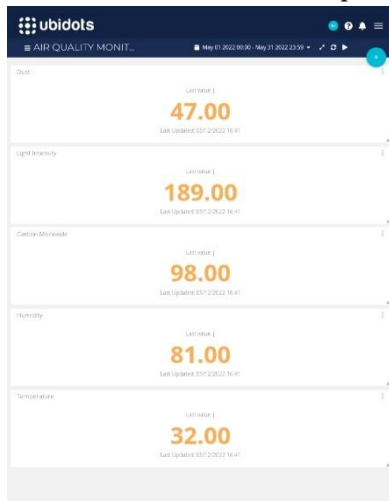


Fig.(b)

Fig.(b) shows the readings of Carbon monoxide, dust, temperature, humidity and light intensity in the indoor. The system has an alerting mechanism. The sensor read all the values continuously like a chain. In the program we set a pre-set value for each sensor. When the sensor value breach the threshold limits the buzzer starts the alarm and indicated that the pollution is high. At the same time the exhausting fan is turned on along with the

buzzer. This process continued until the value of the sensors drop below the threshold limit and buzzer and exhaust fan turned off. Based on these readings, such information can then be used by the authorities to take prompt actions.

We had made a prototype of an Air Pollution Monitoring and Controlling system to provide monitoring the pollution by CO gas and dust particles and control this pollution. This system is mainly used in indoors like industries and homes. It is an embedded system consists of embedded software and hardware part dedicated for controlling the pollutions in the polluted areas like industries or any other places. It is a simple model and which is made up on a hand board material. The circuits are placed on that body. In this system we use a online platform Ubidots and this platform monitor the pollutions and collect all information's. This platform also stores the previous values of the sensors. In this project we mainly use five sensors that are CO sensor (MQ7), Dust sensor (GP2Y1010AU0F), LDR sensor, Temperature sensor (LM35), Humidity sensor (DHT22). The most important components of this project are Arduino Nano and Raspberry pi 1B.Our system is Mainly based on Raspberry Pi 1B but this project has five sensors and need the support of Arduino Nano. A 16* 2 LCD display is placed on the hard board. It is very use full for monitoring the pollution level at real time.it also helps to understand if the pollution level is high or low. There are five sensors are placed on the hard board CO sensor (MQ7), Dust sensor (GP2Y1010AU0F), LDR sensor, Temperature sensor (LM35), Humidity sensor (DHT22). Carbon monoxide is a harmful gas, the level of Carbon monoxide in the atmosphere is detected by the CO sensor which continuously measures the value and upload to the Ubidots along with other sensor values. The industrial floor is filled with dust particle which causes lung problems The dust sensor measures the quantity of dust particles in the air and displayed it on the LCD display and in the website. The next sensor used is the LDR sensor is a Light depended resister which monitors the intensity of light. The remaining two sensors are temperature sensor and humidity sensor which measures the variations in the temperature and humidity. The connections are made very simple so that everyone can easily understand our project.

In our society the level of pollution and mechanization pollution has increased many folds. This result in deuteriation of individuals health of entire population. The gases released by vehicles and industries plays a major role in the pollution and our project is to reduce this pollution. The main hardware is the raspberry pi which is must faster than Arduino. This project also provides online platform Ubidots for monitoring the pollutants level from anywhere at any time. The system also has a data base of all the tracked pollution history which can be visualized at any time. So, this project can be considered as a multi-benefactor project for government, public and environment. The circuit is very simple and the sensors used are low cost so, the system is less expensive. The software part of the system is also quite easy to learn and it can be done by programmer having the basic knowledge and software skills. The system records the parameters at every micro second so we get the accurate readings of the air pollution which helps to analyses the data. There is some scope of implementing in our system that we can reduce the pollution level with an exhausting fan. The system also contains a buzzer that alert when the pollution level exceed. And the fan will automatically run. There will be more scope of improvements in the future by the advancements of technology.

## 5. CONCLUSION

Our project proposes a real time monitoring of air pollution at various locations and indoors. The IoT system designed measures pollution in real time at the location and hence is cost effective. The user interface helps the people to know the pollution level at a certain area and the health hazard associated with it. People with specific allergies can avoid from visiting the place and hence be free from air prone health hazards. The system is scalable and supports any number of IoT devices that may be deployed since it's based on cloud platform. The interface supports all operating systems. A smart way to monitor the various environmental parameters using a Raspberry Pi module has been discussed in this paper. The concept of IoT based air pollution monitoring and controlling system helps improve the quality of air, monitor the level of noise, temperature and humidity. It is a low-cost and efficient method of monitoring. The monitoring of accumulated data in the cloud storage helps to analyze the various

patterns in the environmental parameters and accordingly notifies the public. The exhausting fan reduces pollution like smoke, dust and CO when it exceeds the limit in the indoors. It can be employed to reduce the man power in collecting the data and analyzing it. At the same time the system also helps us to reduce the pollution and can also be used take action on the people responsible for pollution. The system also has a data base of all the tracked pollution history which can be visualized at any time. So, this project can be considered as a multi-benefactor project for government, public and environment.

## 6. FUTURE SCOPE

Chemical reactions involving with pollutants can create acidic compounds, which can cause harmful to animals, human, vegetables and crops and buildings. Sometimes when an air pollutant such as sulphuric acid combines with water droplets that make clouds called smog. the water droplets become acidic, forming acid rain. When the acid rain falls over an area it can kill trees and harmful for animals and fish also other wildlife's monitoring is an important part of effective air quality management system. Air monitoring is useful to assess the extent of pollution in smart cities.

In this project we can also control quality of air in the environment using air filter. Air filter is one of the vacuum chambers which will abstract carbon and dust particles from the polluted air in the atmosphere. In the future we can make the sensors in the helmets or in watches for the workers so that they can check their surroundings pollution free and safe to work. We can also add GPS location by this the government can locate the place where pollution is high and take appropriate actions.

**Conflict of interest statement**

Authors declare that they do not have any conflict of interest.

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