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Awareness of Air Pollution through IoT

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Abstract:
At present the ambient Air is polluted with hazardous gases emitted by motor vehicles, home electronic appliances and industrial factories. The ambient air is polluted with higher levels of the hazardous gasses like Particulate Matter, Nitrogen Dioxide, Sulphur Dioxide, Carbon monoxide, Ammonia etc. This polluted air is adversely affects the health of humans, animals, birds and the growth of trees. The Nature and its beautiful treasure are damaging a lot. So, how to avoid these adversaries of polluted air? If we aware the people with the information of toxic levels of harmful gases in ambient air, then people can take precautions about their health and they can think about the reduction of the air pollution. This awareness of air pollution can be give to the people by using Internet of Things (IoT) applications. There are several IoT applications available to know the air pollution levels. Those are Breezo Meter, Plume Air Report, Safar Air etc.

Keywords: Ambient Air Pollution, Hazardous Gases, Awareness, IoT Applications, Breezo Meter, Plume Air Report etc.

I. INTRODUCTION

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). According to the World Health Organization, around *two million* people die prematurely from the effects of polluted air every single year. It is a such as mining, construction, transportation, industrial work, agriculture, smelting, etc. However, natural processes such as volcanic eruptions and wildfires may also pollute the air, but their occurrence is rare and they usually have a local effect, unlike human activities that are ubiquitous causes of air pollution and contribute to the global pollution of the air every single day. [1]

II. TYPE OF AIR POLLUTANTS

The chemical compounds that lower the air quality are usually referred to as air pollutants. These compounds may be found in the air in two major forms:

- In a gaseous form (as gases),
- In a solid form (as particulate matter suspended in the air).[1]

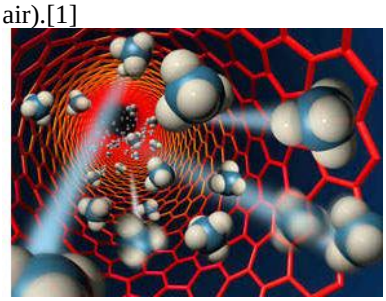

Figure.1. Flying Molecules in Air

Any gas could qualify as pollution if it reached a high enough concentration to do harm. Theoretically, that means there are dozens of different pollution gases. In practice, about ten different substances cause most concern:

1. **Sulfur dioxide**: Coal-fired power plants are the world's biggest source of sulfur-dioxide air pollution, which contributes to smog, acid rain, and health problems that include lung disease.
2. **Carbon monoxide**: This highly dangerous gas forms when fuels have too little oxygen to burn completely.
3. **Carbon dioxide**: carbon dioxide is also a greenhouse gas released by engines and power plants. Since the beginning of the Industrial Revolution, it's been building up in Earth's atmosphere and contributing to the problem of global warming and climate change.
4. **Nitrogen oxides**: Nitrogen oxide pollution comes from vehicle engines and power plants, and plays an important role in the formation of acid rain, ozone and smog.
5. **Volatile organic compounds (VOCs)**: They're used as solvents in many different household chemicals such as paints, waxes, and varnishes.
6. **Particulates**: Particulates of different sizes are often referred to by the letters PM followed by a number, so PM_{10} means soot particles of less than 10 microns in cities, most particulates come from traffic fumes.
7. **Ozone**: At ground level but not at stratosphere, it's a toxic pollutant that can damage health.
8. **Chlorofluorocarbons (CFCs)**: These gases were widely used in refrigerators and aerosol cans until it was discovered that they damaged Earth's ozone layer.
9. **Unburned hydrocarbons**: Petroleum and other fuels, when they burn incompletely, they can release carbon monoxide or float into the air in their unburned form, contributing to smog.
10. **Lead and heavy metals**: Lead and other toxic "heavy metals" can be spread into the air either as toxic compounds or as aerosols. [2]

III. AIR POLLUTION MONITORING IOT DEVICES

IoT devices applications make a real-time air pollution monitoring and forecasting. By using IOT, these systems can reduce the hardware cost into 1/10 as before. [3] The air pollution monitoring devices are categorized as outdoor and indoor related.

3.1 Out Door Air Monitoring Devices:

Air monitoring equipment, measure particulate **pollutants** and ambient **pollution** with the latest IoT technology available.

Figure.2. Aeroqual AQM 65

Figure.3. Dust Sentry PM10 Dust Monitor

3.2 Indoor Air Monitoring Devices:

These are sensor-based instruments and used widely in indoor and industrial environments to measure common air pollutants, in some cases with ppb (parts per billion) level detection.[4]

Figure.4. Series 500 – Portable Indoor

Figure.5. SM70 – Fixed Indoor Air Quality Monitor

IV. ARCHITECTURE OF AIR MONITORING IOT DEVICES

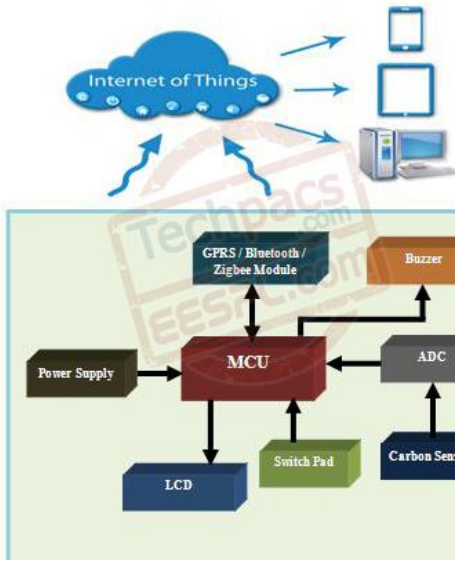

Figure.6. Architecture of Air Monitoring IoT Devices

Internet of Things (IoT) which is outcome of merged field of computer science and electronics. Here the sensing devices are connected to the embedded computing system to monitor the fluctuation of parameters like air pollution levels from their normal levels. Based on the framework shown in above figure, it consists of different sensor devices and other module. In this MCU could be an Arduino UNO or Raspberry pi e.t.c. Board with Wi-Fi module is as embedded device for sensing and storing the data in cloud. Arduino UNO board consist of analog input pins (A0-A5), digital output pins (D0-D13), inbuilt ADC and Wi-Fi module connects the embedded device to internet. Sensors are connected to Arduino UNO board for monitoring, ADC will convert the corresponding sensor reading to its digital value and from that value the corresponding environmental parameter will be evaluated. The Wi-Fi connection has to be established to transfer sensors data to end user and also send it to the cloud storage for future usage. Before sending the sensed data to cloud, the data will be processed in MATLAB for analyze. [5] **ZigBee** is a wireless networking standard that is aimed at remote control and sensor applications which is suitable for operation in harsh radio environments. It is connected to MCU. Various sensors like Sensors Carbon Monoxide – CO, Carbon Dioxide – CO2, Oxygen – O2, Methane – CH4, Hydrogen – H2, Ammonia – NH3, Isobutane – C4H10, Ethanol – CH3CH2OH, Toluene – C6H5CH3, Hydrogen Sulfide – H2

e.t.c. These devices continuously sending data to the cloud data storage through Internet. Where data analyzed by IoT softwares and displayed to the users in their smart phones and computer screens.

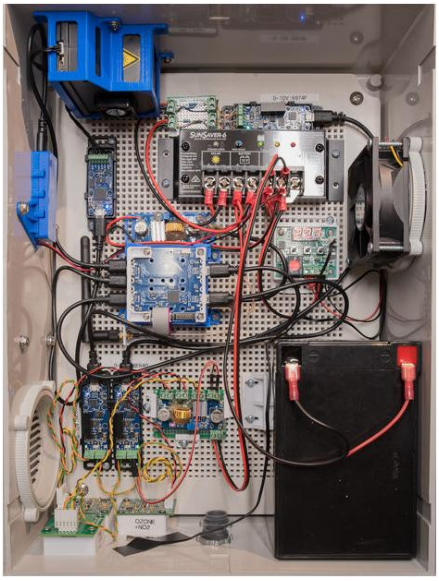

Figure.7. Components and Connections of Air Pollution Monitoring System

V. AIR POLLUTION MONITORING CENTERS

Throughout the world in each country there is an Air Pollution Monitoring System. The government of each country is maintaining these systems. Throughout the country there will be number of air monitoring stations. The data of air quality at these stations are centralized at one head station; from there city wise air quality information is displayed to the public. People of the nation can get this information from the related official websites. Another way is there are several smart phone applications like Breezo Meter, Plume Air Report, and Safar Air etc.

5.1. EPA - Environmental Protection Agency – United States

The EPA maintains a repository of air quality data through the Air Quality System (AQS), where it stores data from over 10,000 monitors in the United States.[1]

5.2 . CPCB - Central Pollution Control Board - India

Air Quality Monitoring is an important part of the air quality management. The National Air Monitoring Programme (NAMP) has been established with objectives to determine the present air quality status and trends and to control and regulate pollution from industries and other source to meet the air quality standards. It also provides background air quality data needed for industrial siting and towns planning.[6]

5.3 Air Quality Index

The Minister for Environment, Forests & Climate Change Shri Prakash Javadekar launched The National Air Quality Index (AQI) in New Delhi on 17 September 2014 under the Swachh Bharat Abhiyan. There are six AQI categories, namely Good, Satisfactory, Moderately polluted, Poor, Very Poor, and Severe. The proposed AQI will consider **eight pollutants** (PM_{10}, $PM_{2.5}$, NO_2, SO_2, CO, O_3, NH_3, and Pb) for which short-term (up to 24-hourly averaging period) National Ambient Air Quality Standards are prescribed. The AQI values and corresponding ambient concentrations (health breakpoints) as well as associated likely health impacts for the identified eight pollutants are as follows: [7]

Table.1. AQI values and corresponding ambient Concentrations

Pb (24hr)	NH_3(24hr)	SO_2(24hr)	CO (8hr)	O_3(8hr)	NO_2(24hr)	$PM_{2.5}$(24hr)	PM_{10}(24hr)	AQI Category
0-0.5	0-200	0-40	0-1.0	0-50	0-40	0-30	0-50	Good (0-50)
0.5-1.0	201-400	41-80	1.1-2.0	51-100	41-80	31-60	51-100	Satisfactory (51-100)
1.1-2.0	401-800	81-380	2.1-10	101-168	81-180	61-90	101-250	Moderately polluted
2.1-3.0	801-1200	381-800	10-17	169-208	181-280	91-120	251-350	Poor (201-300)
3.1-3.5	1200-1800	801-1600	17-34	209-748	281-400	121-250	351-430	Very poor (301-400)
3.5+	1800+	1600+	34+	748+	400+	250+	430+	Severe (401-500)

Table.2. Health impacts for the AQI Values

Associated Health Impacts	AQI
Minimal impact	Good (0-50)
May cause minor breathing discomfort to sensitive people.	Satisfactory (51-100)
May cause breathing discomfort to people with lung disease such as asthma, and discomfort to people with heart disease, children and older adults.	Moderately polluted (101–200)
May cause breathing discomfort to people on prolonged exposure, and discomfort to people with heart disease.	Poor (201-300)
May cause respiratory illness to the people on prolonged exposure. Effect may be more pronounced in people with lung and heart diseases.	Very poor (301-400)
May cause respiratory impact even on healthy people, and serious health impacts on people with lung/heart disease. The health impacts may be experienced even during light physical activity.	Severe (401-500)

VI. CONCLUSION

It is very much necessary to aware the people with Air Pollution information. It is easily possible by IoT applications. The present electronics and computer science technology makes possible to develop several IoT applications. By using these Air Pollution Monitoring IoT applications people can lead happy life. These applications not only give the air pollution information but also make the people to think about the air pollution reduction.

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