REVIEW ON AIR POLLUTION MONITORING AND DETECTION USING VARIOUS TECHNIQUES

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Abstract: Air pollution can be defined as an alteration of air quality that can be characterized by measurements of chemical, biological or physical pollutants in the air. Therefore, air pollution means the undesirable presence of impurities or the abnormal rise in the proportion of some constituents of the atmosphere. Thus, in this paper, comparison of various air pollution monitoring and detection techniques implemented using different technologies are discussed.

Index Terms – air pollution, monitoring, detection techniques and different technologies

1 INTRODUCTION

Air pollution is a major contributor to global warming and climate change. Air pollution is classified into two sections: visible and invisible air pollution. Air pollution is caused by the presence in the atmosphere of toxic substances, mainly produced by human activities even though sometimes it can result from natural phenomena such as volcanic erruptions, dust storms and wildfires also depleting air quality.

1.1 SOURCES OF AIR POLLUTION

Sources of air pollution can be classified into different categories.

Mobile sources- such as cars, buses, planes, trucks and trains. Mobile sources account for more than half of air pollution.

Stationary sources- such as power plants, oil refineries, industrial facilities and factories. Emissions from industries and factories releasing large amount of carbon monoxide, hydrocarbons, chemicals and organic compounds into the air.

Area sources- such as agricultural areas, cities and wood burning fireplaces. Area sources are made up of lots of smaller pollution sources that aren't big deal by themselves but when considered as a group can be.

Natural sources – Agricultural activities, due to the use of pesticides, insecticides and fertilizers that emit harmful chemicals.
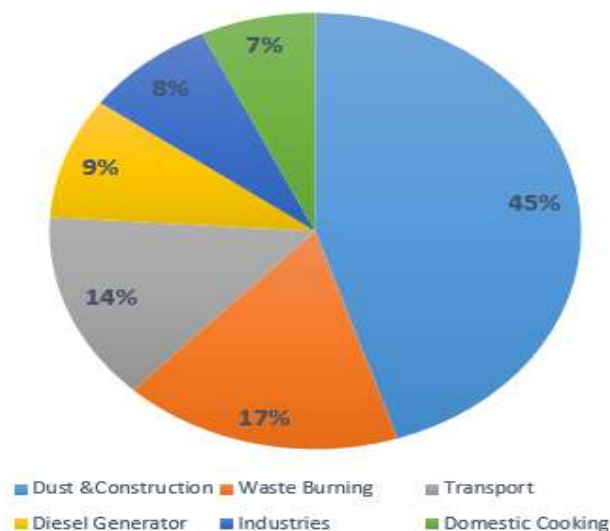

Fig.1: Distribution of Air Pollution causing sources

2. EFFECT OF AIR POLLUTION

It is impossible to describe the whole extent of potential and actual damage caused by all forms of air pollution. But here are the main consequences.

Effect on the Environment – Air pollution has a major process of plant evolution by preventing photosynthesis in many cases, with serious consequences for the purification of the air we breathe. It also contributes to the formation of acid rain, atmosphere precipitations in the form of rain, frost, snow or frog which are released during the combustion of fossils fuels and transformed by contact with water steam in the atmosphere.

Effect on Global Warming – Air pollution is a major contributor to global warming and climate change. In fact, the abundance of carbon dioxide in the air is one of the causes of the greenhouse effect. The presence of greenhouse gases should be beneficial for the planet because they absorb the infra-red radiation produced by the surface of the earth.

Effect on Human Health - our continual exposure to air pollutants is responsible for the deterioration of human health. Air pollution is indeed a significant risk factor for human health conditions causing allergies, respiratory and cardiovascular diseases as well as lung damage.

3. AIR POLLUTION PREVENTION METHODS

Renewable fuel and clean energy production – The most basic solution for air pollution is to move away from fossil fuels, replacing them with alternative energies like solar, wind and geothermal.

Energy Conservation and Efficiency – Production clean energy is crucial. But equally important is to reduce our consumption of energy by adopting responsible habits and using more efficient devices.

Eco friendly transportation - Shifting to electric vehicles and hydrogen vehicles and promoting shared mobility i.e., carpooling and public transports could reduce air pollution.

Green Building – From planning to demolition green building aims to create environmentally responsible and resource efficient structure to reduce their carbon footprint.

4. LITERATURE SURVEY

Some of the existing methodologies for the air pollution monitoring and detection are discussed below. This section explains about the work done by various researchers using different technologies for air pollution monitoring. Mainly 4 techniques used for air pollution monitoring and detection namely—Wireless Sensor Network (WSN), Internet of Things (IOT), Electrochemical Gas Sensing technique, MyRio- LabView Technique

4.1 Wireless Sensor Network based air pollution monitoring and detection techniques:

In [1] authors propose continuous monitoring methods. This method uses sensors to monitor the parameters and send to the control center by network. This system focus on implementation of air pollution monitoring system and develop an integrated wireless sensor board which employs CO2, NO2, NH3 temperature sensor, ATMEGA 16 micro-controller, data base server and a Zigbee module. The ATMEGA16 microcontroller is the main component of air pollution detection unit. The operating system that runs inside the chip coordinates the substance measurement process, the acquisition of the GPS coordinates and the data transmission to the central server. The microcontroller is mounted on a development board that provides an RS232 serial communication to the Zigbee modem and receiver and a parallel connection to the gas sensors. The connection between gas sensors and the ATMEGA16 microcontroller cannot be made directly because of the very small output voltages provided by the sensors (mA). This problem is solved by electronic circuits for signal conversion like OA (Operational Amplifiers) and transistors. The necessary code for controlling the sensors on the Motors is Coded using embedded C language, in which the input and the output ports can be defined easily. In this technique IDE compiler is used to compile the code and upload it to the board using an A-B wire.

4.2 Internet of Things (IoT) based air pollution monitoring and detection technique:

In [2], the author designed the technique to test and monitor the pinpoints of air pollution of any area. This technique consists of a microcontroller (Arduino UNO R3), gas sensors, mobile unit, a temporary memory buffer and a web server with internet connectivity which collects data from different locations along with co-ordinates information at certain time of a day. The readings for particular location are averaged in a closed time and space. The Global Positioning System GPS) module is attached to a system to a system to provide accurate pollution sources in an area. The recorded data is periodically transferred to a computer through a General Packet Radio Service (GPRS) connection and then the data will be displayed on dedicated website with user acceptance.

In [3] the authors provide a technique that will provide good air quality data and comprises of various gas sensors, GSM module, cloud server and mobile application. The system has unique features such as mobility, extensibility and user friendly. A combination of display, server and mobile application in case of data monitoring gives a balanced and robust composition in the field of data monitoring. Air pollution data are collected with the help off different gas sensors. The acquired data are then processed using Arduino microcontroller. After processing Arduino send data to the server where the data are updated and recorded continuously. Real time data can be monitored with the help of android application. If any pollution data exceeds threshold limits the systems alarms the responsible authority.

4.3 Electrochemical Gas Sensing technique:

In [4] the authors provide a technique that employs Electrochemical Sensors used for measuring oxygen and toxic gases. They measure the concentration of specific gas within an electric circuit. This is done by oxidation and reduction methods. These reactions produce positive or negative current flow through said external circuit. An electrochemical sensor is made up of "Working electrode", "Counter electrode" and "Reference electrode". All these components are built inside the sensor with a liquid electrolyte. Sensor work by means of gas diffusion. Gas finds its way into the outlet of the membrane on top of the sensor housing. This reaction is either oxidation or reduction based on the gas. Oxidation causes the flow of electrons to move from working electrode to counter electrode through external circuit. Reduction causes the low of electrons to move from counter electrode to working electrode. Either direction of electron flow creates an electric current proportional to concentration of gas. The electrons within the electric circuit detect and amplify the current. It then scales the output accordingly with the calibration to give a reading in engineering units.

4.4 MyRio LabView technique:

In [5] the authors provide a technique that employs air quality monitoring based on MyRio Labview which could monitor the air quality at various different locations. The sensors are connected to Arduino Mega and MyRio Controllers, the output is processed by LabView Software on the user computer remotely. The system detects the gaseous element present in the air using sensors. The sensors are connected to particular module that has its own circuit. The module is then connected Arduino Mega. The coding in the Arduino Mega activates the sensors to produce the readings of gaseous element present in the air. On the other side Arduino Mega is interfaced with MyRio using UART (Universal Asynchronous Receiver Transmitter) so that data can be accessed using LabView Software. The readings can be monitored by the user via LabView Graphical User Interface (GUI) and is saved in Excel format.

In [6] the authors provide a method for monitoring pollutants on desktop/laptop through an application designed using Graphical Programming language LabView Software and provides alert if the air quality characteristics exceeds acceptable levels and is sent via Android Application. The detection system consists of two parts. The first part includes calibration and measurement stage. This part requires a combination of network of sensors, Control and Acquisition Unit. The output of sensors is stored in data base. The second part concerns the development of Graphical User Interface supervision. This interface exploits the value of data base already filled in the first part. Useful data is extracted, normalized and stored in the second database. Classification and identification methods are applied to detect between various gases.

5 COMPARATIVE ANALYSES

After detailed study of various techniques used for air pollution monitoring techniques, IoT based technique is widely used. Advantage of IoT based system is that it constantly collects accurate data, keep tracks of air quality in an area and displays air pollutants quantity on the output devices. This technique can deliver real time measurements of air pollutants. It avoids the problem of inconsistent pollution value. The IoT based technique is scalable and supports any number of Iot devices. The interface supports all Operating System.

CONCLUSION

In this paper, we have studied various ideas proposal for air Pollution Monitoring and detection techniques. Since a stabilized system is needed for preventing harm caused to the environment due to excessive emissions if air pollutants. The study shows that mainly IoT based techniques are mostly used for air pollution monitoring but the cost of implementing IoT based system is very high. To make a cost-effective solution, artificial intelligence and machine learning based system were developed for automating the process of air pollution monitoring with maximum efficiency and low cost.

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