



INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X

Impact Factor: 6.078

(Volume 7, Issue 4 - V7I4-1643)

Available online at: <https://www.ijariit.com>

Air pollution monitoring using IoT

Ajay Suri

ajay.suri@abes.ac.in

ABES Engineering College,
Ghaziabad, Uttar Pradesh

Siddhant Sahu

siddhant.17bec1082@abes.ac.in

ABES Engineering College,
Ghaziabad, Uttar Pradesh

Shivam Sharma

shivam.17bec1123@abes.ac.in

ABES Engineering College,
Ghaziabad, Uttar Pradesh

Shalu Rawat

shalu.17bec1126@abes.ac.in

ABES Engineering College,
Ghaziabad, Uttar Pradesh

Rishi Yadav

rishi.17bec1059@abes.ac.in

ABES Engineering College,
Ghaziabad, Uttar Pradesh

ABSTRACT

As the world becomes more industrial to support the basic necessities and luxuries of life, adverse effects have been noticed in the environment. One of these adverse effects is air pollution. Air pollution has risen to such a level in certain regions of the world that it has started to cause health related issues to all of the living beings dwelling in that region. The purpose of this paper focuses on designing and implementation an air pollution monitoring system based on Internet of Things (IoT) that would read the levels of pollutants in the air and other air quality factors, and thereby transmit these readings via wireless communication to a smart cloud platform where all these readings can be displayed in a distinguished manner. Such system is a vital need so as to check the atmosphere one lives in, and thereby take precautionary measures to protect oneself and the surrounding nature.

Keywords— AQI, IoT, sensor data, Wi-Fi

1. INTRODUCTION

In the urban environment, air pollution is one of the major challenge which is not only related to health of humans and animals, but also it has its impact on plants, aquatic life and other biotic components of our different ecosystems. Air pollution has also been known to affect non-living things like buildings and monuments, as it leads to acid rain that can corrode different materials gradually [1]. Internet of Things, or IoT, is a network of different computing machines which maybe digital or mechanical, that share data within the network without the involvement of human-to-human or repeated human-to-machine interactions, and each of these 'things' are distinguished using unique identifiers (UIDs) [2]. Hence, IoT has been a technology helping in improvisation of automation in industries as well as in households. Cloud infrastructure, on the other hand, is a connection between a virtual host and a

virtual client where some virtual resources like memory can be integrated to store data for the client. This connection is usually global, that is, it is a virtual storage platform that can be accessed from any part of the world. Hence for data collection, access and management features, cloud can be the best platform that can be used. [3]

The integration of the two technologies, viz., cloud and IOT, would make a monitoring system more accessible and capable of being installed even in some other part of the world. A real time monitoring of air pollutants and other factors can be done continuously with the help of sensors, and furthermore, this sensor data can be fed to a smart cloud and can be used to analyze its trend with help of graphical representation. To design such an air pollution monitoring system, air pollutant measuring sensors can be attached to a microcontroller which should have a Wi-Fi module to let the microcontroller connect to the internet so as to send the sensor data to the smart cloud. This monitoring system shall tell various pollutants in the air such as the particulate matter (PM) suspended in the air like PM1, PM2.5 and PM10, where the numeric value attached to PM refers to the size or diameter of the particle in micrometer. This system shall also tell overall Air Quality Index (AQI) which is a measurement of net air pollution, and is determined by measuring the levels of PM2.5, PM10, Sulphur Dioxide (SO₂), Nitrogen Dioxide (NO₂), Carbon Monoxide (CO), Ozone (O₃) and Ammonia (NH₃) emissions in the air [4]. Displaying other air quality factors like temperature, barometric pressure and humidity would also be advantageous to us.

2. LITERATURE REVIEW

A Wireless Sensor Network for CO₂ Monitoring for Vehicles [5] -

An exemplary device would have different sensors placed on objects like an automobile or a living being. It's an innovative

device with integrated sensors and tuning fork sensors are used which are polymer modified. The device collects and sends the samples, conditioning it with removal of interferons and it also has air zeroing capabilities so as to establish of baseline. This forms a discrete and compact unit. Particle filter or zero filters are used while drawing atmospheric air into the system. Then, the air is delivered to the interferon filter for the process of sample conditioning, followed by the cartridge of tuning fork sensors. The sensor readings will be ensuingly digitalized and transferred wirelessly to the interfacing devices. This is done using Bluetooth communication.

Wireless Sensor Network System for Air Pollution Monitoring [6] -

In the proposed model, wireless air pollution monitoring system (WAPMS) consists of an arrangement of sensors and their nodes. For the process of data transmission, a wireless communication system is used. The data is independently gathered by the sensor nodes and then passed to the base stations and sensor network server. The data fetching as well as the transmission of the data is done by the sensor nodes according to a protocol. This system helped the organizations to conceive air pollution indexing.

MAQS: A Personalized Indoor Air Quality Monitoring Mobile Sensing System [7]-

This proposed paper mark outs Mobile Air Quality Sensing (MAQs), which is a portable system for sensing Indoor Air Quality (IAQ). MAQs evaluate air quality factors which affects health of human beings such as carbon dioxide concentrations, volatile organic compounds (VOCs) and harmful microbes in the air using air exchange rates. Portable devices like mobile phones and other devices can be consolidated with MAQs for energy efficiency and thus indoor air quality can be monitored easily.

Wireless Sensor Network Based Air Pollution Monitoring System for Metropolitan Cities [8]-

This paper describes the model which is able to analyze the different pollutants' percentage in different areas of the city. The Bluetooth manager collects and transfers the data to the server of the user. For calculatingg the percentage of pollutants in the air and future predictions of pollution level in the city, ID3 data mining algorithm is used. This helps in faster addressing of risky areas.

Air Pollution Monitoring using Multi-wavelength IR Method For Cities [9]

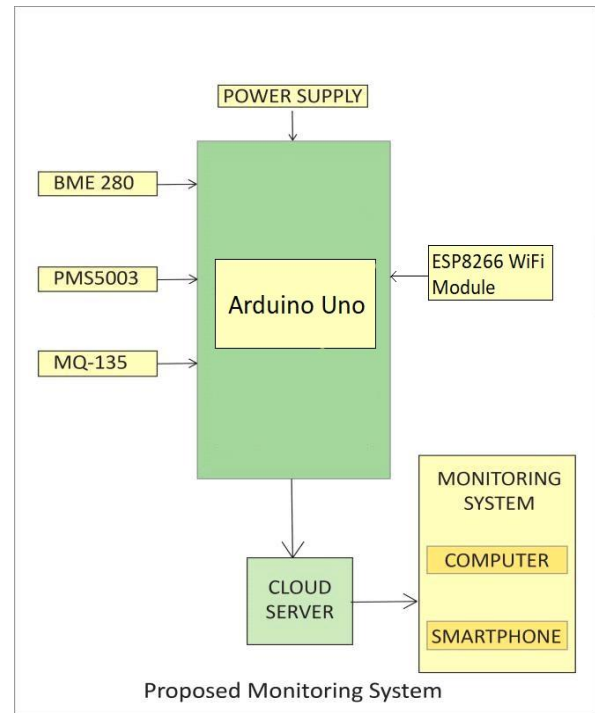
In the proposed model, the production of exhaust gases by different gasoline machines is being analyzed and detected. The process works on the principle of infrared multi-wave length absorption in the range of 1.3-2.4 micrometre, by using light emitting diode (LED) array. Light emitting diode absorption fringe authorize numerous absorption spectra to be overlay. A six component multi wavelengths if light emitting diode fringe was in difficulty for the imitation of the process. The illustration that the scheme is very similar for the instrument to open path indicators wherever the energy repository and also the recipient placed at a distance of tens of meters apart from each other.

Real Time Air Pollution Monitoring System Using Wireless Sensor Networks [10]-

In the proposed system, the readily available gas sensors in the market are used for sensing the prime air polluting gases that are present in the atmosphere. As per the grade and standard,

these detectors are distinguished. The wireless sensor integrate these gas sensors by using multi hop knowledge aggregation algorithm. Air waste substance knowledge is cumulated from the check beds developed. Detection of the air quality present in the environment is done using gas sensors along with waspmote. The simplicity and economical advantage of waspmote is because of the wireless communication among the sensors.

3. PROPOSED SYSTEM OVERVIEW



The proposed air pollution monitoring systems consists of Arduino Uno as the main microcontroller. Arduino is an open-source microcontroller and is based on the microchip ATmega328P. It is developed by Arduino.cc [11]. It consists of fourteen I/O pins, six analogue pins and it can be programmed with Arduino Integrated Development Environment (IDE) using a USB cable of type B. The Arduino IDE is an application available in different platforms (Windows, Linux, macOS) and its functions are derived from C and C++.

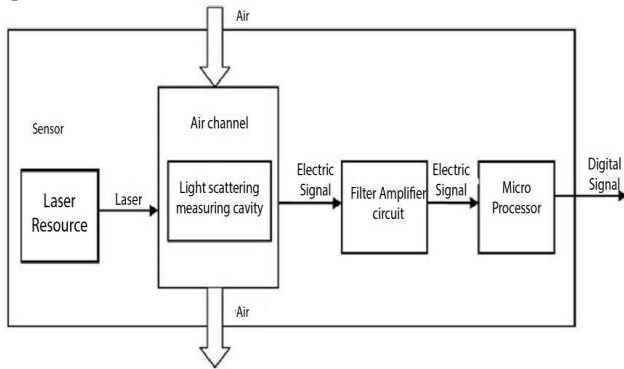
To enable IoT functions in the Arduino and to be able to connect our system to the internet we integrate a Wi-Fi module known as the ESP8266. This module is produced by Espressif Systems and has a full TCP/IP stack. It uses the IEEE 802.11 b/g/n standard to connect to other Wi-Fi routers. [12]

For reading the levels of PM1, PM2.5 and PM10 particles in the air, Plan tower PMS5003 sensor is used. It works using UART communication protocol. This sensor works by emitting laser light which gets scattered by the dust particles in the air; different sized particles (particles with different diameters) scatter light differently, then this scattered light is collected in a certain degree, and the curve obtained in the end of the scattered light change with time is used to determine the equivalent particle diameter and its concentration per unit volume. [13]

The total air quality index or AQI is calculated by using MQ-135 sensor. It is an analog sensor. It can detect gases like Ammonia, Nitrogen Dioxide, Alcohol, Benzene, Carbon Dioxide, smoke, etc. AQI is expressed in PPM (parts per

million) which is used in expressing dilute concentrations. The sensor uses Tin(IV) Oxide (SnO₂) as gas sensing material because of its high resistance. As the polluting gases increases, there is a decrease in the resistance of the gas sensor. This phenomenon helps in gas detection and measurement. [14]

The additional feature of the proposed system includes detecting the levels of humidity, and temperature and pressure of the atmosphere. For this purpose, BME280 sensor is integrated with the Arduino Uno using simple I2C interface. [15]



Functional Block Diagram of PMS5003

The Arduino Uno and all the other mentioned components are integrated together, and it is then connected to the internet using ESP8266 Wifi module. All the data from the sensors is collected and transmitted over the internet to the cloud server using API (Application Programming Interface). A unique API key is used to transmit data to a specific user's account. The key is provided by the cloud server and must be mentioned in the source code which is uploaded to the microcontroller. The cloud used is capable of aggregating, visualizing and analyzing the live data stream uploaded from the monitoring system. The user can log in to his/her account from anywhere and can see the data in a graphical form.

4. CONCLUSION

This paper consists of different technologies used for air pollution monitoring but preferable technique for pollution monitoring would be the proposed one as the integration of IoT with cloud would make the system more global, and furthermore due to the cloud feature added, such system can have numerous applications over the internet and would contribute to the concept of 'Smart City' and 'Smart Homes'. Cost effectiveness is another benefiting aspect of this prototype. Such a system would help in monitoring and keeping small areas, and in turn cities, clean and pollution free.

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