IoT Air Quality Monitoring System

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Abstract— Internet of Things (IoT) is an increasingly popular technology that enables physical devices, vehicles, home appliances, etc. to communicate and even inter-operate with one another. Air pollution in India is estimated to kill about 1.5 million people every year; it is the fifth largest killer in India. Existing monitoring systems have inferior precision, low responsivity, and require laboratory analysis, are the limitations of existing systems. Therefore, improved monitoring systems are needed. To overcome these problems, we propose a three-phase air pollution monitoring system. An IoT kit using gas sensors, Arduino IDE (Integrated Development Environment), and a Wi-Fi module was developed. This kit can be physically placed in various cities to monitoring air quality. The sensors gather data from surroundings and forward the data to the Arduino IDE. The Arduino IDE transmits the data to the cloud through the Wi-Fi module. We also developed an Android application that users can access air quality data from the cloud. If a user is traveling to a particular destination, the pollution level of the entire route is predicted, and a message is sent to user, if the pollution level is too high. The proposed system is analogous to Google Maps.

Index Terms— Air Quality Monitoring System, Android, Arduino IDE, GSM, Sensors, I Thing Speak.

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1 Introduction

Wireless sensor networks (WSNs) are have been used for environmental monitoring, which include collecting the data over time across a particular place where the device is located. WSNs are widely used for real time applications to gather and examine the data without the human involvement. WSNs are used in variety of settings, including personal space, agriculture, home utility monitoring systems, automotive, and many other fields. They are related to the concept of IoT. IoT is a system that consist of sensors / devices which "talk" to cloud through some kind of connectivity. IOT has useful applications in the medical field, education etc. Due to flexibility and low cost IoT has become more and more popular. With the urbanization, industrialization and rapid increase in number of vehicles has caused increase in air pollution.
Governments and Citizens are looking to challenge the common threat of pollution. Currently mobile apps are able to accomplish functions like reporting status of air quality, air quality forecasts, air quality monitoring in a particular area, etc. There are also mobile apps designed for mass polluting sectors like industries, automobiles etc. Industries are now able to integrate and streamline environmental processes, including air emissions analyses, water and energy management, and waste reduction specific to them, through such apps.

Thinking about the evil impacts of Pollution on people, in 2012, one out of eight of all out worldwide passing's were brought about via air Pollution which was 7 million unexpected losses all around [3]. Long-term health effects from air pollution include heart disease, lung cancer, and respiratory diseases such as emphysema. Air pollution can also cause long-term damage to people's nerves, brain, kidneys, liver, and other organs. Some scientists suspect air pollutants cause birth defects.

These passing's were a consequence of various affliction, for example, ischemic coronary illness, interminable obstructive pneumonic sickness, stroke, lung malignant growth and intense lower respiratory diseases in youngsters [4]. The foundations for every one of those illnesses were related with outside and indoor air Pollution. Presently, in the event that on discussions about water Pollution, expending polluted water can cause genuine medical problems in individuals and one may get influenced by hazardous waterborne infections [5].

Air pollution in India is estimated to kill about 1.5 million people every year; it is the fifth largest killer in India. India has the highest death rate from chronic respiratory diseases and asthma, according to the WHO in the world. In Delhi, poor quality air irreversibly damages the lungs of 2.2 million or 50 percent of all children. India's Ministry of Earth Sciences published a research paper in October 2018 about the sources of pollution attributing almost 41% to vehicular emissions, 21.5% to dust and 18% to industries. The director of Centre for Science and Environment (CSE) alleged that the Society of Indian Automobile Manufacturers (SIAM) is lobbying "against the report" because it is "inconsistent" to the automobile industry.

In this paper an IoT-based air excellence monitoring system for traffic system. Detected information will be sent to a computing platform that scales to support each close to period of time incident management and longer term strategic planning decisions. Thus, the planned framework provides measurements of various air quality metrics

which might facilitate in evaluating the impact of industrial emissions.

1 Proposed method and design

IoT air quality monitoring system for pollution management, including air quality analyses, water and energy management, and waste reduction. Such platform provide visibility for users, specifically industries into problems such as chemical leaks, oil spills and toxic substances improper disposal, while strengthening with environmental standards and regulations. This system covers areas like:

- Common platform to track and manage Air quality index.
- Real time processes view, audit incident and findings.
- Trigger notifications for threshold breaks.
- Risk highlights with threshold break.

The implementation details can visualized using the flow chart below,

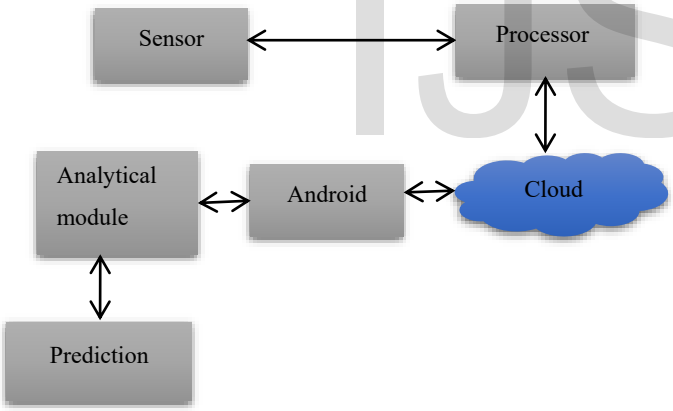

Figure 2.1 System Overview

The data is collected by gas sensors placed at specified location. These data being processed at processor and stored at cloud, the open storage space. The processed data is regularly monitored at IoT platform Thing viewer android application for the analysis and prediction. These smart sensors are continuously collecting data from the surroundings and transmit the information to the next layer wirelessly. The wireless technologies have its own pros and cons in terms of power, data transfer rate and overall efficiency.

The system for air monitoring involves:

Step 1: Collect the concentration of the specified area via sensors.

Step 2: Connect the data after processing by Arduino to the cloud.

Step 3: Analyse the data using IoT platform.

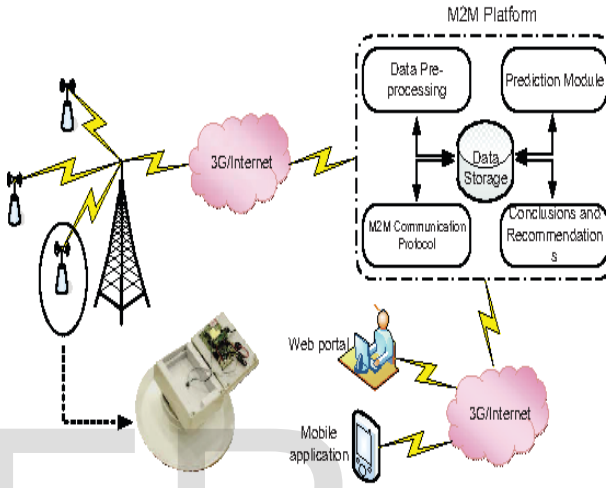

Figure 2.2 System Architecture for IoT Air Quality Monitoring System

IoT Gateway manages the bidirectional data traffic between the networks and protocols. Another function of gateway is to translate different network protocols and make sure that the security of the connected devices and sensors. Gateways can be configured to perform pre-processing of the collected data from thousands of sensors before transmitting it to the next level.

Basically, IoT cloud is a high performance network of networks optimized to perform high speed data processing of billions of devices, and deliver accurate analytics. Cloud system integrates billions of devices, sensors, gateways, data storage and provides predictive analytics. Service providers can prepare for further steps if the data is collected accurately at the right time.

Threshold values are given to the processor to send the status of the surroundings to the cloud and mobile. Sensor details are given in the following table. Proposed air pollution monitoring system is based on the block diagram is shown in fig.3. The data of air is recognized by MQ7 gas sensor, MQ2 gas sensor and MQ135 air quality sensor.

When it connected to Arduino then it will sense all gases, and will give the Pollution level in PPM (parts per million).

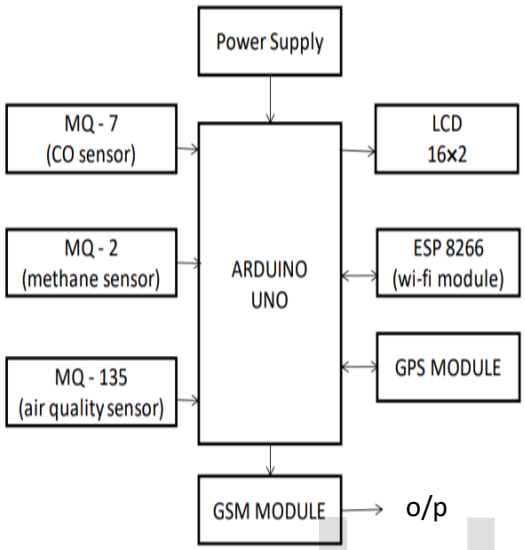

Figure 2.3 Proposed system

Gas sensors will give the output in form of voltage levels and we have to convert it into digital form. So for converting the output in digital, we have used a library for gas sensors. Sensor is giving us value of 90 when there is no gas near it and the air quality safe level is 330 PPM and it should not exceed threshold values. When it will exceed the limit, it will cause Headaches, sleepiness and stagnant, stuffy air. If it exceeds beyond threshold, then it will cause increased heart rate and many different diseases. When the value will be less than threshold, then the LCD and web page will display "no effect". When the value will increase from threshold, then the server get message and the LCD and web page will display "Risky". And when it will increase above the threshold, the server get an alert message on smart phone through GSM. The LCD and web page will display "Very high". According to the model the 3 sensors works as input data, they transmit data for knowing which gas it is. LCD and GSM module are the output devices. ESP8266 (WiFi module) and GPS module are used for easier transmission of data.

TABLE I

THRESHOLD VALUES

MQ2	MQ 7	MQ 135
Risky ; 370 – 810	Risky ; 370 - 800	Risky ; 330 - 500
Very Risky ; 810 - 2000	Very Risky ; 800 - 2000	Very Risky ; 500 – 800

TABLE II

SENSOR DETAILS

Sensor	Gas	Description
MQ7	Carbon Monoxide	It can detect CO-gas concentration anywhere from 20 to 2000 ppm.
MQ2	Methane	It Can detect LPG i-butane, alcohol, hydrogen and smoke
MQ135	Air Quality	Responsive to a wide scope of harmful gases like alcohol, acetone, thinner, formaldehyde and so on

A. System Requirement

The air quality monitoring system is a web-based application used for monitoring and management of the air pollution in specific areas. To get the alert to the server of the air pollution control, SMS system is activated using GSM. The details are updated in the web-based application server (thing speak) using internet of things, Table III shows the complete system components.

TABLE III

COMPONENTS REQUIRED

Components	Description	Quantity
Power supply	5 volt power supply for arduinouno	1
Arduino Uno	Micro controller board	1
GSM module	Chip or circuit that will be used to establish communication between a mobile device	1
GPS module	To track location of the device	1
MQ - 7 sensor	Carbon Monoxide (CO) sensor	1
MQ - 2 sensor	Methane sensor (CH3) sensor	1
MQ - 135 sensor	Air Quality sensor	1
ESP8266 WiFi module	32-bit microcontroller	1

A. Design Requirement

An Arduino uno was used for the device because of its relative ease of programming and its suitability for rapid prototyping. The monitoring software for the device was programmed using Arduino IDE. The detection module interacts with the GSM module when sensor value exceeds the threshold value of each sensor. The server continuously update the sensor values on thing speak server and thing viewer application. The GPS tracks the location of the device and send that location to admin's mobile if the air pollution is risky and very high. So that it can implement further action to prevent the air pollution of that specific area. The wifi module wirelessly connects the arduino to the web. Historical data can be used to predict pollution levels for subsequent days.

2 Result and discussion

The proposed model works with small devices, such as sensors, Arduino board, Thing speak (for Cloud) which all are low energy devices. Comparing with traditional pollution monitoring systems, it is more efficient. Thing viewer application in the android system gives the details about each sensor at every instant of time and continuously update the details. The graph showing the details of each sensor is shown in Fig. 3.1, Fig.3.2, and Fig.3.3.

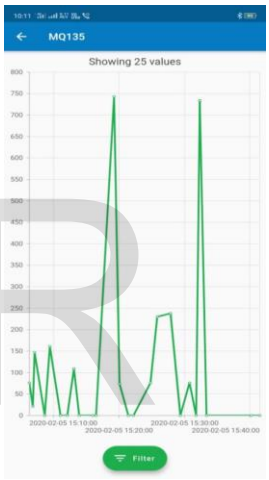

Figure 3.1 Graph showing details about sensor MQ135

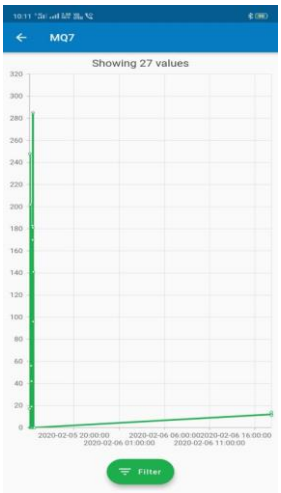

Figure 3.2 Graph showing details about sensor MQ7

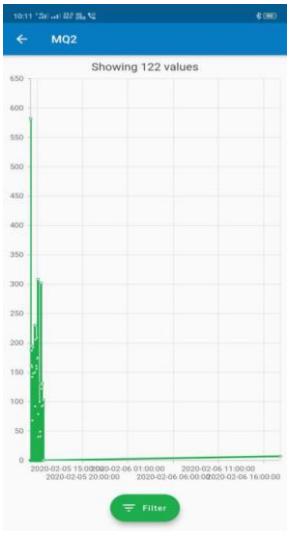

Figure 3.3 Graph showing details about sensor MQ2

Figure 3.4 The SMS sent by the air pollution system

When the air pollution of a specified area is increased to very risky range or very high, an SMS is sent to the mobile about the location details to implement safety measures. When the user access the location details, google map gives the route map for navigation purpose. It is analogous to google map.

The SMS that sent by the system is shown in Fig.3.4. Display of google map showing the location details shown in Fig.3.5.

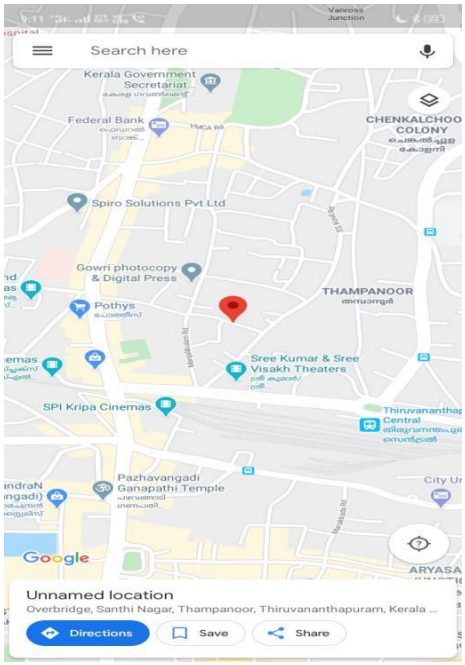

Figure 3.5 display of google map showing the location details

3 Conclusion

Air pollution is evolving as a severe environmental concern due to its enormous impact on the well being of the people and also on the global economy. Pollution is majorly contributed by the industries and automobiles. Therefore, to reduce the level of pollution from these sources and to protect humans and the environment from harmful gasses, An air quality system are designed using different sensors for indoor and outdoor air quality monitoring using arduino, GSM, GPS, and wifi module, that was developed that helps a person to detect, monitor, and test air pollution in a given area. The kit has been integrated with the mobile application that helps the user in predicting the air quality level of their entire route. Further, data logging can be used to predict air pollution levels. This proposed air quality monitoring system along with the integrated mobile application can be helpful to people for analyzing the air pollution of a particular location. The app had following features, indices of air quality for a specific city using real-time computation, air quality daily forecasts, timing outdoor activities for different recommendation of generation, air quality dips associated with health risks, specific reports for air quality measures supported locations, air quality maps generation.

The proposed system faces with computational complexity particularly when we are dealing with big

sensor data. One solution could be using fog computing, instead of cloud computing to reduce computation complexity and enhance the performance of the system. We can also implement zero tolerance fast big data real-time stream analytical tools to process such a complex system.

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