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Mobair: Smart Phone Assisted Air Quality Monitoring System

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***Abstract*—Air pollution is a major hassle in the global world which causes toxicological to human health and the environment. Existing tracking systems consist of low sensitivity, unaware of the region and require laboratory analysis. To triumph over the problems of present systems, presenting a three-segment air pollutant monitoring system by the use of IoT along with cloud to make the services real-time and faster. The proposed device consists of the layout for monitoring air pollutants and creating awareness to the public. An IoT kit consists of sensors, Arduino IDE and esp32 Wi-Fi module. This kit can be physically positioned in numerous cities for tracking air pollutants. The sensors gather records from air and forward the data to the Arduino IDE. The Arduino IDE transmits the sensed data to the cloud through the Wi-Fi module. Developing a portable and user- friendly android application termed IoT-Mobair, facilitates users to know the pollution level between source and destination while travelling. The highly polluted areas are notified based on AQI levels. The user can view the polluted area between source and destination. The proposed application has similarities to Google visitors or the navigation utility of Google Maps.**

Keywords*— *Air pollution monitoring system; Android; sensors; GPS; Cloud; Air quality index

I. INTRODUCTION

Earlier the air we breathe in use to be pure and fresh. A breath of contemporary air has become quite unlikely for the densely inhabited Indian cities. The concentration of toxic gases is getting more toxic day by day in the atmosphere due to rapid industrialization. The human activities are the primary and also the sole reason for environmental pollution of any kind. Something that we tend to interact burning of any material, be it home items or the organizational chemicals, unharnessed harmful gases inflicting pollution. These matters are seriously intense in metropolitan cities.

The atmosphere suffers from global warming and greenhouse effects. These particulates discharged can extremely contaminate the contemporary air. These contaminants can form a thick layer over the earth's surface that causes several adventurous things. Burning plastic releases several harmful gases, this can be a threat to the encompassing atmosphere and cause serious respiration downside in individuals. The thermal power stations considerably increase pollution by cathartic huge amounts of ash, carbon compounds, and SO2. The population explosion has distended the reins of Indian cities, leading to a pathetic traffic conditions on the roads. Vehicles on the road unharnessed gases and dangerous fumes by carelessly burning fossil oil and different fossil fuels. The road traffic that produces an outsized quantity of mud, the usage of refrigerators and coolers generates hydro fluorocarbons into the atmosphere cause pollution.

Mobile application plays a prominent role in human life. It turned the impossible things to make it happen within fraction of seconds. The quality of the air can be determined through applications in different regions. The status of the air quality, temperature, humidity can easily be retrieved through web server applications.

Internet of things is increasingly growing topic in the business intelligence fields. It integrates data from the hardware devices and can be uploaded in cloud. The internet helps to transmit data without requirement of humans and ensures notification. It provides deeper automation, accuracy and analytical data. Internet of things makes things virtually 'smart' over the surroundings. IoT has become an emerging technology for active content, product, or service manageable activities. These applications take information or input from multiple devices and makes sufficient actions to convert into human readable form. They analyze data supported numerous settings and styles so as to perform automation-related tasks or give the information needed by business.

India is home to a fifth of the globe population and each year, nearly 2.5 million deaths are occurred due to pollution. The contamination of air pollutants has destroyed the natural balance of the atmosphere, impairing human, and dependent on life forms. Air quality is measured by the air quality index levels. The National air quality of India was introduced in September 17, 2014. The main pollutants of the air include CO, NO2, SO2, methane and smoke. The combination of these gases in the air exceeds the criteria set by the World Health Organization (WHO). The Central Pollution Control Board along with State Pollution Board determines the air quality for each and every year. The color code range can be drawn based on pollution levels. The polluted area can be reported on a daily basis.

In this paper, we describe the implementation of an IoT mobile-air pollution detection application. In section 2, existing monitoring systems for air pollution are discussed. The architecture design and technology used for air pollution monitoring system is described in Section 3. Development methodology its use in the implementation of the air pollution monitoring system is described in Section 4. Conclusions are reported in Section 5.

II. LITERATURE REVIEW

Air pollutants in massive urban regions have a drastic effect on human beings and the environment. Ecological problems in India are developing quickly. Air infection is particularly induced by automobiles and industries which cause various respiration diseases consisting of bronchial asthma and sinusitis.

The first-rate of air is inferior in metropolitan towns like Kolkata, Delhi, and Mumbai due to a huge amount of carbon dioxide and other dangerous gases emitted from motors and industries [1]. An huge number of projects have been described within the literature that utilize low-cost air pollution sensing gadgets that can be carried by individuals or by using versatile automobiles [6]. In studies, [2] [3], the authors tested an environmental sensing approach that reinvigorate interest and sympathy of citizens towards pollution. Exposure Sense [7] is a transportable participatory sensing framework that is used to display screen one's normal activities.

In another study [4], the authors present a cloud-based system that uses knowledge-based discovery to find real-time air quality data. The records are gathered by monitoring stations that are positioned in various geo-locations. This system uses mobile customers for tracking purposes.

De Nazelle et al. [5], the authors validated environmental sensing tactics that reinvigorated the attention and sympathy of individuals towards pollution.

III. PROPOSED APPROACH

The proposed approach detects the concentration of air pollutants in the area of interest via sensors. Fig. 1 represents the architecture diagram of IoT based air pollution monitoring system. The sensed data is collected in Arduino and transmitted through Wi-Fi module which is stored in cloud - Ubidots. The uploaded data is retrieved by user-friendly android application - MOBAIR helps the user to know the pollution level in the region. The routes are drawn from source to destination and pollution level is estimated in real time computation. The quality of the air is predicted and analyzed using analytical module based on air quality index levels.

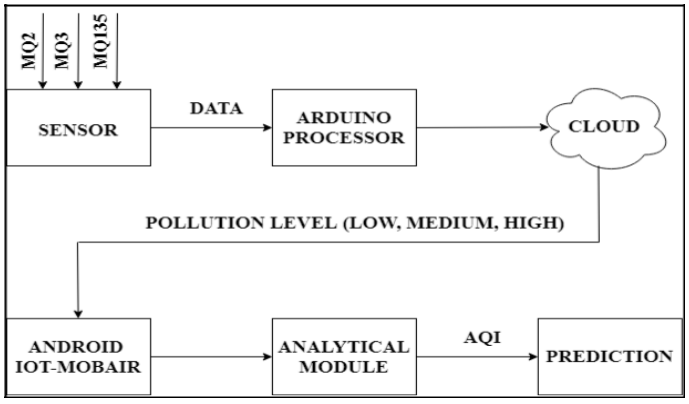

Fig.1 Architecture Design of IoT Based Air pollution Monitoring System.

A. *Internet of things*

The Internet of Things (IoT) is a system of connecting hardware devices along with software applications. IoT provides a communication between applications and components and that are supplied with distinctive identifiers. It facilitates to transfer knowledge over a network while not requiring human-to-human or human-to-computer interaction.

Air pollution detection kit is developed using IoT [MQ2, MQ3, MQ135, esp32]. The sensors sense the real time air pollution level in particular region. The gas sensor detects dangerous gases like LPG, i-butane, paraffin, propane, methane gases which are paired up in the atmosphere.

B. *Ubidots-Cloud Service*

Ubidots is an Internet of Things (IoT) information analytics and visualization companion. It is a platform to turn sensor facts into information that matters for business-decisions, device-to-device interactions. The sensor readings from Arduino IDE are uploaded to cloud service framework - Ubidots. It provides user-friendly protocols to store and access the data.

The real time air quality percentage and levels are continuously updated in the Ubidots portal. The uploaded data can be visualized as per user perception in the form of ranges and charts. It also generates the color code based on authorized levels and determines AQI.

C. *Android Platform*

Recently, improvements in smart phone technology have changed the importance of cellular telephones. A phone is not just used for communicating but has also become a crucial part of everyone's daily life. Presently the electronic market is acquired by Android technology.

Over time, smart phones and the Android system are become more prevalent. In this work, we used Java language, the Android Studio platform, Android ADT, and the Android SDK to develop the IoT-Mobair android application. The IoT-Mobair application uses user location data (via GPS system), the Internet of Things (IoT), sensors, and standard websites to give air quality data. If the user travels from source to destination, the entire route pollution rate is monitored and alerts a notification message. If the pollution rate is huge, the user can re-route their journey.

IV. IMPLEMENTATION AND RESULTS

The comprehensive implementation details can be Visualized as following:

A. *Detection of air pollutants levels*

The data is generated from the gas sensors (Fig.2 Gas sensors, esp32).These concentration is obtained from the air. Table 1 shows the standard air quality levels. Air contamination can be characterized as the outflow of harmful substances to the air. The main components of pollutants are:

- nitrogen oxides(NOx),
- sulphur dioxide,
- ozone(O3),
- particulate matters,
- carbon monoxide(CO)
- volatile organic compounds(VOCs).

TABLE 1 SENSORDETAILS

Values	Color	Description
0- 50		Good
50- 100		Moderate
100 - 150		Unhealthy for sensitive groups
150 - 200		Unhealthy
200 - 250		Very unhealthy
300 - 500		Hazardous

Fig. 2 IoT Kit

B. Connecting Arduino to Cloud

IoT Kit is constructed in which the data generated by sensors is sent to the cloud, where it is processed and displayed to the user in the appropriate form. Fig. 3 gives the details of JSON data uploaded to Ubidots cloud service framework.

Fig.3 Ubidots Platform

C. Connecting Ubidots to Android

Step 1: Draw route from source to destination

The routes are drawn from source to destination and pollution level is estimated in real time computation. The quality of the air is predicted and analyzed in mobile application based on air quality index levels.

Notification message will be appeared to the user by the comparison of pollution rate in the intermediate waypoints.

Step 2: Prediction and analysis

Historical data can be used to predict pollution levels for subsequent days. The data collected from the sensors and other trusted websites is made as are placed in a large database.

When the user enters his destination of travel, the *IoT-Mobair* android application first converts the address into corresponding latitude/longitude form. The latitude and longitude are searched in the cloud-based database. Intermediate places between the starting and finishing location are also displayed.

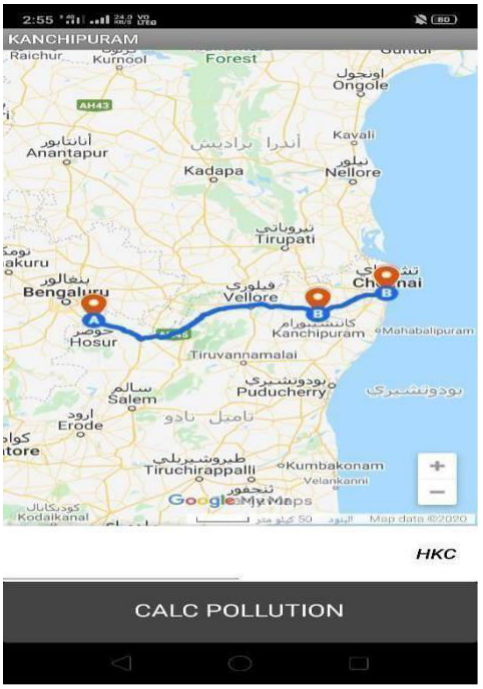

Fig.4 Route from Hosur – Chennai via Vellore

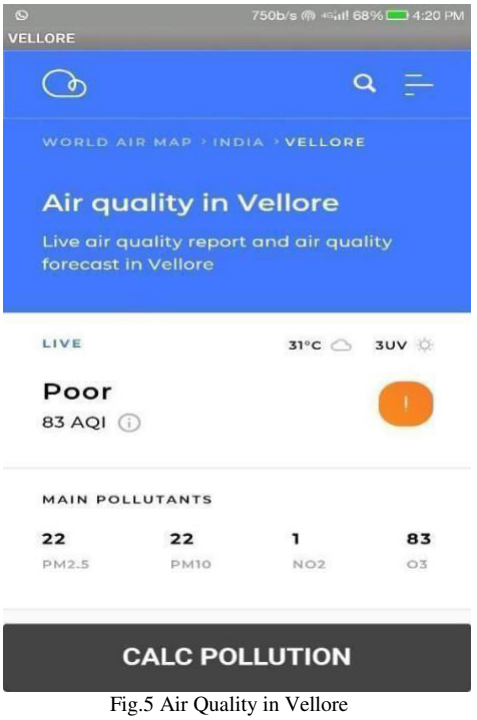

Fig.5 Air Quality in Vellore

V. CONCLUSION

Pollution in earlier days was negligible. Due to rapid industrialization and advanced technology, air pollution reached the extreme limit of harmfulness. In order to protect humans from respiratory diseases and safeguard natural resources, the air pollution detection kit is physically placed in different locations to determine pollution level. The IoT kit is associated with android application IoT-Mobair that helps the users to obtain the pollution rate in real time computation. Further, data logging can be used to predict AQI levels. Specific reports for air quality measures based on locations and air quality maps generation are the main features of IoT-Mobair.

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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