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Air Quality Measurement: Digital Dashboard Using Smartphone

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Abstract— In cities all over the globe are transforming into smart cities. Smart cities initiatives need to address environmental concerns such as air pollution to provide clean air. A scalable and cost-effective air monitoring system is imperative to monitor and control air pollution for smart city development. Air pollution has notable effects on the well-being of the population a whole, global atmosphere, and worldwide economy. This paper presents a scalable smart air quality monitoring system with low cost sensors and long-range communication protocol. The sensors collect four parameters, temperature, humidity, dust and carbon dioxide in the air. The proposed end-to-end system has been implemented and deployed in Yangon, the business capital of Myanmar, as a case study since Jun 2018. The system allows the users to log in to an online dashboard to monitor the real-time status. In addition, based the collected air quality parameters for the past two months, a Machine Learning model has been trained to make predictions of parameters such that proactive actions can be taken to alleviate the impacts from air pollution.

Keywords—Temperature, Humidity, Dust and Carbon dioxide, Machine Learning omponent, Formatting, Style, Styling, Insert

I. INTRODUCTION

Air pollution is the introduction into the atmosphere of chemicals, particulates, or biological materials that cause discomfort, disease, or death to humans, damage other living organisms such as food crops, or damage the natural environment or built environment. A substance in the air that can be averse to humans and the environment is known as an air pollutant. Pollutants can be in the form of solid particles, liquid droplets, or gases. In addition, they may be natural or man-made. Pollutants can be classified as primary or secondary. Usually, primary pollutants are directly produced from a process, such as ash from a volcanic eruption, the carbon monoxide gas from a motor vehicle exhaust or Sulphur dioxide released from factories. Secondary pollutants are not emitted directly. Rather, they form in the air when primary pollutants react or interact. An important example of a secondary pollutant is ground level ozone one of the many secondary pollutants that make up photochemical smog. Some pollutants may be both primary and secondary: that is, they are both emitted directly and formed from other primary pollutants. Air pollution occurs when gases, dust particles, fumes (or smoke) or odor are introduced into the atmosphere in a way that makes it harmful to humans, animals and plant. Air pollution threatens the health of humans and other living beings in our planet. It creates smog and acid rain, causes cancer and respiratory diseases, reduces the ozone layer atmosphere and contributes to global warming. In this industrial age, air pollution cannot be eliminated completely, but steps can be taken to reduce it. The government has developed, and continues to develop, guidelines for air quality and ordinances to restrict emissions in an effort to control air pollution. On an individual level, we can reduce our contribution to the pollution problem by carpooling or using public transportation. Additionally, buying energy-efficient light bulbs and appliances 2 or otherwise reducing our electricity use will reduce the pollutants released in the production of electricity, which creates the majority of industrial air pollution.

II. LITERATURE REVIEW

Traditionally, pollution measurements are performed using expensive equipment at fixed locations or dedicated mobile equipment laboratories. This is a coarse-grained and expensive approach where the pollution measurements are few and far in-between. In this paper, we present a vehicular-based mobile approach for measuring fine-grained air quality in real-time. We propose two cost effective data farming models – one that can be deployed on public transportation and the second a personal sensing device. We present preliminary prototypes and discuss implementation challenges and early experiments [1]. The air pollution rates now a days are drastically increasing in all the developed and the developing countries which requires a more portable and cost-effective solution. The proposed system includes the design for monitoring air pollution and creating awareness among the public. This paper aims at using IOT along with cloud to make the services real time and faster. The proposed system is installed in a particular locality where there is acute air pollution. The level of each hazardous pollutant is monitored at periodic intervals. The Air 8 Quality Index (AQI) for the observed pollutants is determined and awareness is created among the public through an android app which displays the level of each observed pollutant and also the air quality index in that particular location. Thus, the quality of air in that area can be understood by the public by viewing the concentration of the gases in both numerical and graphical format. Further this system is to be extended in future by allowing the public to register themselves in an app which pushes weekly or monthly air quality report through message which reaches the user as a notification that is more comfortable in access [2]. With the swift growth in commerce and transportation in the modern civilization, much attention has been paid to air quality monitoring, however existing monitoring systems are unable to provide sufficient spatial and temporal resolutions of the data with cost efficient and real time solutions. In this paper we have investigated the issues, infrastructure, computational complexity, and procedures of designing and implementing real-time air quality monitoring systems. To daze the defects of the existing monitoring systems and to decrease the overall cost, this paper devised a novel approach to implement the air quality monitoring system, employing the edge-computing based Internet-of-Things (IoT)[3]. In the proposed method, sensors gather the air quality data in real time and transmit it to the edge computing device that performs necessary processing and analysis. The complete infrastructure & prototype for evaluation is developed over the Arduino board and IBM Watson IoT platform. Our model is structured in such a way that it reduces the computational burden over sensing nodes (reduced to 70%) that is battery powered and balanced it with edge computing device that has its local data base and can be powered up directly as it is deployed indoor. Algorithms were employed to avoid temporary errors in low-cost sensor, and to manage cross sensitivity problems. Automatic 9 calibration is set up to ensure the accuracy of the sensors reporting, hence achieving data accuracy around 75–80% under different circumstances. In addition, a data transmission strategy is applied to minimize the redundant network traffic and power consumption. Our model acquires a power consumption reduction up to 23% with a significant low cost. Experimental evaluations were performed under different scenarios to validate the system’s effectiveness [4]. Humanity, moving to an era focused upon development has forgotten the importance of sustainability and has been the major culprit behind the rising pollution levels in the earth's atmosphere among all other living organisms. The pollution levels at some places have reached to such high extents that they have started harming our own health. Hence, it is a significant indication to keep track of pollution levels in our surroundings in order to ensure that we do not get affected by the ill effects of pollution and at the same time improvise our actions in order to maintain pollution free environmental conditions. So, this paper covers the design and development of a device prototype that monitors air and noise pollution in real time and sends alerts to desired authorities whenever the pollution levels cross the threshold via push notification service on mobile phones using a cloud service provider, hence setting an example for an efficient IOT (Internet of Things) device[5].A cost effective and user-friendly indoor air quality (IAQ) monitoring system based on ZigBee wireless sensor network implemented with the TI CC2430 ZigBee chip is described. In this proposed system, a temperature and relative humidity sensing module and a carbon dioxide sensing module were integrated in each sensor node which was placed in different indoor environment to monitor the IAQ parameters or indoor environment ubiquitously [6]. The application of the theory of compositional data in multivariate patio temporal statistical models is still scarce, even though the results obtained are robust. Actually, this kind of models are attractive to pollution model developers, due to, its versatility in the patio-temporal variables; but nobody has tried to use it with compositional data yet. The main differences between a conventional model and two CoDa models (with two sequential binary partition, SBP) were analyzed. The first SBP was proposed by pollutants relationship interpretation, and the second one was imposed as standard SBP (R studio). Initially the conventional temporal model is used to predicting pollution levels to fill missing data or predicting pollution levels on future days. The application of compositional data theory in conventional temporal air quality models allowed to obtain acceptable quality models, whose results were adjusted to the observed values. Nash-Sutcliffe Efficiency Index (NSE) and root-mean-square error (RMSE), were used to evaluating the model quality and fitted values respectively [7].

III. EXISTING SYSTEM

There is no current system to monitor the air pollution. The pollution will affect the people in that area. It also affects ozone because the amount of pollutant is not monitored properly and can’t know the amount Location update unavailable. This application is not there in GSM mobile. According to the existing system it is not that much eases and comfort for the peoples to view the amount of pollution which is prevailing in the locality. The particular location cannot be found because it does not consist, this cannot be used that much in the society. There is no specific level of Indications about of the controller. The controller receives the value and converts into digital form and those values are updated in the web server through GSM modem. The default values are already stored in the webserver. The current data will be compared with the default values to analyze the result. The pollution status will be uploaded in the webserver. So, the user can view anywhere through internet. When there is a pollution that occurs this shows the total amount of gases which is present in the particular locality example CFC (chlorofluorocarbon) carbon-monoxide and many toxic gases can identify by the amount of percentage which is present on it. The main working principle behind this is IOT which collects information from the cloud which consists of information about the pollution status which is present in our environment. The microcontroller which is used in this device is that Arduino microcontroller which consists of 6 outputs and 6inputs so that many sensors can be clubbed together which totally sums up together as a pollution detector and monitoring using an IOT device

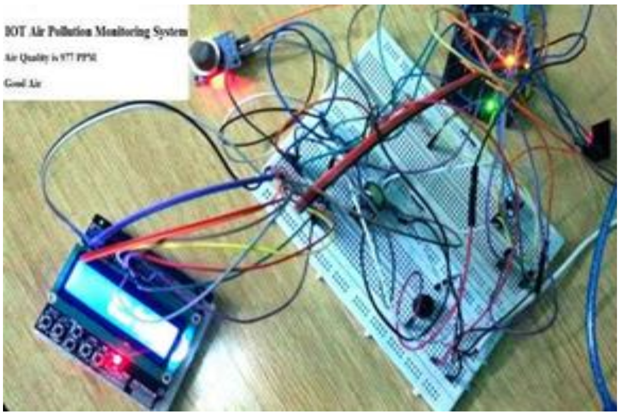

FIG 3.1: MODEL OF EXISTING SYSTEM

DISADVANTAGES

- On Board display not connected to internet.
- Require laboratory analysis.
- Low Efficiency

IV. PROPOSED SYSTEM

In our proposed work, we are going to monitor the quality of air through different sensors. Thing speak IoT platform used to define the derivations that mentions the correct ppm on the screen with correct calibration. We have implemented it with less cost i.e., when we are pushing the data to the cloud, no need to see the output on LCD which adds more cost to the work. When we are targeting IoT as a platform, our intension should present the idea on internet using the platforms like thinger.io or thing speak or Cayenne website which are beautifully designed to present the output and even able to download the dataset. When doing an experiment air quality monitoring, no need to use LPG or methane detecting sensors as it is used for Home/office safety. We have used Wi-Fi to push the data onto the cloud rather using GSM or GPRS module. The problem in another paper that cited at has not calibrated the sensor and not even converted the sensor output value into PPM. As per the guidelines by UN Data, 0-50 PPM is SAFE value, 51-100 is moderate. Delhi is the most polluted city in the world recorded around 250PPM. As we are using two sensors, both of them have internal heat element, it draws more power (P= V*I), so though the both sensors are turned ON, its output voltage levels vary and shows unpredictable values due to insufficient power drive. So, we used a 9V battery and a 7805 family LM7805 Regulator for the CO sensor MQ7. We have used Arduino Uno Development kit that comes with ATMega328P microcontroller. In order to provide WIFI Support for it, we have used cost effective ESP-01 Wi-Fi module which helps us to connect to the Thing Speak Platform.

ADVANTAGES

- Better inform and monitor the impact of regulations to control air quality.
- Plan the placement of vulnerable facilities like hospitals and schools to reduce asthma in children and improve the outcome of sick patients.
- Empower city residents to make more informed decisions to limit their exposure to harmful air pollution.

V. ARCHITECTURE DESIGN

A design is a plan or specification for the construction of an object or system or for the implementation of an activity or process, or the result of that plan.

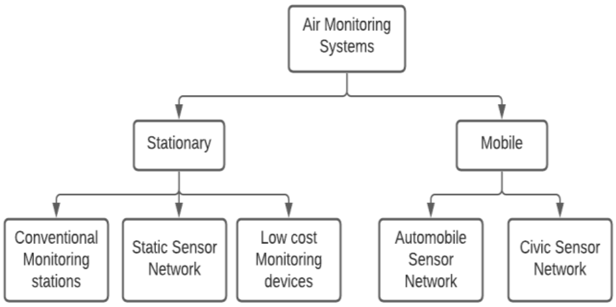

Fig 5.1. Flow Chart

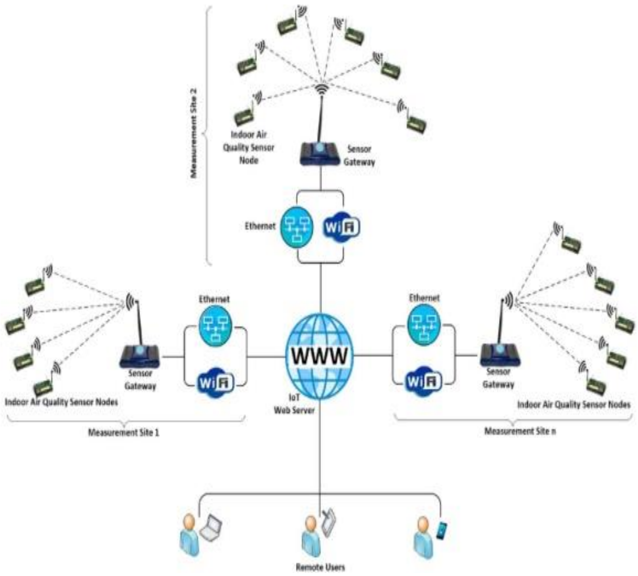

Fig 5.2. Design Plan

To obtain reliable and accurate data, conventional monitoring systems use complex measurement algorithms and various supplementary tools. As a result, these apparatuses are usually very high in cost and power consumption, and large in size & weight. Technical advancements resolve these issues to some extent, in that low-cost ambient sensors with a small size and quick response are easily available. However, they cannot achieve similar data precision levels as conventional monitoring devices.

Flow chart is a type of diagram that represents a workflow or process. It shows steps in sequential order and is widely used in presenting the flow of algorithms.

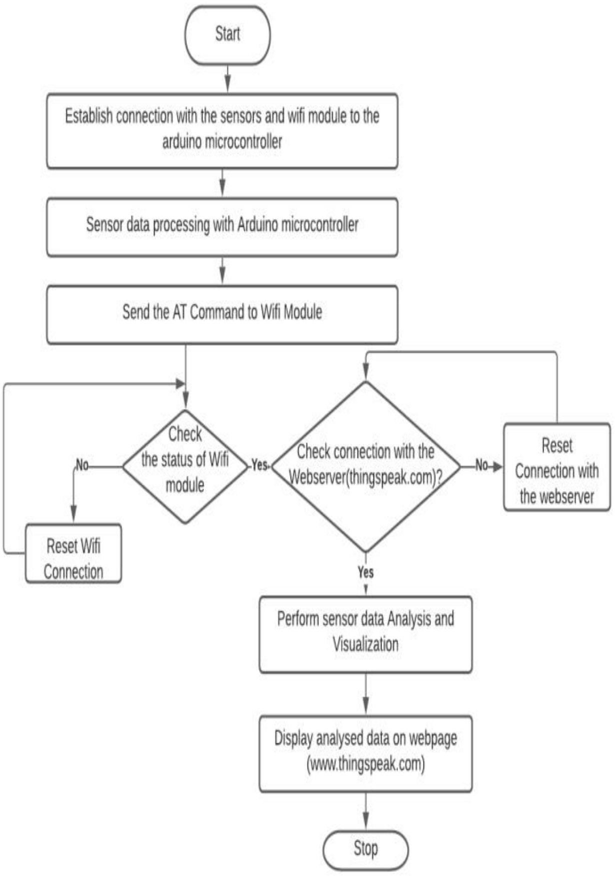

Fig 5.3 Proposed system with flow chart

The activity can be described as an operation of the system. So, the control flow is drawn from one operation to another. This flow can be sequential, branched or concurrent. Activity diagrams deals with all type of flow control by using different elements like fork, join etc.

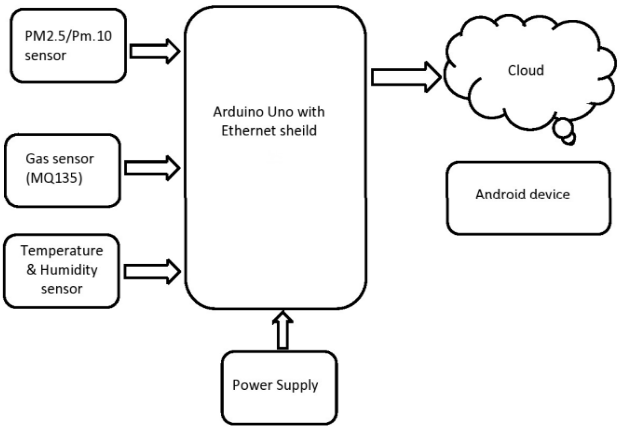

Fig 5.4. Activity Diagram

VI. RESULTS & CONCLUSION

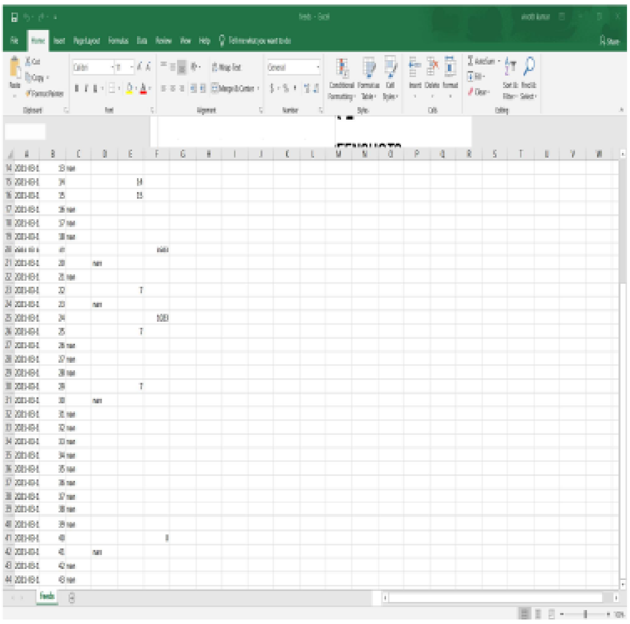

Fig 6.1 Data sets Collected from Sensors

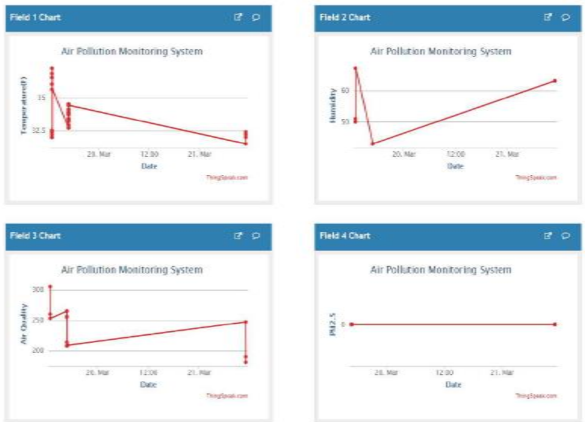

Fig 6.2 Pollution levels representation by graph

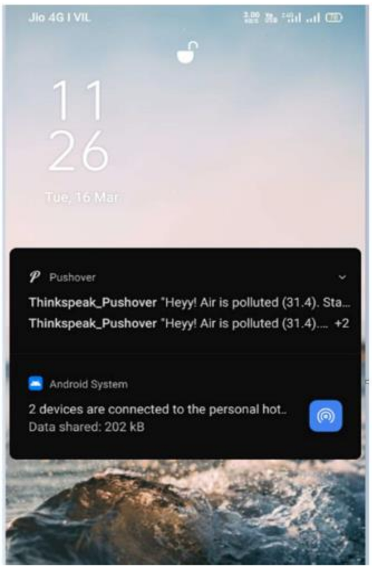

Fig 6.3 Notification of Air Pollution details

The above results shows that Air pollution can be monitored by different sensors and that collected data will be sent to cloud. If the result of collected data values exceeds the threshold value, that information can be sent to Admin. In that way we can measure the quality of air remotely. The smart way to monitor environment and air pollution being a low cost but efficient and embedded system is presented in this paper.

Here different sensors and their working procedure were discussed. How they work, their functionality, their optimal uses and their data taking procedures and comparison with standard base data's are also discussed here. The air pollution monitoring system was tested for monitoring the gas levels on different parts. It also sent the sensor parameters to the data server. Our project device showed that it is effective and cheap and with some highly working sensors it can really be a reliable one to everybody and its data's will be a key to take some necessary steps for the betterment of the society as it will help to identify the affected area so that we can take early steps to reduce damages for the next generation. This proposed a smart air pollution monitoring system that constantly keeps track of air quality in an area and displays the air quality measured on an LCD screen. It also sends data measured to the "Thing speak" platform. The system helps to create awareness of the quality of air that one breathes daily. This monitoring device can deliver real-time measurements of air quality. Our work can demonstrate vast opportunities to work on the device, on the app and also on the field using the device that we have worked with. The device can be used any time efficiently in different locations of a city and then research with the achieved data for that particular area in that city.

VII. FUTURE WORK

The device can be updated with additional sensors that can sense data from the existence of other gases such as O2 and H2. These gases will provide the condition of the atmosphere and authority can take into further decisions accordingly. The sensors that we have been worked with can also be reset according to most recent time update. The android app which we have developed for turning on and off the device can be updated with newer features by implementing necessary codes. In future time, our device can be kept testing for checking whether the sensors still run properly and give real time data. The webpage that we have designed, there is more opportunities to add options like related tables, pie chart, diagram that will be implemented by back-end programming (server side) so that those options can be visible to the administrator and user as well. With the future plan programmer can add PHP programs to create additional tables to show amount of O2 or H2 and pie chart to show which color represents which particular gas and also diagram that can show relations with gas and time. Like Through-out the year on which time the amount of gases are in what level and also the increase and decrease level and rates of the gases. Related app can notify when it is actual time to take data reading by sending the notification to user that will be programmed on the server-side by PHP language. Also, other language can be used. In the hardware device it can be added light system. Light system will be work like automatic way. Such as, there are four lights for four types of gases. While a particular sensor detects the gas for that sensor, the related light beside that gas will be on and while the sensor stops getting that particular gas the light will be off automatically. For this matter, there will be necessity of PHP back-end code implementation also that is must.

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