GRD Journals | GRD Journal for Engineering | National Conference on Emerging Trends in Electrical, Electronics and Computer Engineering (ETEEC-2018) | April 2018
e-ISSN: 2455-5703

Pollution Monitoring using Aurdino and Android

[1]Abin Jose [2]M. Naveen [3]Andal S
[1,2]UG student [3]Assistant Professor
[1,2,3]Department of Electrical and Electronics Engineering
[1,2,3]Christ the King Engineering College, Coimbatore, Tamil Nadu

Abstract

Air quality Monitoring provides raw measurements of gases and pollutants concentrations, which can then be analyzed and interpreted. Air pollution is a concern in many urban areas and is the major reason for respiratory problems among many people, monitoring the air quality may help many suffering from respiratory problems and diseases, and thereafter informing engineering and policy decision makers to improve the quality of air. Major contributor's air causing respiratory problems are - Fine particles produced by the burning of fossil fuels (i.e. the coal, petroleum) - Noxious gases (sulfur dioxide, nitrogen oxides, carbon monoxide-CO, chemical vapors.) - Ground-level ozone (a reactive form of oxygen and a primary component of urban smog) - Volatile Organic Compounds (have a high vapor pressure at ordinary room temperature, formaldehyde- HCHO gas being major component). A prototype for a low cost indoor air monitoring device has been developed to measure the concentration of CO and HCHO gases, monitoring at a specified rate and communicating over cloud to notify to any wireless device when the threshold of these gases is reached. Initial plans included monitoring of additional CO_2 and other noxious gases. But, this could not be achieved due to restrictions on cloud traffic.
Keyword- Aurdino, Android, AWS Cloud

I. INTRODUCTION

As urbanization causes the growth of suburban communities, the existing transportation infrastructure dependent on fossil fuels must expand. Increase in vehicle use gives rise to an increase in traffic related pollutant emissions. According to census data, about 79% of the US population lives in urban areas. As per 2010 Highway Statistics there are 242 million vehicles in the US alone. To track the effect of this large fleet of urban vehicles on the environment and on the health of individuals, it is imperative to track pollutant levels in the urban and suburban settings. According to the US EPA, the six common air pollutants are particulate matter (PM), ground-level ozone, carbon monoxide (CO), sulfur oxides, nitrogen oxides, and lead. These are called the criteria pollutants and thus are required to be measured to tell us how healthy the air is to breathe. Among these, vehicular emissions contribute carbon monoxide, carbon dioxide and nitrogen oxides to the air pollution. In fact, seven million people die every year because they are exposed to harmful air conditions. One in every eight deaths globally, are due to poor air quality, making air pollution the single greatest environment health risk on Earth. Several studies have shown a correction between poor childhood health and infant mortality in areas with high concentrations of CO and PM. Schools, low-income housing and roadways are commonly implicated. The current pollution measurement methodology uses expensive equipment at fixed locations or dedicated mobile equipment. The raw data obtained in this manner is used to further extrapolate the extent and concentration of pollution through dispersion models. Yet these studies are often conducted in isolation, and very little data is available on how the concentrations of air pollutants vary throughout areas in the developing world. This monitoring strategy limits the potential to identify factors that affect air quantity and thereafter use that data to inform decisions to improve air quality.

A best approach would provide more frequent and spatially dense pollutant measurements. A scalable sensing platform could effectively disseminate pollution information to users in need. Today, the scarcity of fine-grained air quality information is hindering public awareness of health issues arising from pollution. Studies suggest that the health effects among asthmatics from short-term changes in air pollution levels are an important public health problem. We anticipate that, with the help of best air quality measurements, people could be advised to take actions based on real time pollution levels to accommodate individual health needs. The availability of real-time air quality data could make drivers better educated about driving patterns and how it impacts the environment and increases pollution. Better driving habits will lead to reduced pollution. Also, more health conscious citizens may choose alternate "healthy" routes based on the pollution information. It will benefit them as well as others by reducing pollution concentration in peak roadways so everybody breathes cleaner air. At the same time, the emergence of cheap commodity air pollution sensors and the increase of cellular bandwidth have made sensing platforms capable of real-time air quality data collection increasingly feasible. The availability of data produced by the air monitoring device is also takes crucial part in taking care of persons who has respiratory problems and dust allergies. The best way to make the data available anywhere we want is nothing but making use of internet. The most emerging topics Internet of Things provides the most secured and unlimited access to the any device in the world. Background Air pollution in large urban areas may have a significant impact on human health and on the environment. Urban air quality is usually monitored by highly reliable networks of fixed stations. A fixed monitoring station can accurately measure a wide range of pollutants. However, permanent monitoring stations are frequently placed so as to measure ambient background concentrations or at potential hotspot locations, and they are usually several kilometers apart. Urban pollution varies spatially, as it is reasonable to expect, according to human activities, topography, and local micrometeorology. The large cost of acquisition and maintenance of air quality monitoring stations limits the number of such facilities, resulting in a non-scalability of the system and in an extremely limited spatial resolution of the pollution maps. To overcome these problems it is necessary to adopt more pervasive and mobile monitoring systems. In authors show an environmental sensing approach that empowers citizens to reinvigorate their awareness of, and concern for, pollution. Exposure Sense is a rich mobile participatory sensing infrastructure able to monitor people's daily activities as well as to compute a reasonable estimation of pollution exposure in their daily life. In authors demonstrate the usability of the smartphone technology to track person level time, geographic location, and physical activity patterns for improved air pollution exposure assessment. In authors introduce a cloud-based knowledge discovery system that Infers real-time, fine-grained air quality information throughout a city on the basis of the air quality data reported by existing monitor stations and a variety of data collected in the urban area, such as meteorology, traffic flow, human mobility, structure of road networks, and points of interests. The system offers a client, with which a user can monitor the air quality of multiple locations in a city. In this project we used a cloud platform providing users with air quality data. Exploiting smart-phones capabilities, our implementation implements an ubiquitous and unobtrusive monitoring system able to inform users about their daily air pollution exposure by combining user location data and urban air quality information provided by the network of monitoring stations. This is especially useful for poor and developing countries where air quality is a big health concern. Designing.

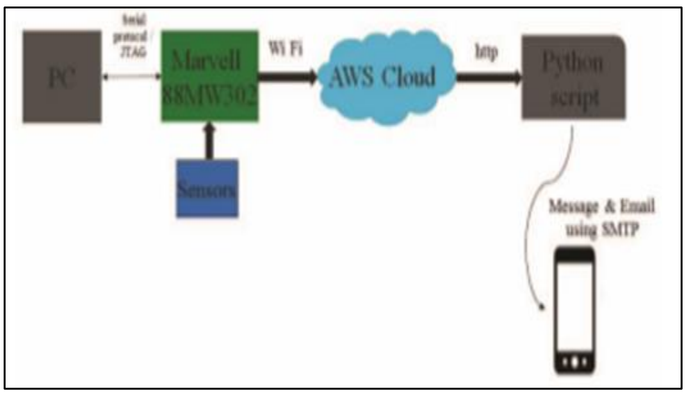

Fig. 1: Architecture of air quality monitoring system

In order to deploy a scalable and cheap air monitoring system with fine special and temporal scales, we propose an efficient and scalable platform that enables users to monitor their daily exposure to air pollutants by giving air quality information provided by heterogeneous sensing infrastructure. As shown in figure 1, our system is composed by PC, Marvell board, Sensors and Mobile. The sensor reading are transmitted to sever as well as AWS cloud, ensuring their integrity, security and availability and provides those date for several services. Exploiting low cost sensors pervasiveness, the system covers all the city area and collects detailed urban air quality data, offering a wide spatial coverage, and a fine granularity of the detected characteristics. The sensors periodically monitor the air quality and transmit, the data can be monitored and accessed unlimitedly from anywhere using mobiles or PC's with internet.

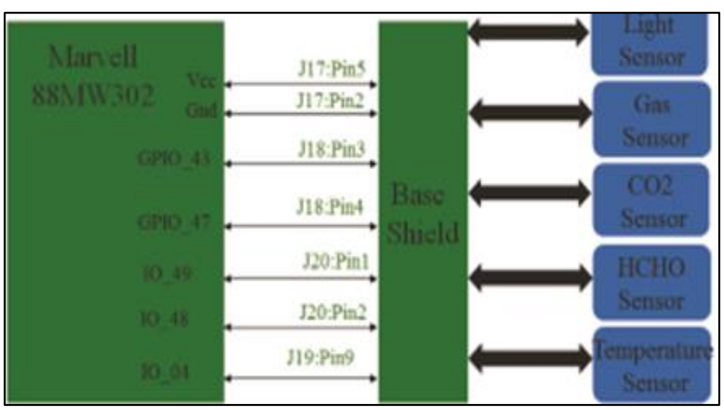

Fig. 2: How the hardware is connected

Our implementation has sensors for Light, Gas, CO_2, HCHO and Temperature to monitor the environment around. Depending on the reading of the sensors, the notification to the personnel will be sent through a text message along with an email even though the users are not monitoring the data by themselves. There is a limit to the number of environment sensors connected to the board using base shield. The maximum sensors can be connected is 16 which is really high count. Using this base shield you can connect different type of sensors that are of the type connected to the ports analog, digital, I2C, UART on the base shield. All this data will be converted to digital at the Marvell 88MW302 board.

A. Hardware

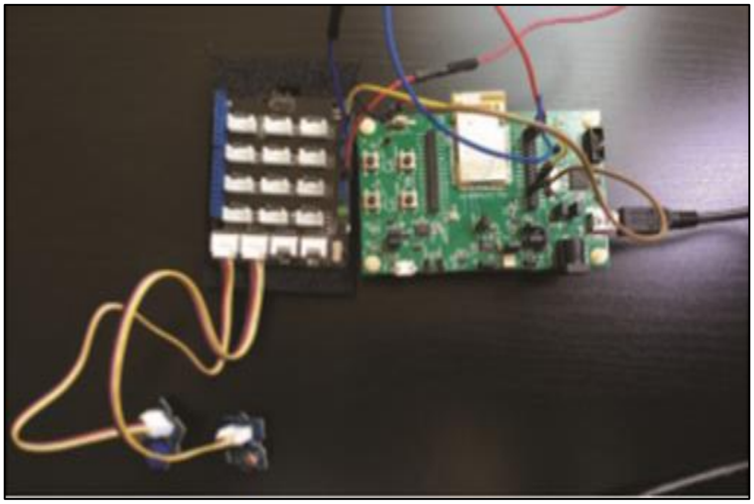

Fig. 3: The Setup of Hardware

The prototype draws air through the unit, measurements are gathered using Gas, Co2 and HCHO, Light and Temperature sensors and then the data is transmitted via a GSM cellular network to the internet and from there it can be accessed using cell phones, laptops and other end-services.

B. Marvell 88MW302

The kit is powered by Marvell EZConnect Wi-Fi microcontroller system-on-chip (SoC), a singlechip SoC with 1x1 802.11n Wi-Fi and full-featured Cortex-M4 microcontroller. The SoC includes 512kB SRAM and a flash controller to enable executing code from external QSPI Flash. The SoC also enables easy interfacing to sensors, actuators, and other components via a full set of I/O interfaces including SPI, I2C, UART, I2S, PWM, ADC, DAC etc. The development kit includes a set of IO headers that bring out these interfaces to connect to external sensors or other peripheral boards.

C. Marvell AWS IoT Starter SDK

Marvell AWS IoT STARTER SDK: Developers can get started with the Marvell AWS Starter SDK available at GitHub. The starter SDK will allow developers to quickly prototype their IoT device concept by using the IO interfaces available on the development kit. The SDK includes libraries to connect the kit to a Wi-Fi network and then establish a secure, bi-directional communication to the AWS cloud and interface to the various IoT related services offered by AWS. Sensors: It is important to know the proper placement of sensors for data collection. Each sensor is installed according to manufacturing guidelines and calibration checked against data collected from sensors. The data sheets include equations to convert collected voltages to the values of sensed data in ppm.

D. AWS Cloud

AWS IoT is a managed cloud platform that lets connected devices easily and securely interact with cloud applications and other devices. AWS IoT can support billions of devices and trillions of messages, and can process and route those messages to AWS endpoints and to other devices reliably and securely. Amazon Web Services provides the users with highest security they need with broad and deep platform. The user will be provided with account ID and password to access the data. The AWS helps to connect the board through Wi-Fi to the specific account by providing certificates, public and private keys. Software:- The air quality monitoring code consists of three major parts, data collection, data conversion and data transfer. The data collection can be done using the sensors. These sensors are Marvell compatible allowing for the use of the Marvell IDE as well as the Marvell C programming language. While code is running the main function takes the values from sensors that are connected to the corresponding input pins of the board. The collected values are then converted into their respective concentrations. The data can be connected with the use of WiFi to the AWS cloud.

E. Notifications to Emergency Numbers

The prototype includes Python script to access the AWS data. By using the AWS secret access key and depending on the specified threshold limit on sensor data the notifications will be sent to the emergency numbers and e-mails. There is no limit on the number of notifications. We can notify as many numbers as possible using e-mails (e.g. Gmail).

II. RESULT ANALYSIS

Fig. 5: Readings on the POC Control

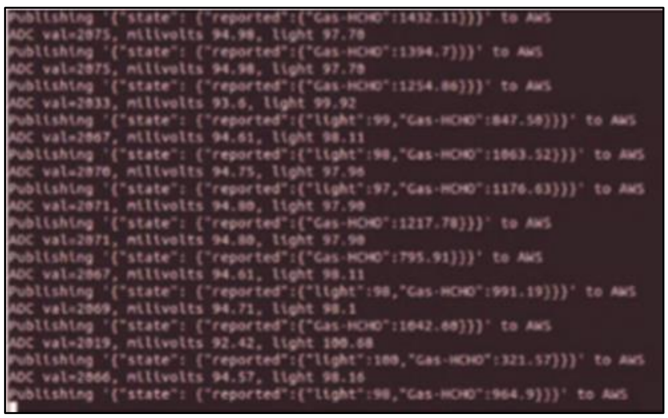

Fig. 6: Readings on the AWS cloud

The prototype was tested over couple of hours in Santa Clara, CA in a really crowded auditorium where the reading of sensors elevated with more people coming in. Low pollutant levels were observed in the morning time as the climate would be pleasant and unpolluted. As the day enters afternoon the readings keeps getting worse. The readings were updated every minute. The items required and the cost of the prototype is shown below.
Item Cost Marvell Board $49 Grove Base Shield $13 Grove Sensors $100 Connecting wires $5.

III. CONCLUSION

A low-cost, high-fidelity air quality monitoring device was designed, built and tested. The device can collect data at every second and transmit data via Wi-Fi and notify the personnel depending on the threshold level. The device is low-cost because it costs only $170 to produce it. The device can serve a big humanitarian needs near schools and playgrounds in monitoring the quality of air the children breathe, in factories or high traffic areas where the emissions are higher and affect many people, in developing countries and in places where the air-quality is very bad and can be a health hazard by alerting the people to dangerous levels of these sensed pollutants. Also, this prototype can be extended as low cost mobile device that anyone can use and it monitors the air along one's path.

REFERENCES

[1] Atzori, L., Iera, A., Morabito, G.: The Internet of Things: a Survey. Computer networks 54(15), 2787– 2805 (2010)
[2] Lo Re, G., Peri, D., Vassallo, S.D.: A Mobile Application for Assessment of Air Pollution Exposure. In: Mobile and Information Technologies in Medicine and Health 2013 (2013)
[3] Gaglio, S., Lo Re, G., Martorella, G., Peri, D.: High-level Programming and Symbolic Reasoning on IoT Resource Constrained Devices. In: Accepted at the First International Conference on Cognitive Internet of Things Technologies (COIOTE 2014) (2014)
[4] O. Aziz and S. N. Robinovitch, "An analysis of the accuracy of wearable sensors for classifying the causes of falls in humans", IEEE Trans. Neural Syst. Rehabil. Eng., vol. 19, no. 6, pp. 670-676 (2011)

[5] G C. Fox and Supun Kamburugamuve, "Architecture and Measured Characteristics of a Cloud Based Internet of Things API", 2012 international conference on Collaboration Technologies and Systems(CTS), pp. 6-12
[6] R. Shepherd, "Monitoring chemical plumes in an environmental sensing chamber with a wireless chemical sensor network", Sens. and Act. B, vol. 121, pp. 142-149, (2007)