MANTECH Publications

Journal of Internet of Things and Information Technology
Volume 3, Issue 1, January-April, 2020

"IoT Based Air Quality Monitoring System for Smart City"

Uttam Patil*, Yogeshwar Gadade**, Mayur Kulkarni**, Tushar Patil*

Professor, Students***

Department of Electronics Engineering

D.K.T.E's Textile and Engineering Institute, Ichalkaranji. India

Corresponding Author's Email id: *uapatil2002@gmail.com*, gadadeyogeshwar@gmail.com**, mpk5267@gmail.com**, tusharpatil9878@gmail.com***

DOI: - *http://doi.org/10.5281/zenodo.3764703*

Abstract

Objective of this paper is to design and implement a system for air quality monitoring for smart city using Internet of Things called also the model initiates from sensor devices that can sense, compute, and communicate data in a network. This study measures real-time PM2.5, temperature, humidity, Air Quality Index. Monitored data is wireless transmitted via Wi-Fi module to a server. When the sensor node reads pollutant gases composition, temperature and humidity it will be displayed on the website. The monitored data with date and time can be retrieved as a tabular data for future analysis. With implementation of this work, precautionary alerts can be given to public on the designed website to wear anti-pollution mask, change paths while transporting where the relishing air pollution ensuring high reliability. It will promote the public awareness about state of air pollution and how much important it is to reduce it. There will be news, surveys regarding pollution in different countries, different ways to reduce air pollution on the website.

Keywords: *IoT, Air Quality Index, Cloud, Wi-Fi node, Sensor data, Smart City.*

INTRODUCTION

Air pollution has been common health concern not only for humans but also for animals, plants, oceans, aquatic life worldwide. In most of countries air quality monitoring is done manually via centrally located station. Meanwhile, many populated areas of the world lack Continuous, long term air quality measurement. To date, the Geographic coverage of air quality monitoring networks has been constrained due to the implementation cost, architecture, and individual requirements for monitoring stations.

Internet of Things (IoT) has become a very popular paradigm in the modern wireless communication era. The basic idea of the IoT is the distribution of all-over "objects" or "things", which collects and exchanges data in order to achieve a common objective by means of mutual interactions. The networked connection of these physical objects to the Internet provides access to monitored remote sensor data, so that it is possible to control the physical world from a distance [1].

A fundamental aspect of the Internet of Things is the integration with the Cloud infrastructure, which hosts interfaces and web-based applications that enable the communication with sensors and external systems. Therefore, the Cloud computing infrastructure might provide data access and management features, with the aim of collecting and managing data made available by smart objects.

A real time monitoring of the existence and the concentration of air pollutants is necessary, in order to check air quality status and trends. By continuous real time monitoring of outdoor pollutant levels, IoT might help health departments to take the most suitable and effective decisions in case the environmental conditions become incompatible with the public health [1].

In this paper, will present a system for monitoring the air pollution based on Arduino and will implement a prototype of this system, deploy it in Dept. Moreover, we will design a website on Cloud-based platform that manages data collected from sensor send will display it on the website.

Finally, will design and investigate the system performance in terms of long-term operability, real-time measurement

accuracy compared with nearby stations, and feasibility for application in other location.

LITERATURE SURVEY

Some of the existing methodologies for the air pollution monitoring are described as below. In plug and sense device method, it Uses multiple sensors with location co-ordinate, AQI LED indicator is actuated as per pollution level and the Real time pollution level visualized using line graph. In distributed sensor data computing, it uses distributed intelligence for the sensor nodes and uses spatial database for locations [1].

In Arduino based method it uses sensor devices for data, Uses ESP8266 Wi-Fi module for connection to server, Uses Node.js and Node RED for displaying data on the server side. In personal assessment methods, Biochemical dose assessment methods are used Ex. Bio markers. In ZigBee technology, ZigBee transmitters and receivers are used. GPS module is used for locations for pollution level on map [1].

PROPOSED SYSTEM

The proposed system includes Arduino software and our own hardware based transmitting monitored data to cloud based server. In detail, the following environmental parameters are collected with the aim of measuring air pollution levels: Carbon Monoxide (CO), Particulate Matter (PM2.5), Ozone (O3), and Ammonia (NH3).

The hardware collects all the data uploading from sensors and transmits it to the Cloud server by using the Wi-Fi module ESP8266, which is mounted on-board serial port. Then the data is analyzed in a form of air quality index.

The data on the cloud server will be displayed location wise. The designed app will be hosted on the same cloud. **(See Figure:-1)**

Arduino is an open source micro-controller which is used with other communication and sensing technologies. This single-board development environment, which allows user to read uploaded data from sensors and allows to control different devices.

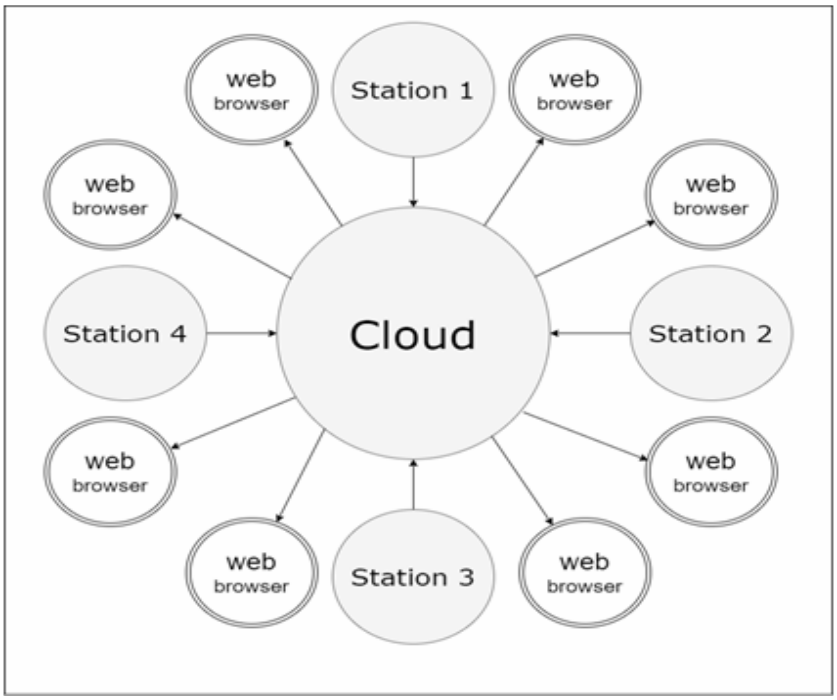


Fig -1: System Architecture

ESP8266 is a low cost Wi-Fi module with an AT commands library .It allows the Arduino to connect to the Internet through a Wi-Fi connection. Moreover, ESP8266 has a full TCP/IP protocol stack integrated on the chip.

There are some constraints in terms of resolution. Indeed, the inputs upload in the from analog sensors operate by default at10-bit resolution. The on/off switch in go the sensors can be operated remotely according to sensor-based data that are stored and maintained directly at the Cloud server. The Arduino collects all the data uploading from sensors and transmits it to the Cloud server by using the Wi-Fi module ESP8266,which is mounted on Arduino through an on-board serial port to air quality etc. will be updated on the website.

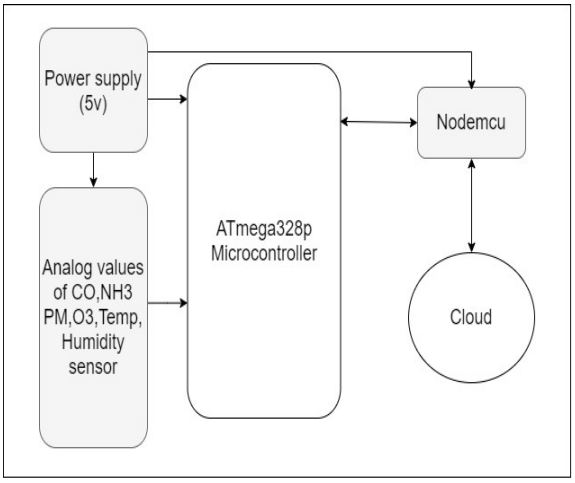


Fig-2:Block Diagram

DEFINITION OF AIR QUALITY INDEX

An air quality index is defined as an overall scheme that transforms the weighed values of individual air pollution related parameters (for example, pollutant concentrations) into a single number or set of numbers (Ott, 1978). The result is a set of rules (i.e. most set of equations) that translates parameter values into a more simple form by means of numerical manipulation[2].

If actual concentrations are reported in µg/m3 or ppm (parts per million) along with standards, then it cannot be considered as an index. At the very last step, an index in any system is to group specific concentration ranges into air quality descriptor categories[2].

Structure of index:

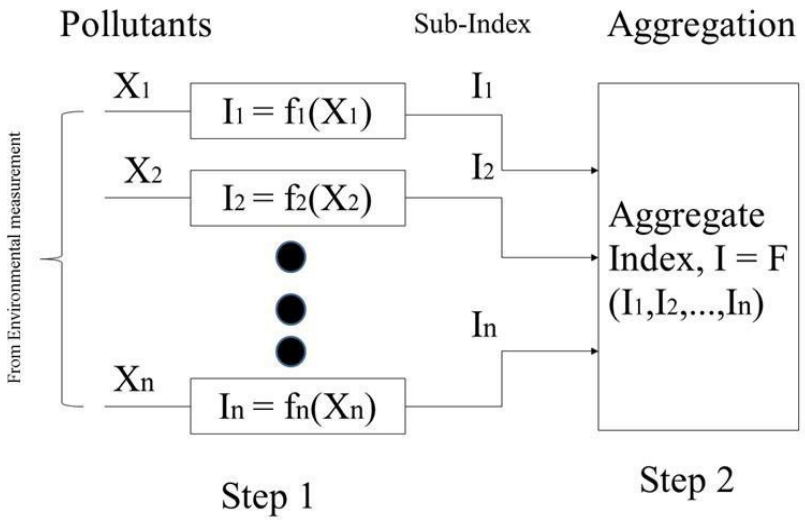
Primarily two steps are involved in formulating an AQI

i. formation of sub-indices (for each pollutant) and

ii. aggregation of sub-indices to get an overall AQI.

Formation of sub-indices (I1, I2,...., In) for n pollutant variables (X1, X2...., Xn) is carried out using sub-index functions that are based on air quality standards and health effects. Mathematically;

$Ii=f(Xi), \quad i=1, 2,...,n$



Each sub-index represents a relationship between pollutant concentrations and health effect. The functional relationship between sub-index value (Ii) and pollutant concentrations (Xi) is explained later in the text. Aggregation of sub-indices, Ii is carried out with some mathematical function (described below) to obtain the overall index (I), referred to as AQI.

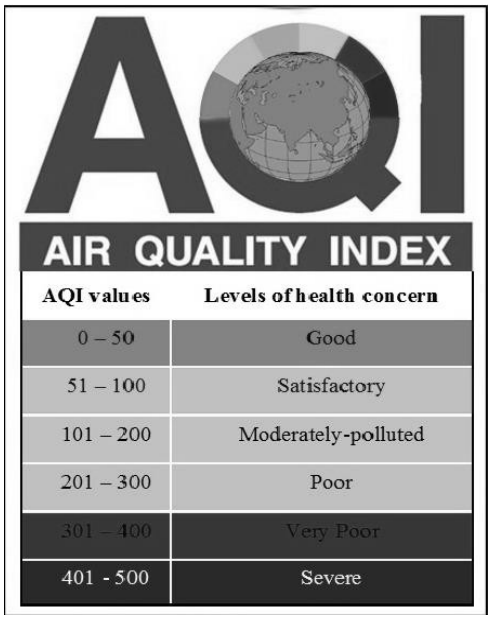
I=F (I1, I2,....,In)

Min or Max Operator (Ott 1978)

I = Min or Max (I1, I2, I3,..., In)

The revised air quality standards (CPCB, 2009) necessitate that the concept of AQI in India is examined afresh. An AQI system based on maximum operator function (selecting the maximum of sub-indices of various pollutants as overall AQI) is adopted. Ideally, eight parameters (PM2.5,CO, O3, N H3,Pb) having short-term standards should be considered for near real-time dissemination of AQI. It is recognized that air concentrations of Pb are not known in real-time and cannot contribute to AQI. However, its consideration in AQI calculation of past days will help in scrutinizing the status of this important toxic.

The proposed index has six categories and the schemes shown below [2].



HARDWARE IMPLEMENTATION

Sensors: This sensors has a high sensitivity and fast response time. The sensor's output is an analog resistance. The drive circuit is very simple, just a voltage divider; all you need to do is power the heater coil with 5V DC or AC, add a load resistance, and connect the output to an ADC[3].

MQ7: This is a Carbon Monoxide (CO) sensor, suitable for sensing Carbon Monoxide concentrations(PPM) in the air. The MQ-7 sensor can measure CO concentrations ranging from 20 to 2000ppm[4].

MQ-131: This is a OZONE(O3) sensor, suitable for sensing OZONE concentrations(PPM) in the air. This sensor can measure O3 concentrations ranging from 10 to 1000ppm.

MQ-137: This is a AMMONIA(NH3) sensor, suitable for sensing AMMONIA concentrations(PPM) in the air. This sensor can measure NH3 concentrations ranging from 5 to 200ppm.

GP2Y1010AU0F: This is a particulate matter(PM)sensor, suitable for sensing PM concentrations(mg/m3) in the air. The sensor can measure concentrations ranging from up to 500mg/m3[4].

Printed Circuit Board: For the signal conditioning of all sensors we required controller board which made by own This circuit board we make compatible with Arduino IDE. In this board we use same Arduino board controller ATmega328P in DIP package.

Nodemcu: For establishment of wireless connection between station and cloud we used Nodemcu board[4].

SOFTWARE IMPLEMENTATION

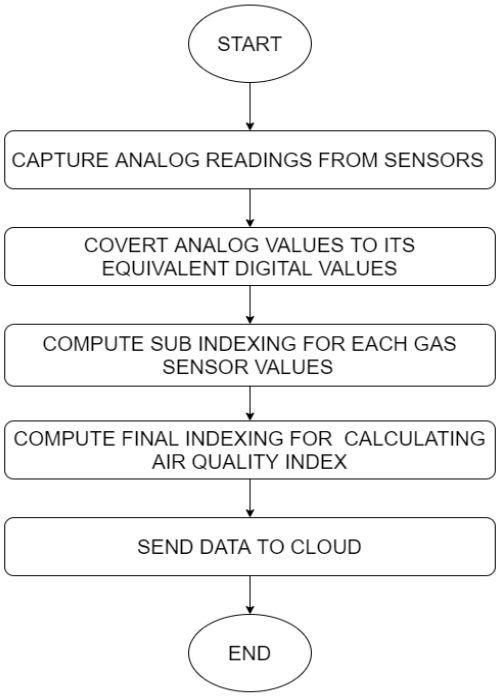
Station-side software: In the station software we use Arduino IDE which is based on c & c++ programming language.

Station-side workflow:

Server-side software: In the server software we used the PHP as back end language and HTML, CSS & JS used as front end language.

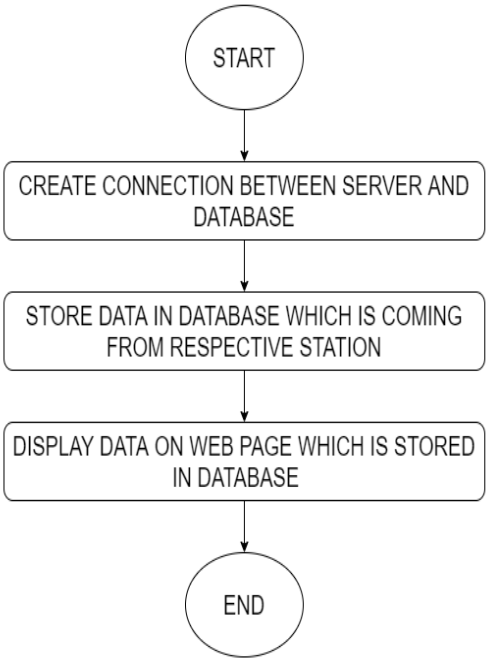
Station-side workflow:

.

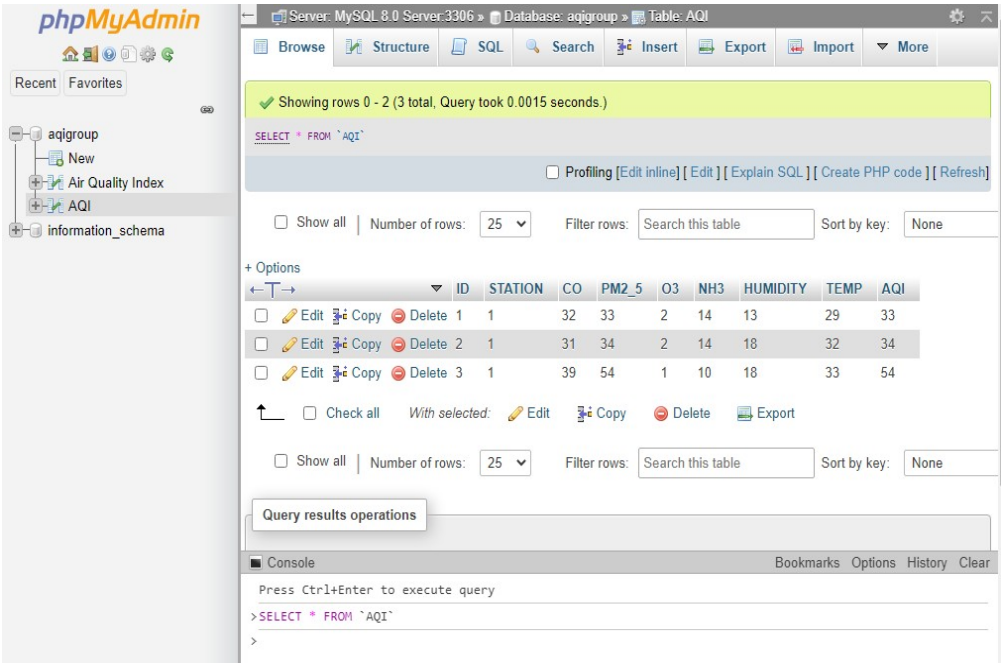


Server-side software: In the server software we used the PHP as back end language and HTML, CSS & JS used as front end language.

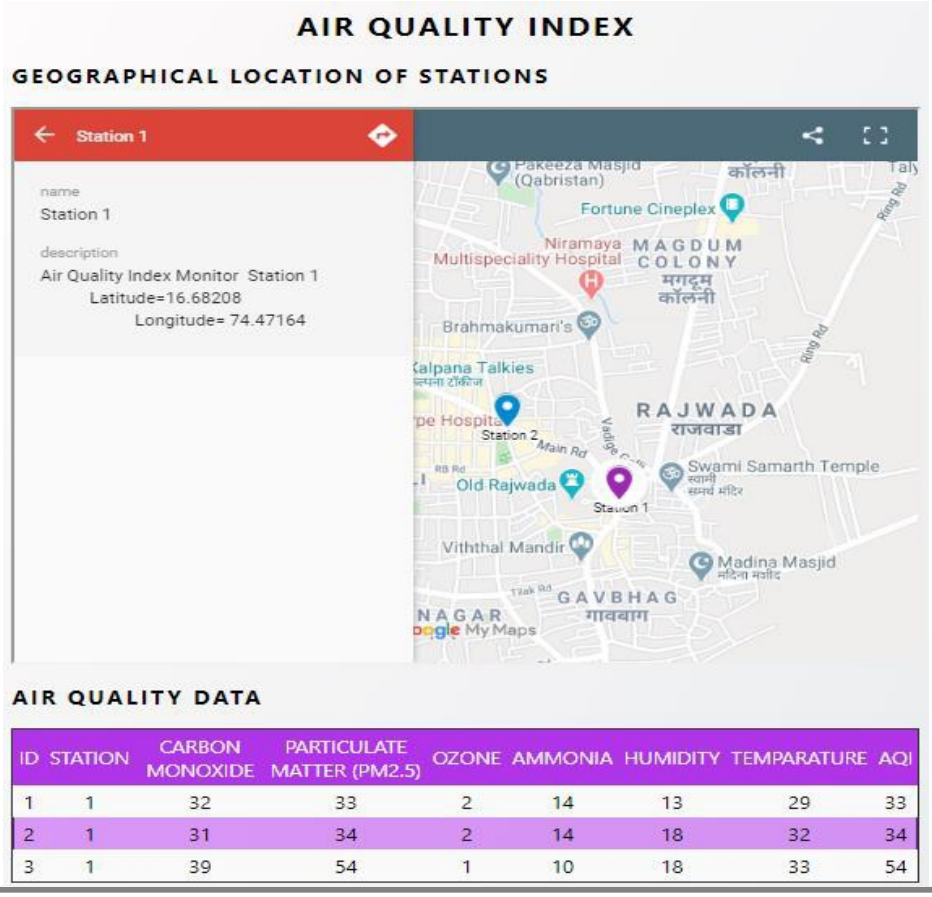
Server-side workflow:



Database: We used the MYSQL database for the storage air quality data.



RESULT



AIR QUALITY DATA

ID	STATION	CARBON MONOXIDE	PARTICULATE MATTER (PM2.5)	OZONE	AMMONIA	HUMIDITY	TEMPARATURE	AQI
1	1	32	33	2	14	13	29	33
2	1	31	34	2	14	18	32	34
3	1	39	54	1	10	18	33	54

CONCLUSION

This paper presents the summary of various techniques of air quality monitoring. These techniques are elaborately discussed in the paper. In the proposed system, one of the most preferred technique is cloud based air quality monitoring system. Using the same cloud data, website is hosted and data is displayed on the website. There are more design options are present. We choose one of them.

REFERENCES

I. P. D. Landge and R. R. Harne, "Air Quality Monitoring System for City: A Review", International Research Journal of Engineering and Technology(IRJET), vol. 05, no. 01, pp. 521–522, Jan. 2018.

II. Central Pollution Control Board, "National Air Quality Index," PR Division on behalf of Dr. A.B. Akolkar, Member Secretary, CPCB, Delhi-110032, Oct. 2014.

III. Z. Yunusa, M. N. Hamidon, A. Kaiser, and Z. Awang, "Gas Sensors: A Review," Researchgate, vol. 168, no. 04, pp. 61–75, Apr. 2014.

IV. G.Spandana and R. Shanmughasundram, "Design and Development of Air Pollution Monitoring System for Smart Cities," 2018 Second International Conference on Intelligent Computing and Control Systems (ICICCS), Jun. 2018.

V. Oza S. et al. (2020) IoT: The Future for Quality of Services. In: Kumar A., Mozar S. (eds) ICCCE 2019. Lecture Notes in Electrical Engineering, vol 570. Springer, Singapore.

Cite this Article as

Uttam Patil, Yogeshwar Gadade, Mayur Kulkarni, Tushar Patil (2020) **"IoT Based Air Quality Monitoring System for Smart City"** Journal of Internet of Things and Information Technology, 3 (1), 11- 20

http://doi.org/10.5281/zenodo.3764703