A Review: Cost Effective IOT Based Air Pollution Monitoring and Air Quality Analysis

Neha R. Rewatkar[1]
MTech (VLSI)
BDCE Sewagram
neharrewatkar@gmail.com

Prof. Deepali M. Khatri[2]
Associate prof. E & T Department
BDCE Sewagram
deepali.85@rediffmail.com

Abstract: **-** In this paper a cost effective air pollution monitoring system is proposed. This system can be used for monitoring pollutants in air of particular area and to find the air quality analysis. The proposed system will focus on the monitoring of air pollutants concentration with the help of combination of Internet of things with wireless sensor networks. The analysis of air quality can be done by calculating air quality index (AQI). This information will be displayed on the webpage via internet in real time. By the combination of internet of things and wireless sensor networks for purpose of air pollution monitoring it becomes easy to keep the air quality data updated in real time. Also the system is cost effective which make its installation possible in various areas. The developing system will have a complete monitoring system which is IOT based. Also the information will be directly sent to the internet from system; no need of computer for transmission purpose which reduces the cost.

Keywords- *Internet Of Things(IOT), Raspberry Pi, Air Qualioty Index etc.*

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I. INTRODUCTION

Air pollution not only brings serious damage to human health but also causes negative effects to natural environments. The air pollution occurs due to contamination of air with Carbon monoxide (CO), Carbon dioxide (CO2), Nitrogen dioxide (NO2), Sulfur dioxide (SO2) and many other harmful pollutants. It has hazardous effects on human health. Carbon monoxide reduces oxygen carrying capacity of the body's organs and tissues which may lead to cardiovascular disease. Carbon monoxide causes visual impairment, reduced manual dexterity, reduced work capacity, poor learning ability. So it becomes more and more important to monitor and control air pollution. It will become easy to control it by monitoring the concentration air pollutant parameters in air. Using laboratory analysis, empirical analysis conventional air automatic monitoring system has high precision, but large bulk, high cost make it impossible for large-scale installation.

To monitor air quality, wireless sensor networks (WSNs) might be a great tool, because they can automatically collect air quality data. It will also help us to keep a working staff away from danger and a high security can be achieve and it will also help the Government authorities to monitor the air pollution.

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II. WHAT IS AQI?

In India the AQI is centered on five chief pollutants-

1. Particulate Matter with diameter less than 10µm(PM10)
2. Particulate Matter with diameter less than 2.5µm(PM2.5)
3. Ozone(O3)
4. Nitrogen Dioxide(NO2)
5. Carbon Monoxide(CO)

$I_p=[(I_{hi}-I_{low})/(BP_{hi}-BP_{low})](C_p-BP_{low})+I_{low}$
I_p= Index of pollutant
C_p= Rounded concentration of pollutant
BP_{hi}= Breakpoint greater than C_p
BP_{low}= Breakpoint less than C_p
I_{hi}= AQI correspond to BP_{hi}
I_{low}= AQI correspond to BP_{low}

The pollutant with highest AQI reading for particular time in an area will be the AQI of that area. Example if CO reading is higher than all other components for any city then the AQI of that city will be the reading of CO.

Table 1: Standard AQI table

AQI range	PM10(24 hr)	PM2.5(24 hr)	NO2(24 hr)	O3(8 hr)	CO(8 hr)
Good(0-50)	0-50	0-30	0-40	0-50	0-1.0
Satisfactory (51-100)	51-100	31-60	41-80	51-100	1.1-2.0
Moderately Polluted (101-200)	101-250	61-90	81-180	101168	2.1-10
Poor (201-300)	251-350	91-120	181-280	169-208	10-17
Very Poor (301-400)	351-430	121-250	281-400	209-748	17-34
Severe (401-500)	430+	250+	400+	748+	34+

III. LITERATURE REVIEW

1. Distributed System as Internet of Things for a new low-cost, Air Pollution Wireless Monitoring on Real Time

A low-cost wireless monitoring system [1] is developed to measure CO, CO2 and the density of dust parameters based on a multilayer distributed model with an Arduino platform, sensors and wireless connectivity Xbee. The data is collected in computer and send to webpage to monitor air pollution on real-time. The validation of the mentioned concept has been realized in cities Quito, Amaguaña and Tena of Ecuador.

The system is quite complex since they have used various types of software languages for various purposes (For ex. Java for computer system, C/C++ for conversion of analog data to digital form, etc).

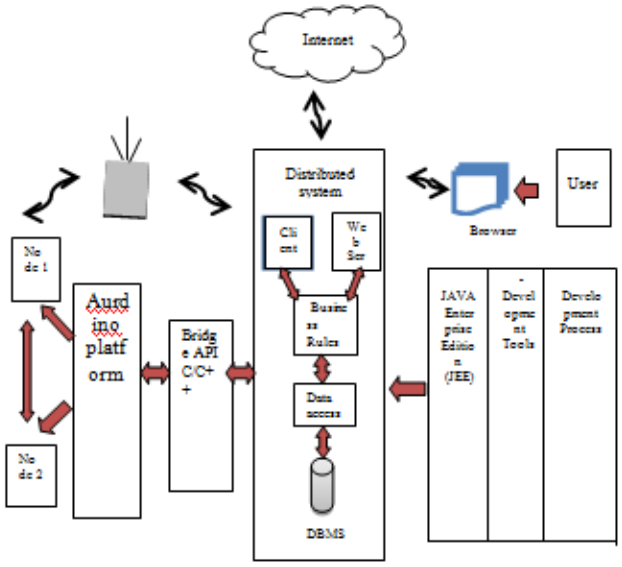

Fig 1: Real time air pollution wireless monitoring

2. IOT- Based Air Pollution Monitoring and Forecasting System

IOT based air pollution monitoring and forecasting system [2] consist of a system where environmental sensors including SO2, NO2, CO sensors and Meteorological sensors (wind direction, wind speed, temperature, humidity and air pressure) are installed in some of the monitoring points.

The system can be laid out in a large number in monitoring area to form monitoring sensor network. It also exhibits the function of forecasting by analyzing the obtained data neural network technology.

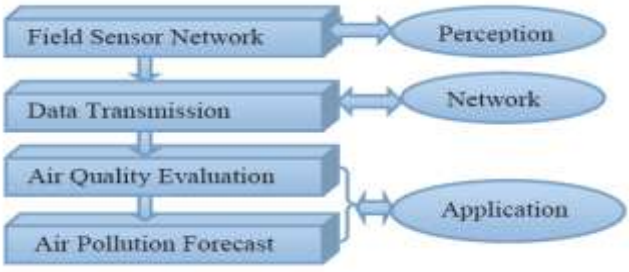

Fig 2: IOT based air pollution monitoring and forecasting system

3. Wireless Sensor Network Based Pollution Monitoring System in Metropolitan Cities

The WSN based air pollution monitoring system [3] is based on AVR ATmega-32 Microcontroller. The sensor grid is used to detect the sensor values from different sensor like parameters MQ5, MQ7, temperature and humidity dataset. ID3 algorithm is used to calculate the values base on probability. Bluetooth module is used to connect the controller with client and the client connects with the server via web services.

This system not only calculates the pollutants present in the air but also can make a forecast to avoid future pollution in the particular polluted area. Here they consider mainly the chemical Industry near Pune and the I.T. area like Hinjewadi.

4. Air pollution monitoring system using Zigbee and GPS module

The Zigbee and GPS based air pollution monitoring system [4] interfaces various sensors to measure the common air pollutants such as SO2, CO, NO2 and NO etc. The measured data is displayed on the monitor using the graphical user interface (GUI). The pollutants level is stored on data based server and interfaced to Google maps to display real time pollutants, pollutants level and locations in large areas.

It uses a low power wireless sensor network also the pollution level and location is displayed graphically using Google maps.

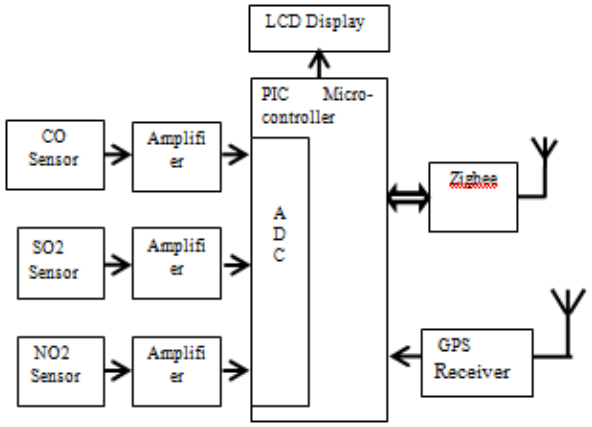

Fig 3: Wireless sensor based air pollution monitoring system

5. Real time wireless air pollution monitoring system

The real time monitoring system [5] has used sensors for sensing concentration of gases like CO2, NO2, CO and O2. Libelium WASP motes are used as the basic wireless communication module, which comprises of the processing unit and the communication unit. The collected samples are packetized and sent to base station. A web interface to view this pollution data in the form of numbers and charts was developed and made available from anywhere on the internet.

The cost Libelium WASP motes is too high. This system consumes lot of energy from batteries.

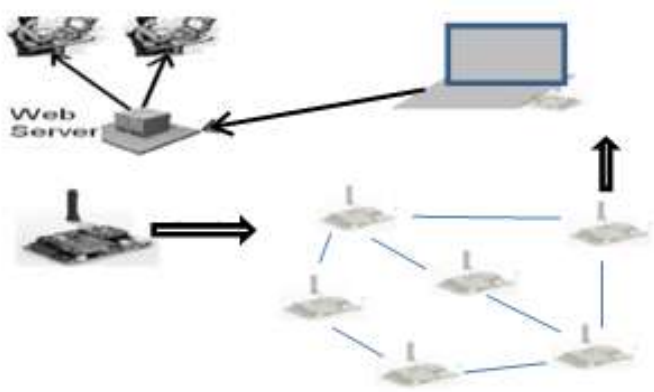

Fig 4: Zigbee and GPS based air pollution monitoring system

6. WSN Based Air Pollution Monitoring System

The designed air pollution monitoring system in [6] was implemented and tested using the wireless sensor network. Pollutant gases such as CO2, NO2, and SO2 are collected from environment. The pollution data from various mobile sensor arrays is transmitted to a central several that make this data available to government authority. The data shows the pollutant levels and their conformance to local air quality standards.

The system uses the AQI to evaluate the level of health concern for a specific area.

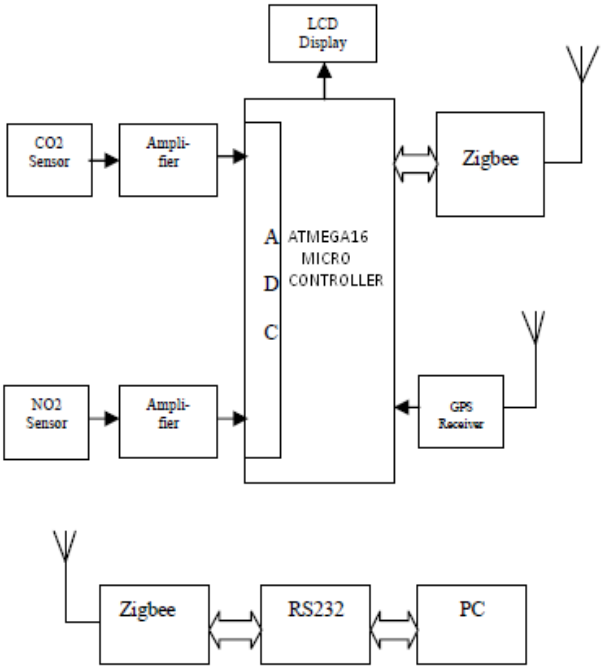

Fig 5: WSN based air pollution monitoring system

7. Arduair: Air Quality Monitoring

The ArduAir [7] is discussed, which is a small, portable and low-cost air pollution monitoring system The ArduAir is used to monitor Carbon Monoxide concentration of an area and collected the data for the same. The sensor based system can also be used for various other gases such as SO2, NO2, CO2, O3, etc. using different sensors. The general public can use this system effectively for monitoring the quality of air around them.

A large scale installation of this system is possible and can be used domestically by a large number of people.

8. Real-Time Indoor Carbon Dioxide Monitoring through Cognitive Wireless Sensor Networks

The real time indoor CO2 system [8] aims to monitor and detect the concentration of CO2 in a real-time basis. It uses IAQ 2000 sensor for CO2 detection. Radio modules used for transferring the data to control room. In control room all data is processed and using GUI it is plotted on graph.

It provides overall air quality alerts time to time.

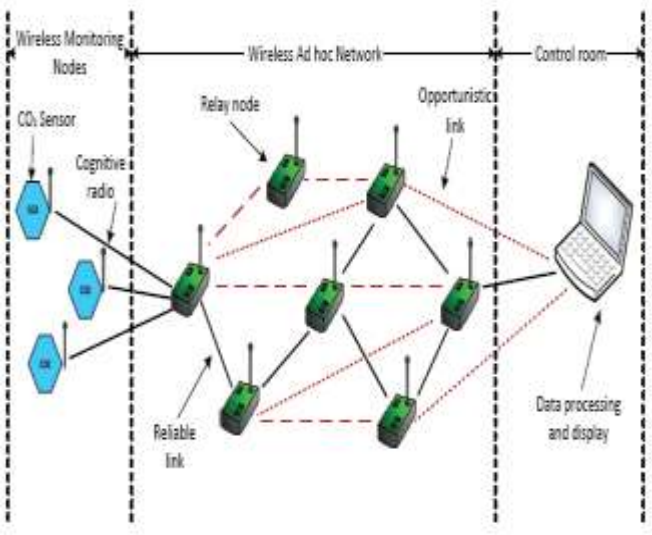

Fig 6: Real time indoor CO2 monitoring

IV. TABULAR COMPARISON

Paper	Sensors	System	Connection Between System and PC	Up-loading method	Analysis
Paper 1	CO, CO2, dust	Arduino platform	Xbee	PC to Web	_
Paper 2	SO2, NO2, CO	WSN	_	PC to Web	Neural Network
Paper 3	_	AVR ATmega-32	Bluetooth	Mobile to Web	ID3 algorithm
Paper 4	CO, NO2 & SO2	ARM 7	Zigbee	PC to Web	_
Paper 5	CO2, NO2, CO & O2	Libelium WASP	Multi-hop network	PC to Web	_
Paper 6	CO, NO2	AtMega 16	Zigbee	PC to Web	Air Quality Index
Paper 7	CO2, NO2, SO2,O3	Arduino	USB Cable	PC to Web	Real time graph plotting
Paper 8	CO2	Microcontroller	Radio Modules	PC to web	Graph

CONCLUSION

Real time air pollution wireless monitoring system uses Xbee whereas Zigbee and GPS based air pollution monitoring system and WSN based air pollution monitoring system uses Zigbee for sending collected pollutant information to the computer. In Wireless sensor network based pollution monitoring system a Bluetooth network is used as well as analysis is done using ID3 algorithm. Arduair Air quality monitoring system uses USB cable for data transfer also real time graph plotting has done. All the above system has short range to send data to the computer. Real time wireless air pollution monitoring system has used multi hop network but it is costlier due to Libelium WAPS. Real time indoor CO2 monitoring system uses radio modules for data transmission and does analysis graphically.

The systems discussed above send data on webpage via computer which is time consuming. The air analysis is done graphically or using some algorithms. It is necessary to develop such a system which can be simply collect pollutant data as well as send it directly to the webpage and analyze it.

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