iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 7 **Issue:** IV **Month of publication:** April 2019

DOI: https://doi.org/10.22214/ijraset.2019.4132

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 7 Issue IV, Apr 2019- Available at www.ijraset.com

Real Time Ambient Air Quality Monitoring System using Sensor Technology

Mr. Arpit Jaiswal[1], Mr. Ravi Kumar Gupta[2], Mr. Brijesh Kumar Dubey[3]
[1]*Scholar, Department of Electrical & Electronics Engineering, PSIT, Kanpur, Uttar Pradesh*
[2, 3]*Assistant Professor, Department of Electrical& Electronics Engineering, PSIT, Kanpur, Uttar Pradesh*

Abstract: Monitoring of air pollution assuming traditional methods is a very expensive and time consuming work. The major pollutants in ambient air are carbon monoxide, nitrogen oxides, hydrocarbons and particulate matter. Sensor innovation has emerged as a cost effective, easy and fast method for monitoring good air quality. In this paper, a glimpse of the studies conducted using sensor technologies are presented and a sensor based monitoring system for real time monitoring of ambient air quality and management is being proposed.

I. INTRODUCTION

Air pollution is a major problem in urban centers as well as rural set-up. The major pollutants of concern are primarily carbon monoxide, nitrogen oxides, hydrocarbons and particulate matter (PM_{10}, $PM_{2.5}$). Ozone, PAN and PBN are other secondary pollutants generated as a result of the photochemical reactions of the primary pollutants. These pollutants affect human health and environment spontaneously.

Therefore, air pollution monitoring is necessary to keep a check on the concentration of these pollutants in ambient air. Conventionally, air pollution monitoring is done by using High Volume Sampler, portable multi gas monitors and gas chromatography.

But all these practices involve use of stationary and expensive monitors. Further, high cost, large size and maintenance cost made them unfavorable for monitoring applications on large scale. In this light; a complimentary solution can be the use of sensor technology for air pollution monitoring.

Due to innovation in sensors there are multiple implications in various fields such as in applications of environmental monitoring, indoor climate control, surveillance, medical diagnostics, disaster management, emergency response, and gathering sensing information in inhospitable locations. Sensor technology has allowed the creation of low-cost air pollutant monitoring systems, with reduced installation costs, quick and easy configuration, and suitable for mass deployment and implementation in real environment in contrast with the conventional air quality monitoring. Several studies suggested different kind of sensors for air pollution monitoring like solid state sensors, semiconductor sensors and laser sensors.

A. Laser Scattering Sensors

These sensors work on the principle of laser scattering. When the laser beam passes through the detecting position, particle produce weak light scattering; light scattering wave and particle in a particular direction is related to the diameter of the particle number concentration.

B. Solid State Sensors

These sensors consist of one or more metal oxides from the transition metals, such as tin oxide, aluminum oxide etc. These metal oxides in the presence of gas, causes the gas to dissociate into charged ions or complexes which results in the transfer of electrons. This built- in heater, which heats the metal oxide material to an operational temperature range that is optimal for the gas to be detected, is regulated and controlled by a specific circuit.

C. Capacitor Type Gas Sensor

Electric capacitance of a condenser depends on the dielectric constant of the materials between the electrodes. If the dielectric constant changes sufficiently on exposure to a gas, the condenser can be a sensor for the gas. These types of sensors have already been developed as humidity sensors in which the condensation of water vapor gives rise to a change in dielectric constant.

In this paper, sensor based system used for real time monitoring ambient air quality is discussed.

©IJRASET: All Rights are Reserved

II. RELATED WORK

Sensor technology is an alternative approach that does not involve the collection and analysis of samples. Different types of sensors are available for different purposes. Photoelectric aerosol sensors (PAS) can be used for monitoring polycyclic aromatic hydrocarbons in real-time in the emissions plumes, especially, from the motor vehicles. While photoelectric aerosol sensors offer advantages like lower costs, ease of data collection, real-time data over source-attribution methods that rely on the sampling and chemical analysis of airborne matter, but in case of high traffic volumes at monitoring site it is difficult to unequivocally attribute PAS signals to individual vehicles. Car cabin air quality monitoring can effectively be analyzed using metal oxide semiconducting (MOS) gas sensors. This laboratory tests showed that the MoO_3 based sensors possessed comparable gas sensing properties. The MoO_3 (75%)-TiO_2 (25%) sensor has a response 74% higher relative to the best commercial sensor tested. Wireless sensor networks that make use of micro sensors can perform intelligent environmental monitoring. Generally, micro sensors employed in WSNs (Wireless sensor networks) show a low performance with regards to accuracy compared to the expensive sensors used for precise measurement.

III. PROPOSED AIR QUALITY MONITORING SYSTEM DESIGN

The proposed sensor based system is a low cost air pollution monitoring system consisting of semiconductor gas sensors and laser sensor, microcontroller and LCD display. It is a compact system which can be assembled and installed. This system can be integrated with Internet of things (IOT) for online air pollution monitoring, which is the need of the hour. By integrating with IOT, sensor based system can also be used for disseminating the information to the public by sending SMS on their mobile, if the pollutant level in a locality exceeds the prescribed Air Quality Index (AQI).

In this system, the selected sensors are interfaced with microcontroller and LCD display which are further connected wirelessly with Laptop. The data logging is done on laptop. Figures 1 and 2 depict the circuit diagram and block diagram of the proposed integrated system.

.

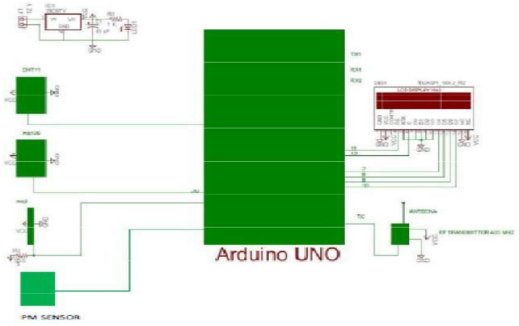


Fig.3. Circuit diagram of proposed system

Mobile Environmental Sensing System Across Grid Environments (MESSAGE) is a collaboration project between five UK universities to develop a pervasive sensing system for monitoring and displaying online information about traffic and traffic related pollution for traffic management and route planning purposes. The project's scopes include system architecture and infrastructure design, data processing and mining, transport system

IV. SENSOR CALIBRATION

The calibration exercise in this paper was performed in order to understand the sensor characteristics toward the target gases, such that the signal conditioning circuitry can be designed and improved. The calibration results also form the basis of translating the sensor measurements to gas concentration in the implementation and deployment phase. Calibration, the process of translating the electrical property from the sensor to a value reported in an official standard understood by the users, must be performed in an environment that is controlled in such a way that physical reference signals can be generated in accordance with the official standards .In our calibration exercise, the test gas concentration is controlled using a calibrated mass flow controller (MFC) (Tylan Model FC-260) in combination with certified gases of known concentrations. All gases used in the calibration are certified to a tolerance of<5% deviation from the stated concentration. For the calibration of CO sensors, synthetic air is used for diluting the CO gas to the required concentration to avoid complications that might arise from day-to-day variations in the gaseous composition of the atmosphere. The synthetic air is fed through two different paths to the MFCs.

©IJRASET: All Rights are Reserved

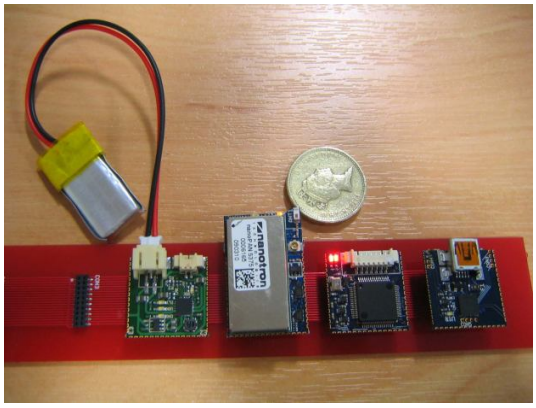


Figure 4. The Bracelet System

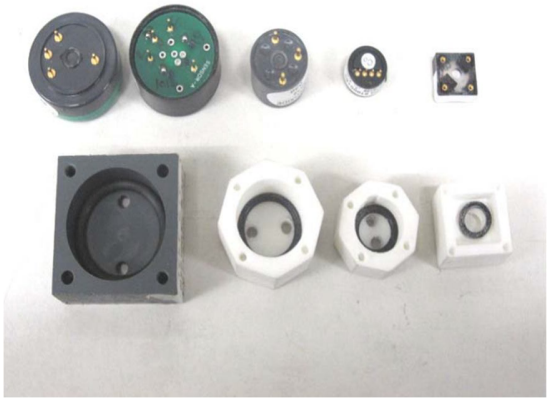
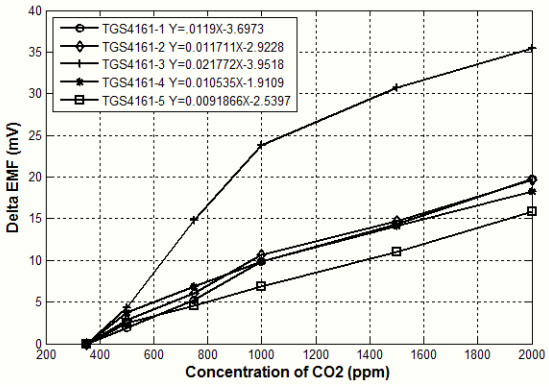


Figure4.1. CO Electrochemical sensors and their isolation

When considering the response time, the calibration environment must be taken into account. For CO calibration, bespoke isolation chambers that were tightly fitted to these sensors were used, since these give very little additional delay over and above the sensor response. For the CO2 and O2 calibration a simple (cheaper) sealed flask was used.



A. Carbon Monoxide (CO) sensor

CO is colorless, odorless and stable gas. It is being produced due to incomplete combustion of fuel in motor vehicles. Monitoring of CO is very important as it has very high affinity to react with hemoglobin to form carboxyhemoglobin. The sensor proposed in the study is MQ9 semiconductor gas sensor. This Sensitivity material used in this sensor is SnO_2. The sensor operates within the temperatures range of -10 to 50°C and consumes less than 150 mA at 5V.

©IJRASET: All Rights are Reserved

B. Carbon Dioxide and NO_x Sensor

The MQ135 Carbon dioxide and NO_x sensor used in the proposed system detects the concentrations of gas in the air and readings are obtained as an analog voltage. This sensitive material used in MQ135 sensor is SnO_2. This sensor operates within the temperatures range -20 to 50°C and consumes less than 150 mA at 5 V.

C. Particulate Matter Sensor

The sensor used for particulate matter is $PM_{2.5}$ laser sensor-SDS011. SDS011 uses the principle of laser scattering in the air and can obtain from 0.3 to 10 microns suspended particulate matter concentration. The data is stable and reliable.

D. Arduino Uno R3 Microcontroller

It is the most flexible hardware platform based on ATmega328P which can be programmed according to the function where it is to be used. It has 6 analog inputs, 14 digital input/output pins, a USB connection and serial interface.

E. 16 x 2 Alphanumeric LCD Display

LCD (Liquid Crystal Display) screen is an electronic display module which find a wide range of applications. A 16 x 2 LCD display is a basic module and is commonly used in various devices and circuits.

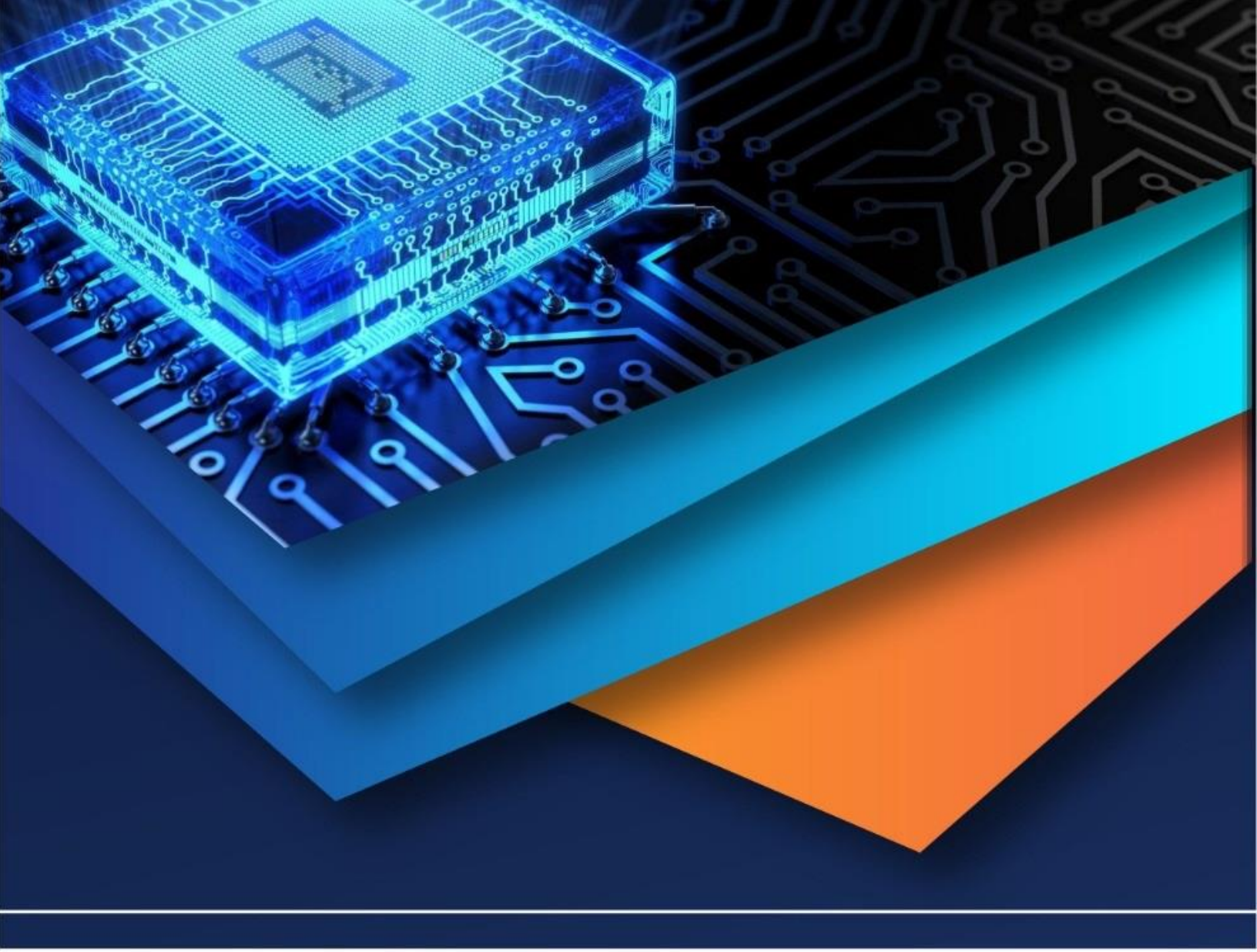
V. CONCLUSIONS

This method of air pollution monitoring using sensors is comparatively cost effective, easy to install and provides real time data of field instead of traditional methods where air pollution level are measured at fixed location or laboratory. The real time data of ambient air quality available through this system can be used for the various air quality management purposes. The system proposed can be improved by including more sensors like ozone sensor, VOC sensors.

REFERENCES

[1] J.C. Dunbar, C.I. Lin, I. Vergucht, J.Wong and J.L. Durant “Estimating the contributions of mobile sources of PAH to urban air using real-time PAH monitoring”, The Science of The Total Environment, vol.279,pp.1-19,15 December 2000.
[2] K. Galatsis, W. Wlodarski, K. Kalantar-Zadeh and A. Trinchi, “Investigation of gas sensors for vehicle cabin air quality monitoring ”, IEEE Xplore,pp.229-232, 2002.
[3] S. Choi, N. Kim, H. Cha, and Rhan Ha, “Micro sensor node for air pollution monitoring: Hardware and Software Issues”, MDPI journal,pp.7970-7987, 2009
[4] L.V. Shum, P. Rajalakshmi, A. Afonja and G. McPhillips, “On the development of a sensor module for real time pollution monitoring”, IEEE, 2011.
[5] D. Soldo and A. Quarto,“M-DUST : an Innovative Low-Cost Smart PM sensor”, IEEE, 2012.
[6] T.H. Wen, J.A. Jiang, C.H. Sun, J.Y. Juang and T.S. Lin, “Monitoring Street-Level Spatial-Temporal variations of carbon monoxide in urban settings using a Wireless Sensor Network (WSN) Framework”, International Journal of Environmental Research and Public Health,vol.10, 2013
[7] C. Chaiwatpongsakorn, M. Lu, T.C. Keener, and S.J. Khang, “The Deployment of Carbon Monoxide Wireless Sensor Network(CO-WSN) for Ambient Air Monitoring”, International Journal of Environmental Research and Public Health,vol. 11,pp.6246-6264, 2014.
[8] A.H. Nograles, A.C. Paolo D, I. Steven, L. Manuel And J. Bethany, “Low Cost Internet Based Wireless Sensor Network for Air
[9] S. Abraham and X. Li, “A Cost-effective Wireless Sensor Network System for Indoor Air Quality Monitoring Apllications, The 9th International Conference on Future Networks and Communications, pp.165-171, 2014.
[10] P. Partheeban, R.R. Hemanmalini and H.P. Raju, “Vehicular Emission Monitoring Using Internet GIS, GPS and Sensors”, International Conference on Environment, Energy and Biotechnology, vol.33, pp. 81-85, 2012.

©IJRASET: All Rights are Reserved



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089 (24*7 Support on Whatsapp)