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Evaluating Air Pollution Parameters Using Zigbee (IEEE 802.15.4)

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Abstract: *Air pollution receives one of the prime concerns in India, primarily due to rapid economic growth, industrialization and urbanization with associated increase in energy demands. Lacks of implementation of environmental regulations are contributing to the bad air quality of most of the Indian cities. Air pollutants produced in any air shed are not completely confined, but at time passing all the geographical boundaries, hence donot remain only a problem of urban centers, but spread and affect remote rural areas supporting large productive agricultural land. In environmental parameters the air pollution is measure by taking one or few samples in a day that means there is no information present about the real time air pollution data. This is the main disadvantages of such system. Most of the countries in the world work on the real time bases to monitor the air quality. In this paper we describe use of ZigBee, sensor nodes, GPS to construct distributed system for urban air pollution monitoring and control. ZigBee module and pollution server is interfaced with GPS system to display real-time pollutants levels and there location on a 24h/7 days basis. In this system there are four transmitter (Node1, Node2, Node3, Node4) are present which transmit the different levels of pollutant substance such as CO2, SO2, and NO2 to the receiver node in real time. The system was successfully tested in the G.H. Raisoni College of Engineering, Nagpur, India.*

Keywords: *ZigBee Sensor Node, Air Pollution, GPS, Environmental Pollution, Real Tim, CO2, SO2, NO2.*

I. Introduction

With fast development of the industrialization and urbanization process in the world, environmental pollution problems become more universal. At present environment contains air pollution, water pollution and soil pollution worldwide. Air pollution is the presence of contaminants or pollutant substances in the air that interfere with human health or welfare, or produce other harmful environmental effects. The World Health Organization states that 2.4 million people pass away each year because of air pollution. Based on the fact above mentioned, the human should focus on design air pollution monitoring method.

Pure air and human health goes Hand in Hand. Air pollution is harmful for human Health. It causes difficulty in breathing, wheezing, coughing and many respiratory problems. Currently there are two methods to monitor air pollution at present. First one is non automatic and other is automatic. The advantages of non automatic sampling method are monitoring devices is simple and inexpensive but it monitors the parameters for certain period. It does not provide the real time monitoring. While the non automatic sampling method provides the real time monitoring of harmful substances in the air. The non automatic sampling method uses the sensors to monitor the parameters, and send the data to central control center.

At present, for monitoring air pollution in wireless network the system includes the GSM, GPRS, etc. But these wireless nodes installation and maintenance are costly. That's why wireless sensor network have been rapidly developed. The wireless sensor network has many advantages application in military and industries. Many air pollution systems which monitor air pollute on due to hazardous health problems of this the government of Tiwan use various air quality monitoring systems [1]. In this they use MAC medium access control protocol for monitoring air quality in wireless sensor network. Khunarak et al. proposed E-nose electronic nose architecture for real time monitoring of indoor chemical polluted materials such as CO, NO2.

These chemical materials are highly toxic and cause respiratory failure [2]. The ARIMA prediction model is used to monitor air quality in wireless sensor network. The ARIMA model predicts the carbon dioxide level in the air in [3]. A conceptual framework for the deployment of wireless sensor network for environment monitoring of Bangalore urban city is proposed in [4]. An outdoor air pollution monitoring system which uses ZigBee networks for monitoring air pollution in ubiquitous cities was reported in [5]. This system integrates wireless sensor board and CO2 sensors which also integrates with the dust, temperature and humidity and ZigBee module. In China, Zhang Qian et al. compared the advantages of ZigBee with Wi-Fi and Bluetooth and give a wireless solution based on ZigBee technology for greenhouse monitoring [6]. Although some authors use ZigBee to monitor air pollution, its application in air pollution monitoring stay little. The exploitation of the technology of the wireless sensor network and ZigBee module, focusing on the air pollution monitoring system.

II. Pollution Parameters

The air pollution means presence of one or more contaminants for temporal duration that can become injurious to human life, vegetable, and animal. The air contaminants include smokes, gases, dusts, paper hashes, poisonous chemical products and many polluted materials.

Certain polluted materials react with each other and produces other pollutants. These pollutants called as secondary pollutants. Carbon dioxide and nitrogen dioxide produced by automobiles motors, lead to the development of ozone. Air pollution has consequences for human health. It causes respiratory harms and even fatality. It also contributes the acid rain and reduction of ozone layer.

The proposed system is able to measuring the following gases in the environment.

a. Carbon Dioxide (CO2) – Carbon Dioxide is a gas essential to life in the planet, because it is one of the most important elements evolving photosynthesis process, which converts solar into chemical energy. The concentration of CO2 has increased due mainly to massive fossil fuels burning. This increase makes plants grow rapidly. The rapid growth of unwanted plants leads to the increase use of chemicals to eliminate them.

b. Sulphur Dioxide (SO2) – Sulphur Dioxide is a pale gas, noticeable by the special odor and taste. Like CO2, it is mainly due to fossil fuels burning and to industrial processes. In high concentrations may cause respiratory harms, especially in sensitive groups. It contributes to acid rains.

c. Nitrogen Dioxide (NO2) – Nitrogen Dioxide is a brownish gas, easily noticeable for its odor, very acidic and extremely oxidant. It is produced as the result of fossil fuels burning. typically NO thrown to the atmosphere is converted in NO2 by chemical processes. In high concentrations, NO2 may lead to respiratory harms. Like SO2, it contributes to acid rains.

III. About Zigbee

The ZigBee is the small range, low power, and low data rate wireless networking technology for many wireless applications. It is present at the bottom three layers i.e. physical, data link, and network layer. This is the recently published IEEE 802.15.4 standards for personal area networks. ZigBee is embattled at radio-frequency (RF) applications that require a low data rate, extended battery life, and secure networking. ZigBee is a wireless technology developed as an open global standard to address the unique needs of low-cost, low-power, wireless sensor networks.

ZigBee network layer supports star, mesh and tree topologies. The ZigBee coordinator is responsible for initiating and maintaining the devices present in the network and other end devices directly communicate with the ZigBee coordinator.

The IEEE 802.15.4 (ZigBee) standard provides three frequency bands for operation: these are 868MHz, 916MHz, and 2.4GHz for ZigBee. 868MHz band used in only Europe and has the 20Kbps data rate of transmission and contain only one channel with BPSK modulation technique. 916MHz band is used in Americas having the 40Kbps data rate of transmission and contain 10 channels with BPSK modulation technique. 2.4GHz frequency bands used throughout the world because of ISM (Industrial, Scientific, Medical) band. It has 250Kbps data rate of transmission and 16 channels with O-QPSK modulation technique.

Transmission distance is within the range from 30 meters in an indoor non-line of sight of environment and 100 meters in line of sight environment. The range problem can be solved by using various routing algorithms at the network layer.

IV. Hardware Architecture

The proposed system is designed by integrating the following hardware modules as shown in figure.

4.1 H/W BLOCK DIAGRAM:

The following diagram shows the hardware block diagram of proposed system.

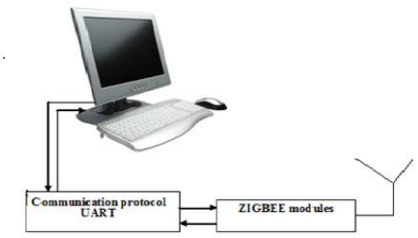

Fig. 2: System Side Block Diagram

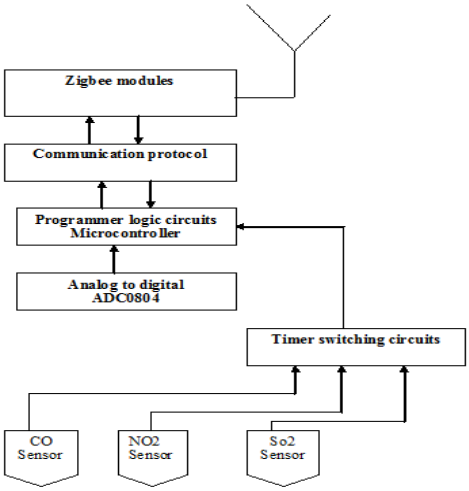

Fig. 3: Node Block Diagram

To satisfy the system's functional and nonfunctional requirements, two major building blocks are needed, namely: a Data Acquisition unit and a Pollution Monitoring Server. The data acquisition unit is designed by integrating microcontroller with a sensor array using analog ports. Data Acquisition Unit is also connected to a GPS module and ZigBee modem using RS-232 interface.

The sensor array consists of three air pollutions sensors including Carbon Dioxide (CO2), Nitrogen Dioxide (NO2), and Sulfur Dioxide (SO2). The GPS module provides the physical coordinate location of the DAQ, time and date in National Marine Electronics Association (NMEA) format [11]. NEMA format includes the complete position, velocity, and time computed by a GPS receiver where the position is given in latitude and longitude. The Pollution-Server is an off-the-shelf standard personal computer. The Pollution-Server connects to a database management system (MySQL) through a local area network (LAN).

V. System Implementation And Result

The proposed system is implemented with four transmitter module (Node1, Node 2, Node 3 and Node 4) and one receiver module. After successful implementation of proposed system the following fig. shows the hardware device snapshot and the different results taken when the system is tested successfully. The results of system testing shows the different graphs showing the various levels of pollutant materials in the environment. There are four transmitter (Node1 Node2, Node3, Node4)having similar hardware architecture. The hardware module and graphs shown below:

5.1 HARDWARE MODULE:

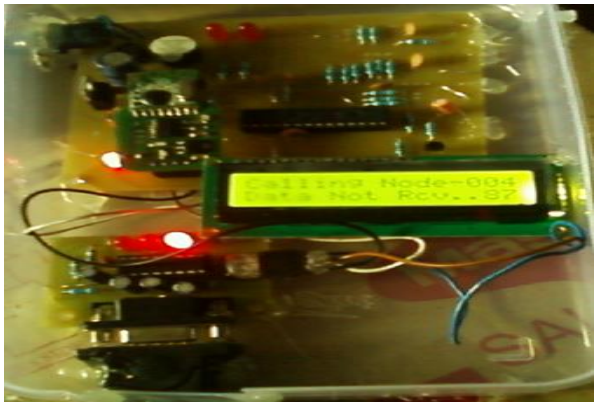

Fig. 4: Data Receiver Module

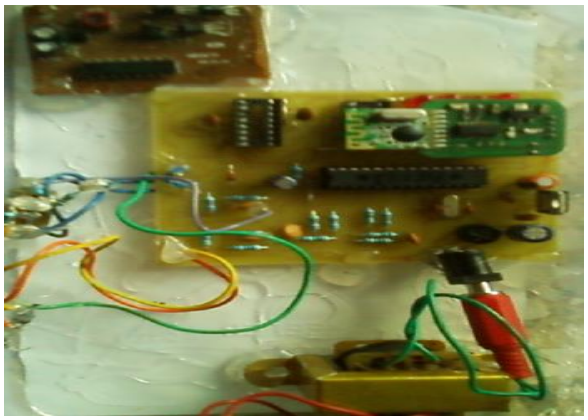

Fig. 5: Data Transmitter Module (Node 1)

5.1 RESULTS AND GRAPH:

Fig. 6: Data Monitoring Graph showing levels of NO2 for Node 1, 2, 3, and 4

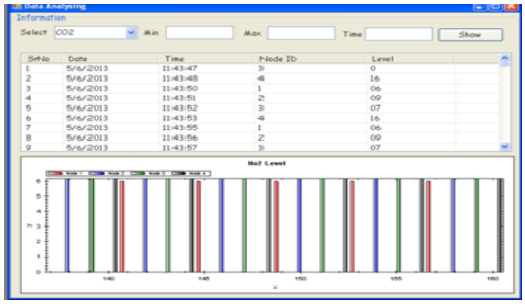

Fig. 7: Data Analyzing Graph showing pollution levels with Date and Time

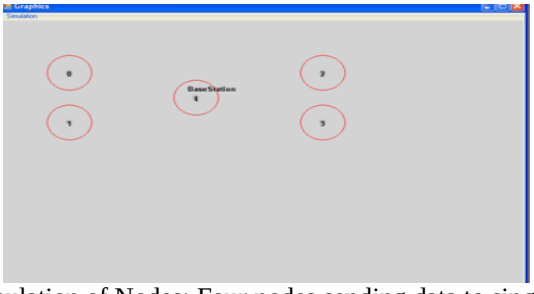

Fig. 8: Simulation of Nodes: Four nodes sending data to single receiver

VI. Conclusion

The main purpose of this paper is to provide an overview of urban air pollution monitoring application. Our work is enabled by ZigBee, pollution sensors and database sensors i.e. attached to pollution server for storing the pollutants levels for future usage by various clients for measuring pollutants in air accurately at short

intervals. The system measures air pollutant gases such as CO2, NO2, and SO2. This paper will give clear idea to move towards real time measuring in an urban area to ultimately improve quality of life on earth. Air pollution in the urban environment is a major threat to human health. As the global population is becoming more concentrated in urbanized areas, new ideas and approaches are needed to help maintain clean air that is safe for everyone to breathe. This study evaluated one such innovative approach.

VII. Acknowledgement

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References

[1] Hsu-Cheng Lu , Jen-Hao Liu , Joe-Air Jiang ; Tzai- Hung Wen , Chih-Hong Sun , Jehn-Yih Juang ,"Apllication Of A Reliable MAC Protocol For The Urban Air Quality Monitoring System Based On The Wireless Sensor Network", IEEE Conference, pp. 1-6, (March 2012)

[2] Khunarak, C., Lutz, M., Kerdcharoen, T., "Wi-Fi Electronic Nose For Indoor Air Monitoring" IEEE Conference, pp. 1-4, (May 2012)

[3] Chung-Chih Lin , Ren-Guey Lee , Shi-Ping Liu , " Wireless Sensing System For Prediction Indoor Air Quality", HSIC, IEEE Conference, pp. 1-3, (May 2012)

[4] Jong-Won Kwon, Yong-Man Park, Sang-Jun Koo, Hiesik Kim, "Design of Air Pollution Monitoring System Using ZigBee Networks for Ubiquitous-City", In Proceedings Of the 2007 International Conference on Convergence Information Technology, pp.1024-1031, (2007)

[5] Zhang Qian, Yang Xiang-Long, Zhou Yi-Ming, Wang Li-Ren, Guo Xi-Shan, " A Wireless Solution For Greenhouse MonitoringAnd Control System Based On Zigbee Technology", J. Zhejiang Univ Sci A, vol. 8, pp. 1584-1587, (2007)

[6] Kavi K. Khedo, Rajiv Perseedoss and Avinash Mungur, " A Wireless Sensor Network Air Pollution Monitoring System", International Journal of Wireless and Mobile Network (IJWMN), Vol. 2,No.2, (May 2010)

[7] A. R. Al-Ali,, Imran Zualkernan, and Fadi Aloul, "A Mobile GPRS-Sensors Array for Air Pollution Monitoring", IEEE Sensor Journal, Vol. 10, No. 10, (October 2011)

[8] Jong-Won Kwon*,Yong-Man Park, Sang-Jun Koo, Hiesik Kim, "Design of Air Pollution Monitoring System using ZigBeeNetworks for Ubiquitous-City", International Conference on Convergence Information Technology, (2007)

[9] Halit Eren, Ahmed Al-Ghamdi, Jinhua Luo, "Application of ZigBee for Pollution Monitoring Caused by Automobile Exhaust Gases", IEEE Sensors Applications Symposium New Orleans, LA, USA - February 17-19(2009)

[10] Han Zhi-gang, Cui Cai-hui, "The Application of Zigbee Based Wireless Sensor Network and GIS in the Air Pollution Monitoring", International Conference on Environmental Science and Information Application Technology, (2009)

[11] W. Chung and C. H. Yang, "Remote monitoring system with wireless sensors module for room environment," Sens. Actuators B, vol. 113 no. 1, pp. 35– 42,(2009)

[12] M. Predko, Programming and Customizing PICmicro Microcontrollers, Mc Graw Hill, (2002)

[13] P.N. Borza, C. Gerigan, P. Ogruţan, Ghe. Toacşe, Microcontrollers – Applications (in Romanian), Ed. Tehnică, Bucuresti, Romania, (2000)

[14] O. Hyncica, The ZigBee Experience.

[15] Y W Zhu,The Design of Wireless Sensor Network System Based on ZigBee Technology for Greenhouse, 2006 IOP Publishing Ltd, pp1195~1199

[16] ZigBee Alliance, ZigBee-Specification National Marine Electronics Association Data. [Online]. Available: http://www.gpsinformation.org/dale/nmea.htm

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