Design of Low Cost Real Time Indoor Environmental Air Pollution Measuring System using ZigBee

Yogesh Kumar Sharma[1] Himanshu Agarwal[2] A.K.D Dwivedi[3]
[1,2,3]Department of Electronics Engineering
[1,2,3]National Institute of Electronics and Information Technology Gorakhpur

Abstract— A real time indoor environmental air pollution measuring system which is cost efficient is sole aim of this paper presentation. Real time indoor air pollution measuring system measures the concentration of various gases in air at the particular time. Some of the indoor air pollutant is CO, CO2, NO2, Formaldehyde, O3 etc. Constant exposure to this pollutant over a long period causes harmful effect on human health. Effect of poor indoor air-quality on human-health is cough, lung disorder, liver and kidney disorder. Some pollutant like Asbestos, Radon can even cause cancer. Proposed measuring system contains a series of sensors, open source hardware Arduino board, a wireless sensor network based on ZigBee. The performance of system is checked in real-field.

Key words: Air Pollution Measuring System, ZigBee

I. INTRODUCTION

Pollution from power plants, industries, vehicles and other sources are a well-known contributor to outdoor air pollution, but our indoor air quality is often worse. It can be up to 10 times worse for us than the outside air. Microbial pollutants like mold, pet dander and plant pollen can combine with chemicals like radon and volatile organic compounds (VOCs) to create a pretty toxic environment in our home; since we spend an average of 90% of our time indoors and 65% of our time inside our homes, that can add up to allergies, asthma and even worse. Most of the population is residing in rural area and using cow-dung cake and wood for cooking food and burning of cow-dung and wood are potential source of carbon-monoxide (CO) and carbon-dioxide. Carbons monoxide (CO), carbon dioxide (CO2), dust and humidity are the main parameters that harm indoor air quality [1]. Everything that comes into our homes has the potential to harm our health; it includes things from the building materials and elements that are in our homes like furniture we sit on and the paint that goes on the walls. Adverse health effects from combustion of products range from mild effects to death. Carbon monoxide, a deadly gas, kills many people in India, as many households still using cow dung cakes and wood for cooking. During power outages, the indoor use of charcoal, gas grills or gas-powered generators can cause serious carbon monoxide poisoning and possibly lead to death of people in the home.

Enough amount of research is going on in the field of indoor air, to develop new applications and systems, which will help to keep indoor air quality as healthy as possible. But not enough data is available for the development of such system. In order to get availability of more and more data, there is need of more and more people can use such system. Hence there is need of low cost monitoring system, so that enough data available for researchers. Many employees working in offices faced the problem of headache, breathing problem, dry skin, and allergy due to poor indoor environment, so there is need of development of early alarming monitoring system [2].

Most of the monitoring systems available in market are working on the principle of place-to-place monitoring. So we need to take monitoring system to observation place, to collect the data and analyze the results. So there is need of building wireless sensor network for remote monitoring of indoor air simultaneously from different places.

II. INDOOR AIR QUALITY

Indoor air quality (IAQ) refers to the quality of air inside and area surrounding the buildings, especially as it relates to the health and comfort of building occupants. Gases (including carbon monoxide, radon, volatile organic compounds), particulates, microbial contaminants (mold, bacteria), or any mass or energy stressor that can induce adverse health conditions, can affect the IAQ.

Collection of air samples, monitoring human exposure to pollutants, collection of samples on building surfaces, and computer modelling of air flow inside buildings are some methods used for the determination of IAQ [3].

III. HARDWARE ARCHITECTURE

Indoor air quality monitoring involved capturing sensor values associated with indoor air quality by using different gas sensors. The system consists of processing unit, which is nothing but Arduino board. We used several nodes, which are nothing but sensor array connected to Arduino board along with XBEE, which is acting as router [4]. The various blocks of working system are given in Figure 1.

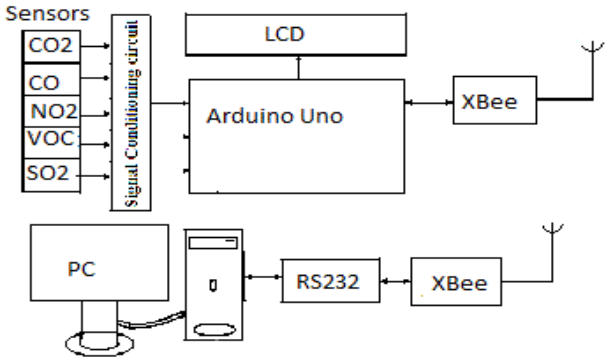

Fig. 1: Block Diagram of Indoor Air Pollution Monitoring System

Computer along with XBEE module forms coordinator. Coordinator acts as a base station that receives and transmits information to routers in wireless sensor network. Python based GUI is developed in computer, which is basic tool to operate IAQ monitoring system by user.

IV. ZIGBEE STANDARD

ZIGBEE supports protocols for defining a type of sensor network that controls applications used in residential and commercial settings such as air conditioning, heating and lighting. It harmonizes the application software layers specified by the ZIGBEE alliance and the IEEE 802.15 that defines the physical and MAC protocol layers [6].

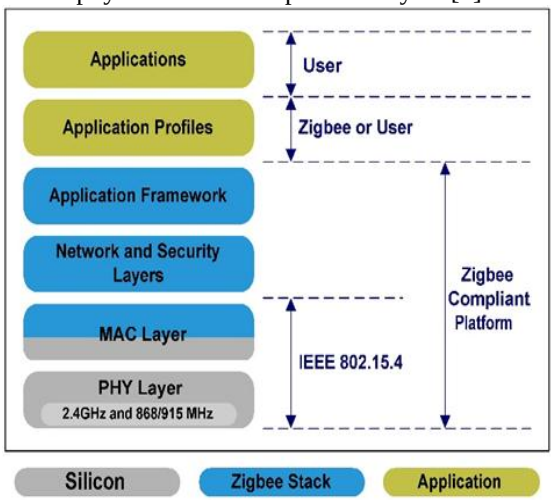

Fig. 2: ZigBee Architecture

V. AIR QUALITY INDEX

An air quality index (AQI) is a number used by government agencies to communicate to the public how polluted the air currently is. As the AQI increases, an increasingly large percentage of the population is likely to experience increasingly severe adverse health effects. Different countries have their own air quality indices, corresponding to different national air quality standards. Some of these are Air Quality Health Index (Canada), Air Pollution Index (Malaysia), and Pollutant Standards Index (Singapore), Air Quality Index (India) [7].

Computation of the AQI requires an air pollutant concentration over a specified averaging period, obtained from an air monitor or model. Taken together, concentration and time represent the dose of the air pollutant. Health effects corresponding to a given dose are established by epidemiological research [4]. Air pollutants vary in potency, and the function used to convert from air pollutant concentration to AQI varies by pollutant. Air quality index values are typically grouped into ranges. Each range is assigned a descriptor, a color code, and a standardized public health advisory. The Ministry for Environment, Forests & Climate Change launched The National Air Quality Index (AQI) in New Delhi under the 'SWACHH BHARAT ABHIYAN'. It is outlined as 'ONE NUMBER, ONE COLOUR, ONE DESCRIPTION' for the common man to judge the air quality within his vicinity.

AQI	Associated Health Impacts
Good(0-50)	Minimal impact
Satisfactory (51-100)	May cause minor breathing discomfort to sensitive people.
Moderately polluted (101–200)	May cause breathing discomfort to people with lung disease such as asthma, and discomfort to people with heart disease, children and older adults.
Poor (201-300)	May cause breathing discomfort to people on prolonged exposure, and discomfort to people with heart disease.
Very poor (301-400)	May cause respiratory illness to the people on prolonged exposure. Effect may be more pronounced in people with lung and heart diseases.
Severe (401-500)	May cause respiratory impact even on healthy people, and serious health impacts on people with lung/heart disease. The health impacts may be experienced even during light physical activity.

Table 1: Air Quality Index

VI. CONCLUSION

The main propose of wireless air pollution monitoring system is to provides real-time information about the level of air pollution in the building and surrounding area, as well as provides alerts in cases of drastic change in quality of air. This information can then be used by the authorities to take prompt actions such as evacuating people or sending emergency response team. The system measures air pollutant gases such as CO, NO2, and SO2. This paper will give clear idea to move towards real time measuring in a building or college premise to ultimately improve quality of life on earth.

ACKNOWLEDGEMENT

The author gratefully acknowledges the suggestions of Dr. A. K. D. Dwivedi, Director of NIELIT Gorakhpur and Er. Vikas Upadhyay, Project Engineer at NIELIT Gorakhpur. The author is grateful for their comments and suggestions that encouraged the author to revise and improve the article.

REFERENCES

[1] http://www.epa.gov/iaq/ia-intro.html#Causes
[2] http://www.bcairquality.ca/
[3] Duflo E, Greenstone M, Hanna R (2008). "India air pollution, health and economic wellbeing" (http://sapiens.revues.org/index130.html). *S.A.P.I.EN.S* 1 (1).
[4] Arduino Uno R3: https://www.sparkfun.com/products/11021
[5] Pillai, M.A. "CAN based smart sensor network for indoor air quality monitoring", Computer Science and Information Technology (ICCSIT), 2010
[6] Xbee ProS2B Module Manual. [Online] http://ftp1.digi.com/support/documentation/90000976_K.pdf
[7] http://airquality.weather.gov/

