



Review Paper on Smart Sensor Network for Air Quality Monitoring

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Abstract— *Green and clean environment across the globe is very much essential for the health of the nature. Unfortunately different kinds of pollutions are affecting the quality of the environment around us. This review paper is mainly dealing with “Air pollution”, which is a very sensitive issue in developing and developed countries and is directly affecting the human health and disturbs the biological balance of mother earth. Here our aim is to develop a system which will detect maximum air pollutants and which is highly responsive, accurate and low cost and low power consuming.*

Keywords— *Semiconductor sensors, IEEE 802.15.4 standard, Microcontroller, Lab VIEW (GUI)*

I. INTRODUCTION

Pollution is the introduction of impurity into the natural environment that causes adverse change in the environment around us. Pollution can take the form of chemical substances such as solid particles, liquid droplets, or gas [1] and energy such as noise, heat, light. The different kinds of pollutions are air pollution, water pollution, noise pollution or may be soil pollution.

Air pollution comes from both natural and human-made sources. However, globally human-made pollutants from ignition, construction, mining, agriculture and warfare and industrialization are increasingly significant in the air pollution equation. An air pollutant is a substance in the air that can have adverse effects on humans and the ecological community. So there is increasing demand for detection and monitoring of green house gases because of rise in polluted gases [2].

But in this paper our objective is to deal with the air pollution and we will concentrate on Indoor air pollution because it is major environmental risk to health [3]. So proposed system meets all the requirements for pollution monitoring. It measures and records concentration of different polluted gases such as CO, CO₂, LPG along with Temperature. Additionally it detects quality of the air and dust particles in the air.

II. PARAMETERS AFFECTING ENVIRONMENT

By the ever growing awareness of GREEN EARTH since last few decades, it has been brought to the notice that human activities are mainly responsible for all kind of air pollutions. Apart from industrial and automobile pollution, the big buildings are also have a largest SHARE OF PIE in polluting the environment and consumption [4]. India being a developing nation and the energy required for economic growth is imported in majority; the situation here is under great distress due to kind of increasing pollution on day to day basis.

III. INDOOR AIR POLLUTION

Indoor air pollution issue need to be handled very carefully as it is greatly concentrated with pollutants than outdoor air. There are many causes of indoor air pollution. Indoor air pollution has a reasonable impact on developing countries than it does on developed ones because fuel, such as wood, coal and animal dung, is burned inside homes for cooking and heating. Rarely there is proper ventilation to allow the pollutants to escape, so residents of these homes end up breathing in carbon monoxide and other dangerous contaminants [5]. Indoor air pollutants from indoor fuel burning lead to serious human health problems, such as pneumonia, bronchitis, cancer, heart disease and asthma [6]. In developed countries most dangerous indoor air pollutant is tobacco smoke. Second hand smoke can cause many of the similar health problems as directly inhaling from cigarettes - things like lung cancer, short of breath and heart disease [5].

IV. AIR QUALITY

Good air quality refers to clean and clear air. Fresh air is essential to maintain the delicate balance of life cycle on this planet. The health impacts may be experienced by AIR QUALITY INDEX (AQI). There are six AQI categories, namely Good, Satisfactory, Moderately polluted, Poor, Very Poor, and Severe. The proposed AQI will consider different pollutants for some average period and from that quality of the air can be analysed [7].

V. CAUSES OF GREEN HOUSE GASES

A number of industrial processes, human activities and consumptions produce waste gases or greenhouse gases which are harmful to the environment.

It includes:

1. Generation of electricity by thermal means: Power sector
2. Construction and manufacturing industries
3. Chemical processes
4. Burning of fuel by automobiles
5. Solid waste disposal
6. Waste water handling
7. Burning of solid fuels and natural gas

The harmful effects of air pollution on public health are:

1. Respiratory illness
2. Cardiovascular illness
3. Skin irritation
4. Cancer risk
5. Headache

VI. GENERAL BLOCK DIAGRAM

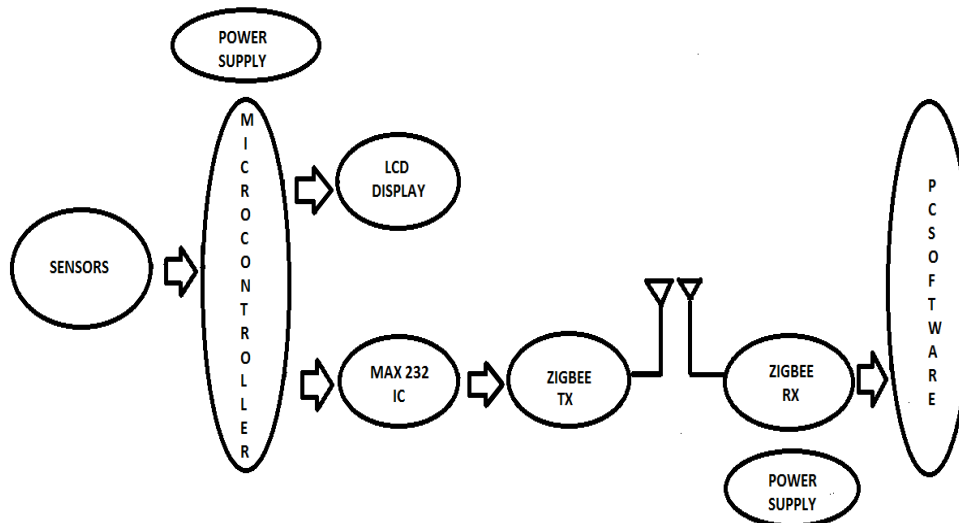


Fig.1 General Block diagram

A. Sensor

Here we are using gas sensors and particle pollution sensors to detect various kinds of pollutants. A gas sensor is transducer that detects gas molecules and produces an electrical signal with a magnitude proportional to the concentration of the gas. Modern semiconductor gas sensors are capable of detecting different gases. They have many advantages such as longer lifetime, lower cost and compact size. They are used for indoor and outdoor air quality monitoring. Sensors are the main components of the system normally known as sensor array [8].

B. Pic microcontroller

For controlling different functions such as A to D conversion, mathematical calculations, calibration and for display purpose microcontroller is used. LCD display is used for display of numeric and alphanumeric characters. We can observe the concentration of different gases on LCD. For level conversion between microcontroller and Zig-Bee module Max IC 232 is used. C programming language can be used for data transfer. Information on PIC microcontroller found in [9] and its coding functions highlighted in [10].

C. Microcontroller features used:

- We are using PIC16f877A microcontroller from microchip.
- It is having 4 IO Ports PORTA, PORTB, PORTC and PORTD for interfacing peripheral devices.
- PORTA is having internal ADC. We connect our sensors to this port in order to convert their output in digital format.
- PORTB is used for LCD display data lines and PORTD pins 7 and 8 are used as “Read/Write”(R/W) and “Enable”(E) for LCD.
- PORTD is having different multipurpose pins such as UART TX AND RX.
- These pins are used for communication with Zig-Bee Module.
- ADC is having resolution of 10 bits.
- UART Baud Rate used is 9600 bits/second.
- We are also using MAX232 IC for voltage level Conversion between microcontroller and Zigbee module.
- PORTC pins are used for interfacing LED indicators.

D. Zig-Bee communication module

Wireless technology developed as an open global standard to address the unique needs of low cost, low power wireless network with low bandwidth requirement is nothing but Zig-Bee. It operates on IEEE 802.15.4 standard.

IEEE 802.15.4 features:

- 802.15.4 is a single packet data protocol for lightweight wireless networks.
- Multilevel security
- Star or peer to peer operation.
- Flexible protocol design suitable for many applications.

The physical layer specifies the operation at 2.4 GHz ISM band worldwide to offer transmission data rate of 250 kbps. Physical range of Zig-Bee is approximately (10 to 20 mt). Zig-Bee is often used in industrial automation and physical plant operation [11].

E. Labview software

LabVIEW is a highly productive development environment for creating custom applications that interact with real world data or signals in the field of science and engineering. Lab view – short for laboratory virtual instrument engineering workbench, is a design environment in which you create programs using a graphical notation. LabVIEW offers more adjustability than standard laboratory instruments because it is software-based. Because of LabVIEW's graphical nature, it is naturally a data presentation package. Output appears in any form you desire. Charts, graphs, and user-defined graphics compose just a fraction of available output options. Information on LabVIEW can be found in [12].

F. Mathematical modelling of sensors

- To find out relation between input voltage and result, we need to derive equations starting from the sensor.
- The Gas Sensor is an environmental sensor. Its Resistance changes with the change in environmental quantities. i.e. Gas in this case.
- We have connected it in series with a Resistor to make a voltage divider. Following diagram shows the circuit.

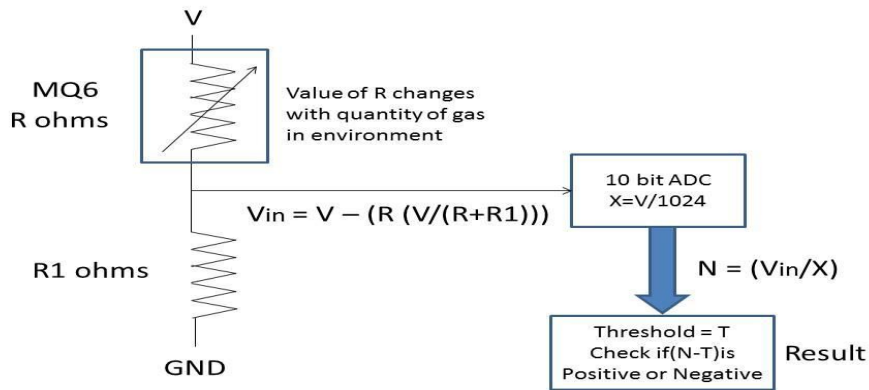


Fig.2 Mathematical modelling of sensor

- Let 'R' be the resistance of the Gas sensor, changing according to the quantity of gas is surrounding air measured in ppm.
- Let 'R1' be the resistance in series to make a resistor divider.
- The output Voltage of this resistor divider network will be $V_{in} = V_{max} \left(\frac{R}{R + R1} \right)$
- This voltage V_{in} is provided to the ADC module to convert it to digital value.
- ADC module is having resolution of 10 bits. Hence when voltage of V_{max} is given at the input of ADC module, it will have output of 1024 and output of 0 for 0 volts.
- To Calculate "volts per increment" X, we use $X = V_{max} / 1024$
- To calculate total increment for input voltage of V_{in} volts, we use $N = (V_{in} / X)$

G. Calibration

Calibration is the process of establishing a relation between two quantities out of which one is standard and other is measured by the instrument or system or any device.

- Calibration is to convert the input voltage from sensor in human understandable and comparable form.
- To convert V_{in} into integer value we use above formula.
- After converting into integer value we need to compare it with a threshold value to decide whether it is more than dangerous limits or not.
- So we decide a practically calculated threshold for each sensor. The threshold value can vary according to environment.
- The integer value calculated using ADC is compared with the threshold for that sensor and final result is decided.

H. Sensors for pollution detection

1. Air quality sensor
2. Carbon monoxide gas sensor
3. Carbon dioxide gas sensor
4. Dust particle sensor
5. LPG detector sensor
6. Temperature sensor

VII. PREVENTING AIR POLLUTION

The root cause of indoor air pollution is excessive use of fossil fuels, LPG, kerosene and home appliances like air conditioner, refrigerator and pollutants those emitted from domestic cleaning products and plastics. Further Smoking adds to a larger extent to the indoor air pollution. External pollutants such as emissions from cars and buildings that seep in through doors and windows add to the indoor air pollution. By efficient use of appliances and by proper ventilation we can lower the pollution.

VIII. OBJECTIVE OF THIS STUDY AND PROPOSAL

The air pollution is having numerous ill effects on human beings as well as the complete biological system on the earth. Reducing all kind of emissions that cause poor air quality and degrade the ambient environment around us requires teamwork. We are trying to develop a system which can detect all kind of air pollutants and is more advantageous compare to other available systems as per the following table.

TABLE I

Parameter	Semiconductor sensors	Other sensors
Energy efficiency	Power requirement is low	Power requirement is high
cost	Less expensive	Expensive
Detection of gases	Detects variety of gases	Detects less number of gases

IX. CONCLUSION

It is evident from the study that no technology or mechanism is available to control the pollution as it is completely related to erratic human behaviour. We can develop the instrument to measure the air pollution around us, but in order to control air pollution it is important that people understand their responsibilities towards protecting mother earth.

Plantation on mass scale can reduce air pollution. Sparing use of energy and fuels will also reduce the pollution drastically. More and more awareness programs should be conducted in the society, so as to educate people and make them understand the causes and consequences of air pollution, and make them realize the importance of prevention of air pollution. This is the need of the hour.

REWARDS OF THE STUDY

The rewards of addressing air pollution include improved human health, increased productivity and reduced health costs and a healthier, more productive environment. The use of Air cleaners can reduce the air pollution to considerable amount.

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