A TECHNICAL REVIEW ON DESIGN OF AIR-POLLUTION MONITORING SYSTEM USING ZIGBEE

Saurav Kumar Bariyar[1], Snigdha Kumari[2], Vikas Ritu Raj[3], Hariom[4]

Raj Kapoor Kumar Gaund[5]

[1,2,3,4] *Student, Electronics & Communication Engineering Department IIMT College of Engineering, Gr.Noida, (India)*

[5] *Assistant Professor, Electronics & Communication Engineering Department,*

IIMT College of Engineering, Gr.Noida, (India)

ABSTRACT

The objective of this paper is to design and develop a wireless system for monitoring the air pollution using ZIGBEE technology and Embedded System. It focuses on implementation of air pollution monitoring system. Each sensor was tested after survey about market trends of a variety of sensors for detecting air pollution. For wireless communication, we used XBEE or ZIGBEE modules. ZIGBEE wireless sensor network (WSN) is constructed for continuously monitoring and transmission of data. One module is coordinator and other is receiver. Coordinator is connected with gas sensors via 8051 microcontroller. A gas sensor is a transducer that detects gas molecules and produces an electrical signal with a magnitude proportional to the concentration of the gas. These sensors give the information of air pollution to microcontroller and microcontroller will send that data to a remote location with the help of ZIGBEE module. The receiver is connected with a LCD via AT89S52 microcontroller. It will receive data from the coordinator and display in the LCD. Finally, integrated wireless sensor board which employs CO sensor, combustible gas sensor, smoke sensor, Temperature sensor and humidity sensor using 8051 microcontroller and ZIGBEE was developed. The performance of this module was tested at different places.

OBJECTIVE

The objective of this paper is to design, develop and test a 8051 microcontroller and ZIGBEE Technology based system to monitor the air pollution. For wireless communication we used ZIGBEE modules. ZIGBEE wireless sensor network (WSN) is constructed for continuously monitoring the quality of air. This dissertation develops the building and optimizing technology of the wireless sensor network based on ZIGBEE. Intelligent node of wireless sensor network with functions such as signal acquisition, data processing and data transmission is developed. The receiver is connected with LCD for display the data. The main features of the project are following:

1. It is AT89S52 microcontroller based air pollution monitoring system
2. For monitoring the air pollution, Temperature sensors –PT100, Hydrogen or LPG sensor – MQ-5, Smoke Sensor – MQ-2, Carbon mono oxide- MQ-7, Humidity sensor – HR202 are used.

3. ZIGBEE modules (XB24-AWI-001) are used for wireless data transmission.

4. Transmission range is 30m.

5. Operating frequency of ZIGBEE is 2.4 GHz frequency.

6. Maximum data rate < 250kbps.

I. INTRODUCTION

Air is the mixture of gases in the Earth, which forms an envelope around the Earth. These gases are present in a certain fixed proportions.

Figure 1 Air Pollution

If some pollutant is introduced in air which causes undesirable change in the composition of air, we say that it is Air pollution. Mainly increase in vehicles and deforestation is responsible for this. Most Harmful effects of air pollution are acid rain and global warming. Air pollution is normally defined as the contamination of the oxygen and atmosphere around us. Air pollution occurs when the air contains gases, dust, fumes, chemicals, biological materials or odour in harmful amounts. That is, amounts which could be harmful to the health or comfort of humans and animals or which could cause damage to plants and materials. The substances that cause air pollution are called pollutants. The atmosphere is a complex dynamic natural gaseous system that is essential to support life on planet Earth. Stratospheric ozone depletion due to air pollution has long been recognized as a threat to human health as well as to the Earth's ecosystems. The concentration of gases in dry air is shown in table 1.

TABLE-1 The Concentration of Gases in Dry Air

Name of Gas	%	Parts per million by volume(ppmv)
Nitrogen(N_2)	78.083 %	780830 ppmv
Oxygen(O_2)	20.945%	209450 ppmv
Argon(Ar)	0. 93%	9340 ppmv
Carbon Dioxide(CO_2)	0.039%	390 ppmv
Neon(Ne)	0.0018%	18.18 ppmv
Helium(He)	0.00052%	5.24 ppmv
Krypton(Kr)	0.000114%	1.14 ppmv
Carbon mono oxide(CO)	0.00001%	0.1 ppmv
Nitrogen di oxide(NO_2)	0.000002%	0.02 ppmv

At present, CO, Smoke, Hydrogen, temperature and humidity are the important parameters for many places, such as warehouses, greenhouses, hospitals, food storages and many other places. ZIGBEE is very suitable for long term monitoring in warehouses, hospital area, environment monitoring and some home application because of the low cost and low power requirement. A manually monitoring system consumes lots of human and material resources. In view of this situation, the air pollution monitoring system based on ZIGBEE technology is designed. The ZIGBEE technique including the IEEE802.15.4 standards is a newly-developing wireless network communications technology. It can cover a wide range and make system more easily extended, high stability, and good maintainability.

Jong-Won Kwon and Yong-Man Park proposed a Design of Air Pollution Monitoring System Using ZIGBEE Networks in 2007,[1]. They focuses on implementation of air pollution monitoring system. They use only Temperature & Humidity Sensor, CO_2 Sensor and Dust Sensor for detecting air pollution. Wireless communication modules for monitoring system were developed using wireless sensor networks technologies based on ZIGBEE. And then a performance of modules was estimated in the real-fields. Through software programs written in nesC for efficient routing in wireless networks were simulated using TOSSIM simulator. Finally, integrated wireless sensor board which employs dust, CO2, temperature/humidity sensor and a ZIGBEE module was developed.

Lin Ke, Huang Ting-Lei and Li Lifang proposed a "Temperature and Humidity Monitoring System" in 2009 .[2]. It was designed for monitoring the storage places for food and medicines. It was a design of wireless monitoring system based on ZIGBEE for temperature and humidity. The system consists of terminal nodes, central node and personal computer. Compared with the traditional methods, this system can work continuously in the monitored area because of its lower power and low complexity characteristics in the hardware design. Test result indicates the system can be placed easily and flexibly, this not only conveniences the user with no wiring work, but also improve the accuracy and reliability of the data.

Al-Ali, A.R. Zualkernan presented an air pollution monitoring system.[3]. An online GPRS-Sensors Array for air pollution monitoring has been designed, implemented and tested. The proposed system consists of a Mobile Data-Acquisition Unit (Mobile-DAQ) and a fixed Internet-Enabled Pollution Monitoring Server (Pollution-Server). The Mobile-DAQ unit integrates a single-chip microcontroller, air pollution sensors array, a General Packet Radio Service Modem (GPRS-Modem) and a Global Positioning System Module (GPS-Module). The Pollution-Server is a high-end personal computer application server with Internet connectivity. The Mobile-DAQ unit gathers air pollutants levels (CO, NO2, and SO2) and packs them in a frame with the GPS physical location, time, and date. The frame is subsequently uploaded to the GPRS-Modem and transmitted to the Pollution-Server via the public mobile network. A database server is attached to the Pollution-Server for storing the pollutants level for further usage by various clients such as environment protection agencies, vehicles registration authorities, and tourist and insurance companies.

Tsujita, W. Kaneko, S. Ueda, T. Ishida, H. Moriizumi, T proposed an air pollution monitoring system. [4]. Metropolitan cities in the world have long been suffering from serious air pollution problems. In Tokyo, the high levels of nitrogen oxides and ozone resulting from heavy traffic emission are of the greatest concern.

However, the cost and size of the chemical analyzers have limited the number of environmental monitoring stations and, therefore, have resulted in insufficient spatial resolution in the measurement of pollutant distributions. The authors have been proposing a gas distribution analyzing system (GASDAS). The use of gas sensors enables compact and inexpensive sensing systems and will lead to a significant increase in the density of monitoring sites. As a first step in the development of GASDAS, nitrogen dioxide and ozone monitoring systems have been developed. The experimental results have shown that the low-cost sensor systems with signal compensation features for the change in weather conditions can be used for the quantitative measurement of spatial pollutant distributions.

Caldararu F., Vasile A., Caldararu M., presented an air pollution monitoring system. The measurement concentration range of SnO_2 semiconductor sensors for toxic and flammable gases (TGS) was extended for use in air pollution monitoring[5]. A real time autonomous system for air pollution monitoring (NH_3, CO, R113 and R22 freons) using TGS sensors and an 80C552 INTEL microcontroller for data acquisition and management was tested. The air pollution concentrations measured in the industrial and residential areas of Bucharest fulfil the Romanian air pollution standards requirements as well as the US EPA ones. A simulator (SIMPA) for real time air pollution measurements was developed for the environment protection laboratories of scientific and technical universities.

Kularatna, N.; Sudantha, B.H proposed an air pollution monitoring system.[7]. An Environmental Air Pollution Monitoring System (EAPMS) for monitoring the concentrations of major air pollutant gases has been developed, complying with the IEEE 1451.2 standard. This system measures concentrations of gases such as CO, NO_2, SO_2, and O_3 using semiconductor sensors. The smart transducer interface module (STIM) was implemented using the analog devices' ADuC812 microcontroller. Network Capable Application Processor (NCAP) was developed using a personal computer and connected to the STIM via the transducer independent interface. Three gas sensors were calibrated using the standard calibration methods. Gas concentration levels and information regarding the STIM can be seen on the graphical user interface of the NCAP. Further, the EAPMS is capable of warning when the pollutant levels exceed predetermined maxima and the system can be developed into a low cost version for developing countries.

This paper describes implementation of the air pollution monitoring system using ZIGBEE technologies and embedded system. The proposed project titled, "Air Pollution Monitoring System using ZIGBEE technology" has been designed to monitor five crucial environmental factors of the air i.e. humidity, temperature, carbon-mono-oxide, smoke and combustible gases. The measured values are transmitted to a distant receiver by means of ZIGBEE wireless sensor network (ZWSN). The air pollution monitoring system uses ZIGBEE wireless technology to transfer vital information of gas content to the receiver. The complete hardware is divided into two different module:

- Coordinator Module
- Receiver Module

II. COORDINATOR MODULE

The Coordinator module will be carried by the user and consist of following components:

❖ Power Supply

❖ Microcontroller Unit

❖ X-BEE Module

❖ ADC-0808

❖ Sensors

❖ LCD Display

The coordinator device consists of power supply which provide 5V DC to all the sensors, LCD, ADC and MCU. The power supply is divided into two parallel connections because one 7805 IC cannot drive the whole circuit. The power supply also includes a 3.5V DC battery for ZIGBEE module. The temperature, humidity and gas sensors give analog output proportional to their content in air. This analog output is feed to microcontroller which converts this analog signal into digital data using ADC. A 8 channel ADC-0808 is used in this circuit. Now this digital data produced is send to ZIGBEE module for transmission using ZIGBEE protocol at 2.4 GHz. This data is also displayed in the LCD for testing purpose only. The detailed block diagram is given in figure 2
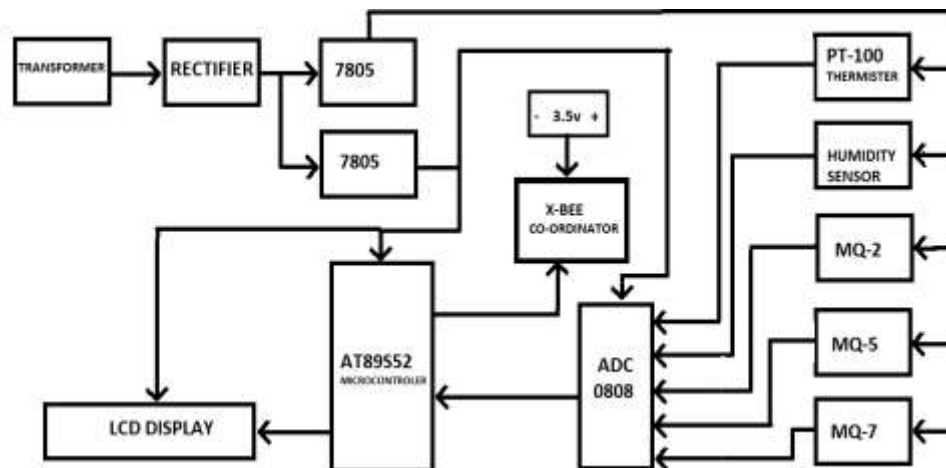

Figure 2 Block Diagram of Coordinator Module.

III. RECEIVER DEVICE

The receiver module is used to receive the data being transmitted by coordinator section via X-BEE unit. The LCD is placed for displaying the data, all the parameters will be displayed on it. The power consumed by the LCD is the main power consumer. The power consumption by other units is very less. The main units of receiver module are:

❖ Power Supply

❖ Microcontroller

❖ X-BEE Modules

❖ LCD Display

❖ Keyboard

The receiver device consist of power supply made up of batteries which produce 3.3V for ZIGBEE module and 5V for MCU and LCD. The ZIGBEE module receives digital data from coordinator device and transfer it to microcontroller serially. The microcontroller is interfaced with keyboard. There is a key dedicated for every sensor. When we press any key, the data of corresponding sensor is displayed into the LCD. The detailed block diagram is given in figure 3.
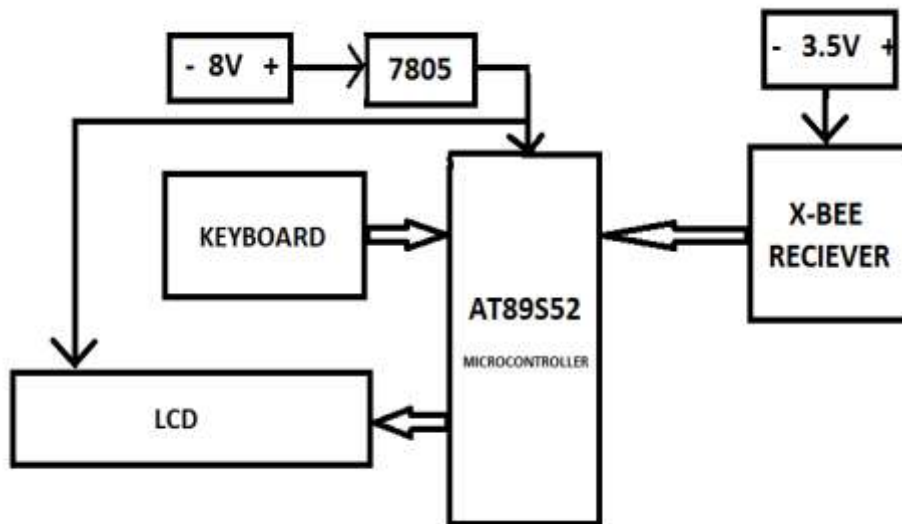

Figure 3 Block diagram of Receiver module.

IV. SELECTION OF COMPONENTS

The selection of components is described below:

4.1 Power Supply

Power supply unit is the heart of any hardware project. Its purpose is to provide regulated power to the circuit as shown in figure 4. In the proposed project, power supply of 5V has been designed in one single circuit.
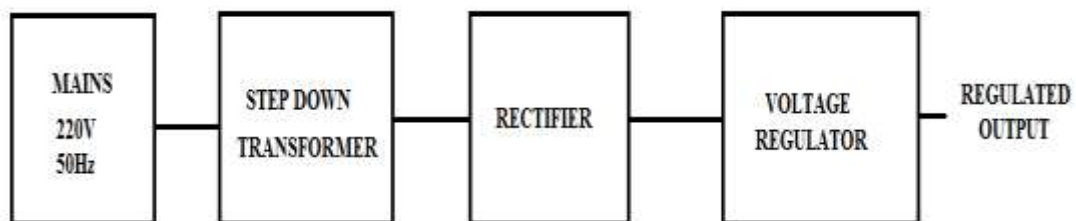

Figure 4 Basic Block Diagram of Power Supply

The primary of the transformer is fed with AC mains of 220V and 50Hz frequency. It then steps down 220V to 12V. The detailed Circuit diagram is given in figure 5. The rectifier then converts the AC into pulsating DC. A capacitor of high value capacitance can be used optionally to filter out the ripples in the rectified output. The function of the 7805 voltage regulator is to provide regulated DC of constant 5V voltage. Power supply of 5V is required for microcontroller, LCD, ADC, Temperature, Humidity and gas sensors.
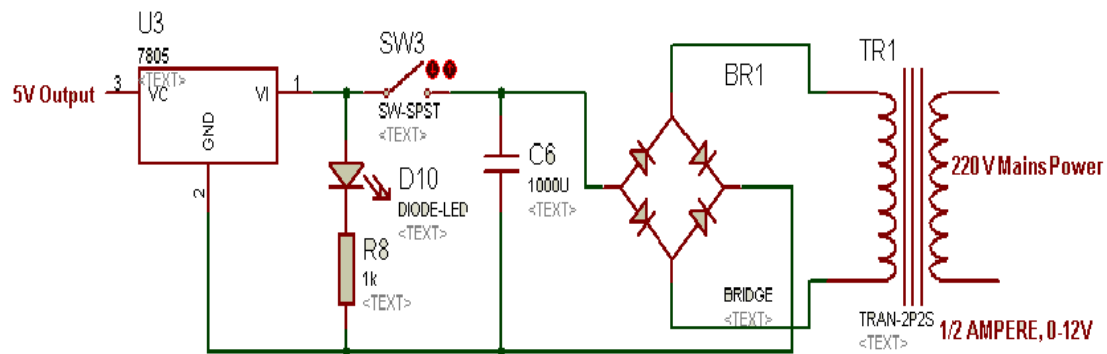
Figure 5 Circuit Diagram to Realize 12V and 5V Power Supply

4.2 Atmel's AT89S52

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory[17]. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional non-volatile memory programmer. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications. The AT89S52 provides the following standard features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, three 16-bit timer/counters, a six-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. In addition, the AT89S52 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes.[18]

4.3 LCD Display

One of the most common devices attached to an 8051 is an LCD display. Some of the most common LCDs connected to the 8051 are 16x2 and 20x2 displays[44]. This means 16 characters per line by 2 lines and 20 characters per line by 2 lines, respectively. In recent years the LCD is finding widespread use replacing LED's. This is due to the following reasons- Declining prices, ability to display numbers, characters and graphics, Incorporation of a refreshing controller into the LCD and ease of programming.

Figure 6   LCD 16x2

4.4 MQ-2 Smoke Sensor

The sensor's conductivity is more higher along with the smoke concentration rising [19]. It use a simple electrocircuit, Convert change of conductivity to correspond output signal of smoke. MQ-2 gas sensor has high

sensity to smoke, fire, cooking fumes and cigarette smoke. it is with low cost and suitable for different application.

4.5 MQ-5 Gas Sensor

MQ-5 Semiconductor Sensor for Combustible Gas Sensitive material of MQ-5 gas sensor is SnO2, which with lower conductivity in clean air [20]. When the target combustible gas exist, The sensor's conductivity is more higher along with the gas concentration rising. It is based on a simple electrocircuit, Convert change of conductivity to correspond output signal of gas concentration. MQ-5 gas sensor has high sensity to LPG, Propane and Hydrogen, also could be used to Methane and other combustible steam, it is with low cost and suitable for different application.

4.6 MQ-7 Gas Sensor

They are used in gas detecting equipment for carbon monoxide(CO) in industry or Traffic.[21]

4.2.8 Resistance Temperature Detector(RTD) - PT100

Resistance Temperature Detectors (RTDs) are temperature sensors that contain a resistor that changes resistance value as its temperature changes. A resistance temperature detector operates on the principle of the change in electrical resistance in wire as a function of temperature.

Figure 4.18 Resistance Temperature Detectors - PT100

They have been used for many years to measure temperature in laboratory and industrial processes and have developed a reputation for accuracy, repeatability, and stability. PT100 is used in this project as shown in figure 7. They are all types of RTD (Resistance Temperature Detector) sensor that are made from Platinum. The Pt100 sensor has a resistance of 100 ohms at 0°C and is by far the most common type of RTD sensor [48]. Thin film Pt100 elements are manufactured using materials and processes similar to those employed in the manufacture of integrated circuits. A platinum film is deposited onto a ceramic substrate which is then encapsulated as shown in figure 8. This method allows for the production of small, fast response, accurate sensors.

"F" Series Thin Film Element

Figure 8. Thin Film PT100 Resistance Temperature Detector

V. HUMIDITY SENSOR HR202

Humidity is a term for the amount of water vapor in air, and can refer to any one of several measurements of humidity. Formally, humid air is not "moist air" but a mixture of air and water vapor and humidity is defined in terms of the water content of this mixture, called the *Absolute humidity*. In everyday usage, it commonly refers to *relative humidity*, expressed as a percent in weather forecasts and on household humidistats; it is so called because it measures the current absolute humidity relative to the maximum.

Figure 9.   Humidity Sensor HR202.

HR202 is a new kind of humidity-sensitive resistor made from organic macromolecule materials as shown in figure 4.22. It can be used in occasions like: hospitals, storage, workshop, textile industry, tobaccos, pharmaceutical field, meteorology, etc.

5.1 ADC-0808

The ADC0808, ADC0809 data acquisition component is a monolithic CMOS device with an 8-bit analog-to-digital converter, 8-channel multiplexer and microprocessor compatible control logic as shown in figure 4.24. The 8-bit A/D converter uses successive approximation as the conversion technique. The converter features a high impedance chopper stabilized comparator, a 256R voltage divider with analog switch tree and a successive approximation register. The 8-channel multiplexer can directly access any of 8-single-ended analog signals. The device eliminates the need for external zero and full-scale adjustments. Easy interfacing to microprocessors is provided by the latched and decoded multiplexer address inputs and latched TTL TRI-STATE outputs. The design of the ADC0808, ADC0809 has been optimized by incorporating the most desirable aspects of several A/D conversion techniques. The ADC0808, ADC0809 offers high speed, high accuracy, minimal temperature dependence, excellent long-term accuracy and repeatability, and consumes minimal power. These features make this device ideally suited to applications from process and machine control to consumer and automotive applications.

5.2 XBee/XBee-PRO OEM RF Modules

The XBee and XBee-PRO OEM RF Modules were engineered to meet IEEE 802.15.4 standards and support the unique needs of low-cost, low-power wireless sensor networks. The modules require minimal power and provide reliable delivery of data between devices. [22]

Figure 10 X-BEE Chip

The modules operate within the ISM 2.4 GHz frequency and are pin-for-pin compatible with each other. ZIGBEE is an open technology developed by the ZIGBEE Alliance to overcome the limitations of BLUETOOTH and Wi-Fi. ZIGBEE is an IEEE 802.15.4 standard for data communications with business and consumer devices. It is designed around low-power consumption allowing batteries to essentially last forever. BLUETOOTH as we know was developed to replace wires and Wi-Fi to achieve higher data transfer rate, as such till now nothing has been developed for sensor networking and control machines which require longer battery life and continuous working without human intervention. ZIGBEE devices allow batteries to last up to years using primary cells (low cost) without any chargers (low cost and easy installation). The ZIGBEE standard provides network, security, and application support services operating on topof the IEEE 802.15.4 Medium Access Control (MAC) and Physical Layer (PHY) wireless standard. It employs a suite of technologies to enable scalable, self-organizing, self-healing networks that canmanage various data traffic patterns. The network layer supports various topologies such star,clustered tree topology and self-healing mesh topology which is essential in Smartdust apart from easy installation and easy implementation ZIGBEE has a wide application area such ashome networking, industrial networking, Smartdust, many more, having different profiles specified for each field. The upcoming of ZIGBEE will revolutionize the home networking and rest of the wireless world.

5.3 Specifications of XBEE

XBEE is the latest module in the market. It can be easily configured by user with the software X-CTU. Specifications of XBEE is given in table 2

Table 2 Specifications of XBEE[40]

Specifications	XBEE
Indoor/Urban Range	Up to 100 ft.
Outdoor RF line-of-sight Range	Up to 300 ft.
Transmit Power Output	1mW (0 dBm)
RF Data Rate	250 Kbps
Serial Interface Data Rate	1200-115200 bps
Receiver Sensitivity	-92 dBm
Supply Voltage	2.8-3.4 V
Transmit Current	45mA (@3.3 V)
Idle/Receive Current	50mA (@3.3 V)
Operating Frequency	ISM 2.4 GHz
Operating Temperature	-40 to 85 C
Antenna Option	Integrated Whip, chip or UFL Connector
Supported Network Topology	Point to point, Point to multipoint & Peer to peer
Number of Channels	16 Direct Sequence Channels
Addressing options	PAN ID, Channel and Addresses

VI. RESULT AND ANALYSIS

The complete prototype was developed and tested under different conditions at different places and different distance ranges. Five sensors gives their analog data to ADC. Then ADC gives digital data to microcontroller for transmission through XBEE Coordinator. Five different parameters were calculated and transmitted over XBEE modules. These parameters are as follows:

❖ Value of Temperature is calculated in degree Celsius

❖ Value of Humidity is calculated in Percentage

❖ Value of Smoke is calculated in Percentage

❖ Value of Combustible gasses is calculated in Parts Per Million

❖ Value of CO is calculated in Parts Per Million

All these parameters were displayed by microcontroller at receiver side based on the data being transmitted by the transmitter module and displayed over the LCD. All the sensors were calibrated for accurate readings. The readings were taken at six different places in Chandigarh. The Testing results are following.

Table 3 : Readings – Inside Building Of Kurukshetra Hostal, PEC University Of Technology Chandigarh.

Date	Time	Temp. (^{o} C)	Humidity (%)	CO (ppm)	Smoke (%)	Combustible (ppm)
1-5-11	Day	28	52	1	0	0
12-5-11	Day	26	42	1	0	0
15-5-11	Day	30	48	1	0	0
1-6-11	Rain	21	83	0	0	0
8-6-11	Day	38	36	0	0	0

Table 4: Readings – At Road Of Sector 14-15, Chandigarh

Date	Time	Temp. (^{o} C)	Humidity (%)	CO (ppm)	Smoke (%)	Combustible (ppm)
8-5-11	Day	34	49	1	1	2
12-5-11	Day	30	42	3	2	2
25-5-11	Day	23	36	1	1	3
1-6-11	Day	23	83	2	3	2
8-6-11	Day	38	38	3	1	2

Table 5: Readings - At Bus Stand, Sector-17, Chandigarh

Date	Time	Temp. (^{o} C)	Humidity (%)	CO (ppm)	Smoke (%)	Combustible (ppm)
1-5-11	Day	26	52	4	2	1
15-5-11	Day	28	49	5	3	2
22-5-11	Day	30	42	3	2	1
29-5-11	Day	23	36	6	3	2
9-6-11	Day	33	62	3	2	1

Table 6: Readings - At CDAC, Phase-8, Mohali.

Date	Time	Temp. (^{o} C)	Humidity (%)	CO (ppm)	Smoke (%)	Combustible (ppm)
9-5-11	Day	33	49	0	0	0
16-5-11	Day	30	42	1	0	0
23-5-11	Day	35	36	0	0	0
1-5-11	Day	20	82	1	0	0
9-5-11	Day	33	61	0	0	0

Table 7: Readings - At PGI, Chandigarh.

Date	Time	Temp. (^{o} C)	Humidity (%)	CO (ppm)	Smoke (%)	Combustible (ppm)
2-5-11	Day	26	52	1	0	0
9-5-11	Day	33	49	0	0	0
16-5-11	Day	30	42	1	0	0
1-5-11	Day	20	82	1	0	0
10-5-11	Day	34	41	0	0	0

Table 8: Readings – CSIO,Sector-30-C, Chandigarh.

Date	Time	Temp. (^{o} C)	Humidity (%)	CO (ppm)	Smoke (%)	Combustible (ppm)
1-5-11	Day	24	52	0	0	0
15-5-11	Day	26	49	0	0	0
29-5-11	Day	21	36	0	0	0
2-6-11	Day	23	72	0	0	0
8-6-11	Day	36	37	0	0	0

VII. RANGE TEST IN AN OUTDOOR AREA

The range tests were done in an outdoor near traffic stream. The distance between coordinator module and receiver are in next table.3. The range tests were carried out with point to point test setup within line of sight distance. The tests were also carried out in one direction only, without any response from the other modules. The range tests in an outdoor area were repeated five times, during daytime (2 p.m-4 p.m). The result have shown that ZIGBEE radio is able to reach to approximately 20 m. At this range the received rates is above 80%. From Coordinator module to receiver module

Table 5.7. Results of the range tests

Experiment Done	Distance(in meters)	Success rate	Error
5 times	5 m	5/5 times	0 %
5 times	10 m	5/5 times	0 %
5 times	15 m	4/5 times	20 %
5 times	20 m	3/5 times	40 %
5 times	25 m	0/5 times	100 %

VIII. CONCLUSION

The objective of this paper is to design, develop and test a wireless system for monitoring the air pollution using ZIGBEE technology and Embedded System. It focuses on implementation of air pollution monitoring system. As the ZIGBEE was applied to communication for monitoring system, available feasibilities are confirmed. The

system possesses low cost, wide coverage, especially mobility on wiring to remove the limitation of traditional wired network systems. Therefore research and development will affect positively for constructing a pollution free City. With the development of technology, the need for a robust and reliable communication method becomes apparent. Generally RF modules and circuits have limitations like limited range, limited frequency range and fewer controls. To overcome these problems ZIGBEE Technology is developed. The main goal of this project was to build an environmental air pollution monitoring system which is capable of measuring common air pollutant concentrations using a semiconductor sensor array and the IEEE 802.15.4 standards. This system can monitor temperature, humidity, carbon mono oxide, combustible gasses and smoke in the air. The sensors were calibrated using the standard static chamber method and hence, the instrument can be used in real environment to measure the ambient air pollution levels of the above mentioned gases. The current pollutant levels of the target gases can be directly read from the LCD. The output of sensors is transmitted at a remote receiver with the help of X-BEE modules. The wireless communication has a great importance in our life. The performance of X-Bee module is better than other RF modules. The performance of this project is tested at different places at different times. In addition, the sensors have minor fluctuations to relative humidity and ambient temperature. The coordinator end is fixed at a location. The receiver end is flexible. The coordinator is having five sensors, so it cannot be derived on batteries. So a power supply is designed for the coordinator end. The receiver is developed being very light and compact, also have excellent power consumption capability. The power consumption is one of the important design criteria while designing of the product. Only LCD is main power consuming component, while all other consumes very less amount of power. This gives a longer battery life to the product which adds to its advantage. The range of the successful communication without lag and error is about 10 meters and line of sight is not required.

IX. FUTURE SCOPE

Though the product developed have many features such as light weight and compact which makes it easy to carry, low battery power consumption, wireless communication over a wide range of distance and user friendly display of the data. But still many features can be added to make it more advantageous for different application. A relative Oxygen sensor and a Nitrogen sensor could be added to simultaneously monitor the complete contents of air and use it for improving uncertainties. A high frequency transmitter and receiver pair over the frequency range of Ghz can be used to avoid the mismatching problem faced during the designing of the prototype. So far the present system is designed mainly for the monitoring and observation applications. The Gas sensors used in this work are SnO_2 based sensing layar which has a limited range and accuracy. They cannot detect an amount of gas less than 1 % in the air. It can be replaced by hight technology digital sensors which can sense gasses in parts per million with large range and very good clarity. In the current version of the Air Pollution Monitoring System (APMS) , the current data is displayed on the LCD. However, improved with an LCD display unit and memories, it can be used as a standalone portable instrument and a data logger. This APMS can also be connected to a PC via serial port . T1out of MAX232 sends the final data to DB9 connector which passes the data to serial input of PC. The PC then displays the measured value of sensors by means of PC Hyperterminal. ZIGBEE module is used for safe and cheap wireless communication which require very less

power. If power and coast is not an issue then a GPRS module can be used with internet. Then the data can be sent anywhere in the world with the help of internet. A GSM module can also be used for the same but they are very costly.

REFERENCES

[1]. Jong-Won Kwon, "Design of Air Pollution monitoring system using ZIGBEE Networks" Research paper in 2007 International Conference on Convergence Information Technology.2007, pp. -1024 to 1031.

[2]. Lin Ke, Huang Ting-Lei and Li Lifang from Guilin, "Temperature and Humidity Monitoring System" , Research Paper in second International Conference on Networks Security, Wireless Communications. 2009 , pp.- 3628 – 3631.

[3]. Al-Ali, A.R.; Zualkernan, I.; Aloul, F. "A Mobile GPRS-Sensors Array for Air Pollution Monitoring". 2010, pp.- 1666 – 1671.

[4]. Tsujita, W. Kaneko, S. Ueda, T. Ishida, H. Moriizumi, T. "Sensor-based air-pollution measurement system for environmental monitoring network". This paper appears in: TRANSDUCERS, Solid-State Sensors, Actuators and Microsystems, 12th International Conference on, 2003. pp.- 544 - 547 vol.1.

[5]. Caldararu, F.; Vasile, A.; Caldararu, M. "Autonomous system for real time air pollution monitoring using semiconductor toxic gas sensors". Electronics Technology: Concurrent Engineering in Electronic Packaging, 2001. 24th International Spring Seminar. 2001, pp.- 233 - 237.

[6]. Young Jin Jung; Yang Koo Lee; Dong Gyu Lee; Keun Ho Ryu; Nittel, S. "Air Pollution Monitoring System based on Geosensor Network". Geoscience and Remote Sensing Symposium, 2008. IGARSS 2008. IEEE International Conferences, Volume: 3. 2008, pp.-1370-1373.

[7]. Kularatna, N.; Sudantha, B.H. "An Environmental Air Pollution Monitoring System Based on the IEEE 1451 Standard for Low Cost Requirements". In IEEE transaction on Sensors Journal, Volume: 8, Issue: 4. April, 2008, pp.-415 - 422 .

[8]. Zhou, Ji-hong; Zhao, Jun-guang; Li, Ping." Study on Gray Numerical Model of Air Pollution in Wuan City ".Challenges in Environmental Science and Computer Engineering (CESCE), 2010 International Conference on IEEE, 2010, pp.- 321 – 323.

[9]. Mohammed AbuJayyab; Salim Al Ahdab; M. Hazem Taji; Zahraa Al Hamdani; Fadi Aloul." PolluMap: A Pollution Mapper for Cities". Innovations in Information Technology, 2006, pp.- 1 – 5.

[10]. Keller-Goralczyk, A.; Finks, J.; Mathir, O.; Helmly, D.; Althagafi. "Air pollution accountability and compliance tracking system (A-PACT system)". Systems and Information Engineering Design Symposium (SIEDS), 2010 IEEE. 2010, pp.- 94 – 99.

[11]. Andrew Wheeler and Ember Corporation," Commercial Application of Wireless Sensor Networks Using ZigBee". 2007 IEEE Journal. 2007, pp.- 70 – 77.

[12]. Han Zhi-gang; Cui Cai-hui; "The Application of Zigbee Based Wireless Sensor Network and GIS in the Air Pollution Monitoring". Environmental Science and Information Application Technology, 2009. ESIAT 2009. International Conference. 2009, pp.- 546 – 549.

[13]. Boscolo, A.; Mangiavacchi, C. "Pollution dynamic monitoring system for city air quality control". Instrumentation and Measurement Technology Conference, 1998. IMTC/98. Conference Proceedings. IEEE. Volume: 1. 1998 , pp.- 202 – 205.

[14]. Data sheets of ZigBee Products of Jennic Technology.

[15]. www.hwsensor.com

[16]. ZigBee Board Datasheet – EB051-30-1. Online page: http://www.matrixmultimedia.com/eblocks.php

[17]. "The 8051 Microcontroller" Architecture, Programming and Application, by Kenneth J. Ayala.

[18]. "The 8051 Microcontroller and Embedded Systems" by Muhammad Ali Mazidi and Rolin D. McKinlay.

[19]. Datasheet of MQ-2, Smoke Sensor. Online page: http://www.alldatasheet.com/datasheet-pdf/pdf/154700/BEL/MQ2.html

[20]. Datasheet   of   MQ-5   Carbon   mono   oxide   Gas   Sensor   ,   Online   page: http://www.alldatasheet.com/datasheet-pdf/pdf/154700/BEL/MQ5.html

[21]. Datasheet   of   MQ-7   Carbon   mono   oxide   Gas   Sensor   ,   Online   page: http://www.alldatasheet.com/datasheet-pdf/pdf/154700/BEL/MQ7.html

[22]. Manual   of   XBee/XBee-Pro   OEM   RF   modules-   802.15.4   .   Online   page   : http://www.digi.com/products/wireless-wired-embedded-solutions/zigbee-rf-modules/point-multipoint-rfmodules/xbee-series1-module.jsp