AIR POLLUTION MONITORING USING ZIGBEE BASED WIRELESS SENSOR NETWORKS

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ABSTRACT

Sensor networks are presently an active research area mainly due to the potency of their applications. This paper is proposed to implement wireless sensor networks based Environmental air pollution monitoring. RSPM (Respirable Suspended Participate Matter), carbon dioxide, carbon monoxide Nitrogen Dioxide (NO₂) and sulfur dioxide (SO₂) are monitored because these gases decide the level of pollution. We have used MQ-7, MQ-2 sensors to monitor the Carbon Dioxide and Carbon Monoxide levels in the atmosphere. The ARM processor (LPC2148) is used as the prominent platform for interfacing those sensors and processing the sensed data wirelessly through Zigbee modules (Tarang F4). The data received from the sensor device is simultaneously stored in a system for a future reference in the levels of contamination. The information in the system is stored via a .Net application enabling the user to access the data whenever required. With the help of this data, proper precautions can be taken to minimize the pollution levels in the air to make human life sustainable.

Keywords: RSPM (Respirable Suspended Participate Matter), Quality Monitoring System, Wireless Sensor Network (WSN).

1. INTRODUCTION

A wireless sensor network comprises of a gourmet of autonomous sensors which aid us to supervise the ambience such as temperature, sound, vibration, pressure, motion or pollutants and transmits the information to the central workplace through zigbee protocol. The upcoming networks are bi-directional and also enables the supremacy over sensors [1]. The military applications such as
battlefield surveillance are inspired by the advancement of wireless sensor networks. Now a days such networks are being utilized in various industrial, consumer and medical applications [2]. Nodes are the integral part of wireless sensor networks. They are of several hundreds or thousands, each of them is connected to 1 or more sensors. Each node has different parts: radio transceiver with an internal antenna, a controller, an electronic circuit for interfacing sensors with energy source and a battery [3]. Size of the sensor node varies in the middle of a shoe box down to the size of a grain of dust. Functioning nodes of genuine microscopic dimensions have to be created. The piece of the sensor is in a range of few hundreds to dollars depending on the complexity of the nodes [4]. Results of size and cost constraints show significant effect on resources such as energy, memory, computational speed and common bandwidth. The topology that has to be used is picked from a set of topologies available like a simple star network or an advanced multi-hop wireless mesh network [5]. By using routing of flooding propagation technique is implemented between hops.

II. RELATED WORKS

The scientists in recent years could not assess the quality of air pollution accurately. Here monitoring comes into the limelight. This monitoring can be studied and understood on the basis of provided raw measurements of air pollution concentrations [6]. This monitoring segregates the bad air pollution from good from day to day, from one area to another and their levels of concentration [7]. How pollutants interact with each other can be understood easily and can be related to traffic levels or industrial action. The weather conditions resulting in the rise to pollution episodes can be predicted by examining the relationship between weather forecasting and air quality [8]. Over the years, vehicle pressure has increased manifold on roads. Many of these vehicles mostly trucks and trailers often bypass pollution tests for months and these turn into smooth bleaching monsters [9]. Further contributing to air contamination or concrete growth of the city and directly proportional to shrinking of green cover.

There are many other factors that are collectively responsible for environmental hazards with a real time monitoring system in place, it improves air quality by compelling stakeholders concerned to undertake corrective measures [10]. The present day pollution analyzers are expected to record ambient air quality based on various parameters such as NO\textsubscript{2}, SO\textsubscript{2}, CO, CO\textsubscript{2} and RSPM (Respirable Suspended Particulate Matter).

III. AIR POLLUTION MONITORING SYSTEM

This project work implementation will try to enhance the previous work by being more flexible and timely. Moreover, accurate data with indexing capabilities will be able to obtain with wireless sensor networks. The main requirements of our proposed system are: To implement a system that improves the interaction between the sensor nodes, it needs to acquire the air pollution data in PPM (parts per million) from the particular region. Collecting more data among a set of nodes from many regions and to transmit them to a gateway. To reduce the maximum possible duplicate values from the acquired data, we used the particular data aggregation which reduces the power consumption during the transmission of huge amounts of data among many sensor nodes or sensor motes. Analysis of collected data from sensor network using graphical and statistical methods such as data tables, analysis and graphs are representing the data dynamically by indexing and categorizing the different pollution levels with associated colors in graphs meaningfully, which expresses the seriousness of air pollution. Reports are generated periodically i.e. monthly or fortnightly from the acquired real time data.
IV. IMPLEMENTED CIRCUIT DESIGN

The hardware design constitutes of ARM 7 (LPC 2148) developer board, CO2 sensor, CO sensor, Two Zigbee modules, RS 232 to USB cable, Front end .Net application to record the acquired values

4.1 Implemented Block Diagram

![Implemented Block Diagram](image)

**Fig.1:** Implemented Block Diagram

4.2 The ARM Processor (LPC 2148)

The ARM7TDMI-S is a general purpose 32-bit microprocessor, which provides high performance and very low power use. The ARM architecture is based on Reduced Instruction Set Computer (RISC) principles, and the instruction set and related decode mechanism are much simpler than those of micro programmed Complex Instruction Set Computers. This simplicity results in a high instruction throughput and an impressive real-time interrupt response from a small and cost-effective processor core. Pipeline techniques are employed so that all parts of the processing and memory system scan operate continuously. Typically, while one instruction is being done, its replacement is being decoded, and a third instruction is being fetched from storage. The ARM7TDMI-S processor also uses a unique architectural strategy known as THUMB, which makes it ideally fitted to high-volume applications with memory restrictions, or applications where code density is an issue. The central idea behind THUMB is that of a super-reduced instruction set. Basically, the ARM7TDMI-S processor has two command sets:

- The standard 32-bit ARM instruction set.
- A 16-bit THUMB instruction set.
4.3 CO₂ SENSOR
A carbon dioxide sensor or CO₂ detector is an instrument for the measurement of carbon dioxide gas. The most common principles of CO₂ sensors are infrared gas sensors (NDIR) and chemical gas sensors. Measuring carbon dioxide is important in monitoring indoor air quality and many industrial processes.

4.4 CO SENSOR
A carbon monoxide detector or CO detector is a device that detects the presence of the carbon monoxide (CO) gas in order to prevent carbon monoxide poisoning. Raised levels of CO can be unsafe to humans depending on the amount present and length of exposure. Smaller concentrations can be harmful over longer periods of time while increasing concentrations require diminishing exposure times to be harmful.

4.5 RS 232
RS-232 (ANSI/EIA-232 Standard) is the serial connection found on IBM-compatible PCs. It is practiced for many functions, such as tying in a mouse, printer, or modem, as well as industrial
instrumentation. Because of improvements in line drivers and cables, applications often increase the performance of RS-232 beyond the space and speed listed in the banner. RS-232 is limited to point-to-point connections between PC serial ports and devices. RS-232 hardware can be used for serial communication up to lengths of 50 foundations.

![RS232 TO USB Cable](image)

**Fig.5: RS232 TO USB Cable**

### 4.6 LCD Display

Liquid crystal displays (LCD’s) have materials which combine the properties of both liquids and crystals. Rather than holding a disappearing point, they experience a temperature range within which the particles are near as mobile as they would be in liquid, but are grouped together in an ordered form similar to a vitreous silica. The LCD’s are lightweight with only a few millimeters thickness. Since the LCD’s consume less power they are compatible with low power electronic circuits and can be powered for long durations. The LCD’s are used extensively in watches, calculators and measuring instruments is the simple seven-segment displays, having a limited amount of data. The accompanying form depicts a general purpose alphanumeric LCD, with two lines of 16 fibers.

![LCD](image)

**Fig.6: LCD**

### 4.7 The front end application

A front end application was developed in .Net to acquire the transmitted air pollution data from the transmitter block. Here wireless communication is done through zigbee protocol. A zigbee transceiver module transmits the data from the arm processor (transmitter end) which is acquired from interfaced mq-7 mq-2 sensors. At the receiver end this .Net windowsform application acquires the data from the receiver end zigbee transceiver module. This windows form application reads the data via selected com port (through which the zigbee module is connected), and finally the acquired data is made to store in the text file along with the date and time.
5. KIT DIAGRAM

![Kit Diagram](image)

Fig.7: Kit

6. CONCLUSION

Environmental science as well as our health are intensively affected by that air pollution. This has lead to the death of many innocent lives as they fall victim to diseases like lung cancer, asthma etc. So the people strive for new breaths of clean and transparent air. This project provides information to the public about projected levels of environment pollution, with extra stress on reduction of outside action and avoidance of car driving and other petrol vehicles in such highly polluted areas. A remote survey is conducted to accumulate the data for future reference. Installing reference air quality monitoring systems based on gas analyzer technology is one way to measure road, motorway and highway emissions. But their cost and size limits the number of monitoring locations.

7. RESULTS

![Net Application](image)

Fig.8: .Net application
GRAPHICAL ANALYSIS OF POLLUTANTS
CO₂, CO AT VARIOUS SITUATIONS (IN PPM)

Fig.9: Graphical analysis of CO and CO₂

7.1 Threshold Values
These values have already been defined by the scientists long ago. The threshold value of CO is 200 ppm (parts per million) and for CO₂ it is 400 ppm. When the levels of CO and CO₂ in air cross these threshold values it becomes harmful for people causing various heart diseases.

Fig.10: Threshold value

8. REFERENCES


