International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

WSN based Air Pollution Control System

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Abstract: ***Air pollution monitoring is extremely important as air pollution has direct impact an human health and environment. A traditional air quality monitoring method is to build air quality monitoring stations but this method is expensive and provides low resolution sensing data. The paper proposed on Urban air quality monitoring system based on the wireless sensor network technology and integrated with the Zigbee wireless technology. This paper focus on Zigbee as a technology innovation which would bring about low cost connectivity, its architecture and applications. Main functioning unit Composed of: A sensing unit is designed and programmed to sense gas pollution in air in busy areas that can sense humidity, light, pressure etc. A converter that transforms the sensed from an analog to a digital signal a processing unit in the microcontroller process the signals sensed from sensor with the help of embedded memory operating system, associated circuitry. A Radio component that can communicate with the Zigbee node or Zigbee router which collect the sensed pollution gas level from sensor node and forward to pollution server. Powering to these component is typically is one or two small batteries .there are also some wireless sensor utilized in application that uses a fixed value, wired power source and do not use batteries as a power source.***

Keywords: Wireless Sensor Network, Zigbee transmitter module, Zigbee receiver module, MQ-7 Sensor, Microcontroller Atmel

1. Introduction

With fast development of the industrialization and urbanization process in the world, environment pollution problems become more common. At present environment contains air pollution, water pollution and soil pollution worldwide. Air pollution is the presence of contaminants or pollution substances in the air that interfere with human health or welfare, or produce other harmful environment effects. The World Health Organization states that 2.4 million people die each year because of polluted air. Based on the fact above mentioned, the human should focus on designing air pollution monitoring system.[1].Wireless Sensor Networks and intelligent wireless systems have successfully been applied in many situations including habitat monitoring, environmental monitoring, structural health monitoring, water and oil and gas pipelines, agriculture, active volcano monitoring, industrial control system, process control system such as the pulp and paper industrial, mineral processing plants, road traffic control system, food and chemical plants and many others. Monitoring and recognition of hazardous gases is important because human olfactory system has a very limited recognition of gases such as CO. O2[2-3]. Humans are able to detect limited amount of mixture of gases yet it is very difficult to discern the different percentages of each gas individually. This is significant as there are number of toxic gases that humans cannot recognize, the carbon monoxide, (CO), has negative biological effects from the smallest organisms to some of the largest organisms depending on the dose level [4]. To detect the percentage of pollution we use array of sensor to measure gas quantity in physical environment the sensor convert them into electrical signal for further processing. These sensor node networks are connected through wireless network and gives wireless sensor network.

2. Hardware Architecture

2.1 Zigbee

ZIGBEE is low-cost, low-power, wireless mesh networking standard. The low cost allow the technology to be widely deployed in wireless control and monitoring applications, the low power-usage allows longer life with smaller batteries, and the mesh networking provides high reliability and larger range.[5] The ZIGBEE Alliance, the standard body which defines ZIGBEE, also publishes application profiles that allow multiple OEM vendors to create interoperable products.

Figure 1: Zigbee Module

2.2 Zigbee Standard:

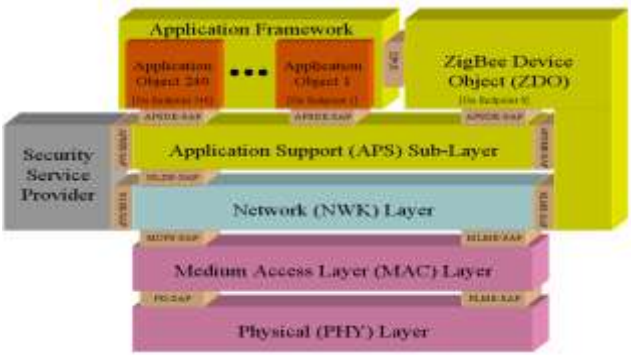

Figure 2: Zigbee Standard

2.1.1 Physical Layer

The physical Layer was designed to accommodate the need for low cost yet allowing for high level of integration. The use of direct sequence allows the analog circuitry to be very simple and very tolerant towards inexpensive implementations.

2.1.2 MAC Layer

The media access control (MAC) layer was designed to allow multiple topologies without complexity. The power management operation doesn't require multiple modes of operation. The MAC allows a reduce functionality device (RFD) that needn't have flash nor large amounts of ROM or RAM. The MAC was designed to handle large numbers of devices without requiring them to be 'parked".[6]

2.3 Zigbee Device Types

Three types of ZIGBEE devices:

2.3.1 Zigbee coordinator (ZC)

The most capable device, the coordinator forms the root of the network tree and might bridge to other networks. There is exactly one ZIGBEE coordinator in each network since it is the device that started the network originally. It stores information about the network, including acting as the Trust Center & repository for security keys.

2.3.2 Zigbee router (ZR)

As well as running an application function, a router can act as an intermediate router, passing on data from other devices.

2.3.3 Zigbee End Device (ZED)

Contain just enough functionality to talk to the parent node (either the coordinator or a router); it cannot relay data from other devices. This relationship allows the node to be asleep a significant amount of the time thereby giving long battery life. A ZED requires the least amount of memory, and therefore can be less expensive to manufacture than a ZR or ZC. [7]

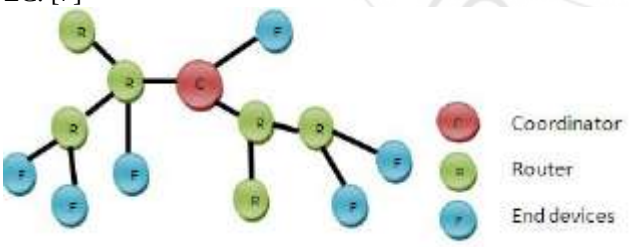

Figure 3: Zigbee Device

The IEEE 802.15.4 standard defines three bands operation: 868MHz, 916MHz and the 2.4GHz for Zigbee. 2.4GHz bands are used the most commonly available wireless communication product throughout the world because of ISM (Industrial, Scientific, Medical) band. In addition this band offers the highest achievable data rate of 250Kbps and 16 channels between 2.4GHz and 2.4835GHz at the physical layer. Typical transmission distances are within the range from 30 meters in an indoor non-line of sight environment to over 100 meters in a line of environment. But problems related a range can be solved through applying routing algorithm at the network layer.

3. Microcontroller

A Microcontroller unit is the base device which could perform the iteration cycles in executing the processing cycles. Various MCU's were available in the market and Intel's 8051 is the first of its kind released. Atmel is a successor company which released a series of such MCU's to market and is quite a successful in capturing the market. Atmel corporation is an American-based designer and manufacturing company, which produces various semiconductor devices, since 1984. The main motive of this company is to focus on Embedded Systems developed on microcontroller unit. A consistent series of devices ranging from 8-bit to 32-bit Arm based architectures were manufactured. Other traditional devices like WiFi, Eeprom, security devices chips, memory drives and various sensors were being developed here. The current project uses a Atmega 8 series 8-bit microcontroller unit which is a generic programming and interfacing platform with 28 pin configuration and has the capabilities of a 40 pin configuration devices. Its 16MHZ operating frequency enhancing capability is a huge advantage in developing this project.

Atmel corporation is an American-based designer and manufacturer of semiconductors, founded in 1984. The company focuses on embedded systems built around microcontrollers. Its products include microcontrollers (8-bit AVR,32-bitAVR,32-bit ARM-based, automotive grade, and 8-bit intel 8051 derivaties) radio frequency (RF)device including Wi-Fi ,EFPROM, and flash memory devices, symmetric and asymmetric security chips , touch sensors and controllers and application -specific products.[8]

4. Gas Sensor Node

4.1 MQ-7 Semiconductor Sensor for Carbon Monoxide

Sensitive material of MQ-7 gas sensor is SnO2, which with lower conductivity in clean air. It make detection by method of cycle high and low temperature, and detect CO when low temperature (heated by 1.5V). The sensor's conductivity is more higher along with the gas concentration rising. When high temperature (heated by 5.0V), it cleans the other gases adsorbed under low temperature. Please use simple electro circuit, convert change of conductivity to correspond output signal of gas concentration.MQ-7 gas sensor has high sensitivity to Carbon Monoxide. The sensor could be used to detect different gases contains CO, it is with low cost and suitable for different application.[9]

5. Simulation and Working

5.1 Transmitter Module

The controller used here is ATMEGA8, an AVR based series. It is a 28 pin controller interfaced with an LCD used to display the data, gas sensor is used to measure the concentration of gas (methane) in the atmosphere. In the simulation it is difficult to design a gas sensor, so we use this

analog vary sensor as a gas sensor and ZIGBEE is shown using the USART communication block in the simulation.

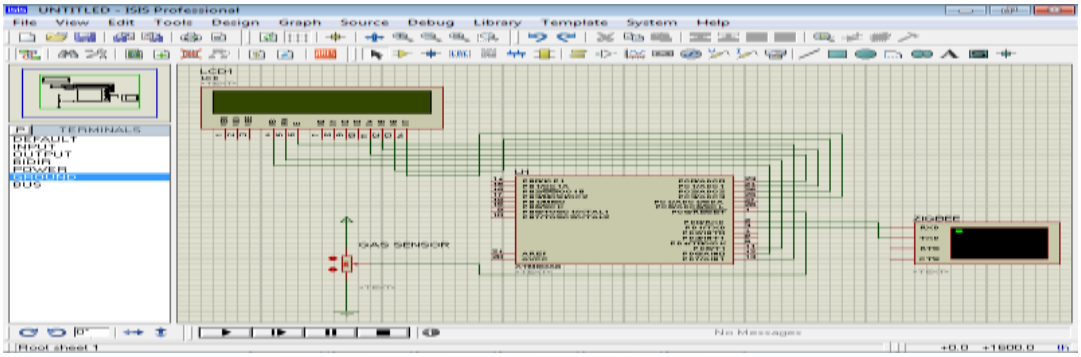

Figure 4: Transmitted Model (Proteus)

LCD has 16 pins. Pins 1, 3, 16 are ground pins and 2, 15 are supply pins. 4, 5, 6 are connected to PORT D (PD5, PD6, PD7) and 11, 12, 13, 14 are the data pins which are connected to PC0, PC1, PC2, PC3 of the microcontroller. Pins 7, 8, 9, 10 are not used because for the data displaying 4 data bits are sufficient so we ignore those 4 pins.

PORT C is also used as ADC (Analog to Digital Conversion) to gather the sensoric information. We are using the same port for both displaying data as well to gather the sensor information. So gas sensor is connected to PC6 of port C. The obtained sensor data is a 10 bit data, but our controller is 8 bit operating. We have to convert the 10 bit data to 8 bit this is possible by conversion techniques. In the program by adding a multiplication factor the 10 bit data (i.e. 2^10 =1024 bits data) has to converted to 8 bit data (i.e. 2^8 =256 bits data). Multiplication factor helps to divide the obtained 1024 data to 256 and that data is being called back through LCD commands through program.

USART (Universal Synchronous Asynchronous Receiver and Transmitter) is a communication protocol used to maintain a 2 way communication among two devices. ZIGBEE is the device medium which uses RF (Radio Frequency) to maintain the bandwidth among 2 modules. Through programming we define the band width rate called Baud Rate of 9600. Baud rate is the rate at which information is transferred in a communication cannel. In the serial port context, "9600 baud" means that the serial port is capable of transferring a maximum of 9600 bits per second.

ZIGBEE is one of the basic modules which work at desired speeds. So we use 2 ZIGBEE modules at both transmitter and receiver module.

5.2 Receiver Module

Receiver module has almost the same parts which were used in the transmitter but instead of a sensor in the receiver module it contains a Buzzer. Whenever there is a drastic change in the level of pollutants percentage in the atmosphere then the buzzer will alarm a signal to take precautions and also the amount of change can be noticed through LCD. In the receiver module buzzer is connected to PORT B (PB0) in the controller.

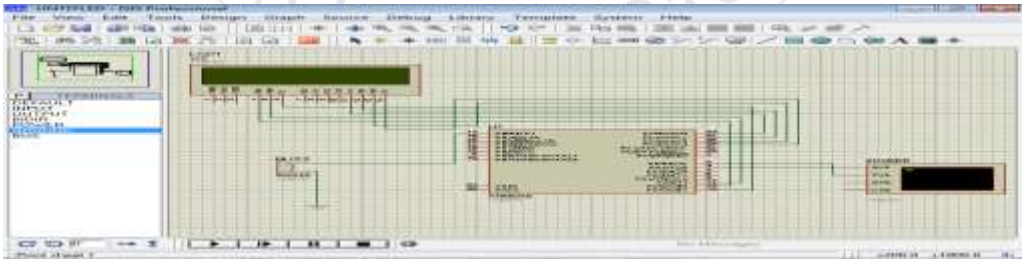

Figure 5: Receiver Module

6. Conclusion and Future Scope

The purposed system is implemented with two module one transmitter module and second receiver module .There is an increase in the level of the pollution over the last decades, leading to several environment problems. A wireless air pollution monitoring array in system designed implemented and using the zigbee network .The pollution data from sensor transmitted to a central server by using zigbee network. The main purpose of this paper is provide an overview of urban air pollution monitoring application. The system measure air pollutant gases. Apart from the sound effects, the monitoring system is simple in structure ,easy to operate, convenient to carry, and real time display. This paper will give clear idea to move towards real time measuring in an urban area to ultimately improve quality of life on earth.

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