IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE)
e-ISSN: 2278-1676,p-ISSN: 2320-3331, Volume 11, Issue 3 Ver. IV (May. – Jun. 2016), PP 79-84
www.iosrjournals.org

Design of Wireless Sensor Network for Home Monitoring

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Abstract: *The wireless sensor network application is proposed to monitor the carbon monoxide level, temperature, absolute pressure, relative humidity and light intensity in indoor spaces. This monitoring system consists of wireless sensor nodes, base station, global system for mobile communication (GSM) wireless transmission module and local monitoring PC. The sensor nodes collect the ambient data and send the measured data using wireless networking based on IEEE 802.15.4/ZigBee standards. Base station stores the collected data from various sensor nodes and display on LCD display. Simultaneously at local PC side monitoring also achieved through serial communication with GUI interfacing. Then GSM module continuously sends the status of indoor spaces to mobile users. The aim is to achieve both good Indoor air quality and power consumption.*

Keywords: *Global system for mobile communication (GSM), Home Monitoring, Indoor Air Quality (IAQ) Wireless Sensor Network, ZigBee.*

I. Introduction

In home environment, problems are like headaches, dizziness, nausea, difficulties in concentration and others affecting the people's life and security. These are the usual symptoms of Sick Building Syndrome (SBS). Improper ventilation, tobacco smoke, chemical contaminants from indoor or outdoor sources, biological contaminants can all cause problems, these problems includes comfort problems due to improper temperature, relative humidity conditions, poor lightening etc.[1],[2].Therefore it is necessary to monitor the Indoor Air Quality (IAQ) that provides useful information to solve these problems. IAQ monitoring can detect the CO concentration in air, temperature, humidity, pressure. Carbon Monoxide (CO) is colorless, odorless and tasteless it cannot be detected by human senses. This means that dangerous concentration of the gas can affects on people health**.** Common sources of CO in homes include fuel-burning appliances and devices such as gas stoves and ovens, water heaters, wood stoves, tobacco smokes etc. The CDC estimates that more than 8,000 people each year are treated in hospital for CO poisoning [3].

This paper presents the design of WSN for home monitoring that monitors CO (carbon monoxide) level, temperature, relative humidity, pressure and light intensity in indoor spaces. The monitored data collection and further processing is achieved by using IEEE 802.15.4/ZigBee standards. The ZigBee based sensor nodes are used for effective communication of data with low power consumption. Global System for Mobile Communication technology is used for wirelessly sending/ receiving data and sends SMS to user's mobile when some dangerous condition has been detected.

A wireless sensor network (WSN) is composition of large number of sensing devices called as sensor nodes. Sensor nodes are small embedded devices able to perform simple computations and to send/receive data. Typically these sensor nodes used to gather information about environmental condition via sensors and pre-process those data for transmission. Initially wireless sensor networks were used by military applications such as battlefield surveillance. However, WSNs are now used in variety of applications such as industrial and civilian areas, including industrial process monitoring and control, traffic control, home automation, health monitoring, environment and habitat monitoring, healthcare applications etc. [4]. By using newly released ZigBee standard for wireless sensor networks provides more opportunities to build wireless monitoring applications. This provides low cost, low power, large range and high reliability. Remote online CO2 leakage monitoring can also be possible with GPS, GPRS technologies and different micro-sensors [5].

The proposed wireless network system for home monitoring is flexible in deployment, low power consumption, and avoids the wiring for infrastructure. The main target of this system is to monitor the indoor space and to keep people comfortable, safe and highly efficient.GSM based technology proposed to keep updated to user about the indoor air quality.

In this paper, other sections are structured as follows. Section II presents system architecture for home monitoring with different sensors and modules selected. Section III describes the sensor node design for home monitoring system. Section IV presents implementation of system. Section V shows the experimental results achieved. Finally section VI is the conclusion and discussion for future work.

II. System Architecture

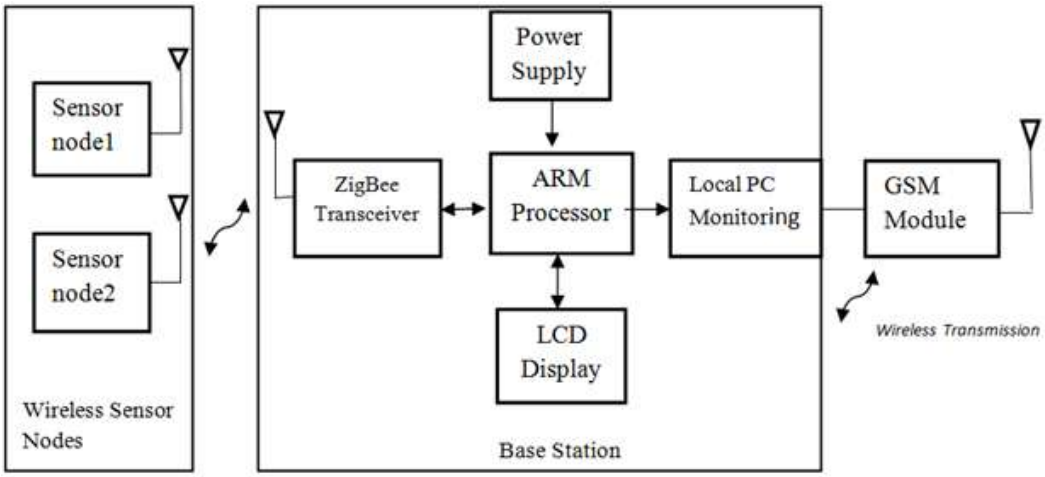

Figure1. Block Diagram of Wireless Home Monitoring System

The proposed system for home monitoring as in Fig.1 is based on wireless sensor network which measures the carbon monoxide level in air, temperature, relative humidity, absolute pressure and light intensity in indoor spaces. The system comprises of sensor nodes, base station and a receiver station. Different sensor node collects the information about the indoor air quality. Then acquired information is transmitted to the base station through Zigbee wireless communication. Base station again repackages that data and transmits to local monitoring station via serial communication. Acquired data information is monitored at local PC with GUI.GSM module is interfaced with local PC. After detection of any intrusion GSM modem sends the appropriate message to user's mobile.GSM based technology used to keep updated user about indoor air quality conditions.

2.1 Internal Structure

The developed system for home monitoring is represented as in Fig.1. The device core is based on ARM7 processor. The system consists of wireless sensor nodes, Zigbee module, base station, LCD display module, GSM wireless transmission module and local monitoring PC.

Wireless sensor nodes comprises of different sensors as CO gas sensor, LM35 temperature sensor, SY-HS-220 relative humidity sensor, intensity of light sensor. These sensors provide satisfactory range and accuracy requirements with low power consumption. The data processing and storage is controlled with ARM7 microcontroller. Wireless data transmission is implemented by Zigbee module and GSM module.

2.2 Microcontroller

The microcontroller (NXP LPC2138 chip) manages the operation of each module. It is based on a 16/32-bit ARM7TDMI-S CPU with real-time emulation and embedded support. These microcontrollers are small in size and of low power consumption. Therefore they are widely used in industrial control system, medical system, embedded soft modem and general purpose applications.

The LPC 2138 operate at CPU frequencies of up to 60 MHZ. It has up to 512 KB on-chip Flash and up to 32 KB of on-chip SRAM memory. The peripherals of LPC2138 includes two 10-bit 8 channel A/D converters of 16 analog inputs, a 10-bit D/A converter gives variable analog output, multiple serial interfaces includes, two UARTs, two I2C bus one SPI, and one SSP, two 32-bit timers ,PWM unit and Watchdog timer. It supports In-System /In-Application programming (ISP/IAP).

2.3 Sensor Specifications

Indoor environmental information is obtained by using sensors: CO gas sensor, temperature sensor, relative humidity sensor, absolute pressure sensor, intensity of light sensor. These sensors provide the useful data to the central processing unit. The sensor is described as follows.

2.3.1 Temperature Sensor

The LM35 series are temperature sensors whose output voltage is proportional to the Celsius temperature. It provides the typical accuracies of ±0.5°C at room temperature. It draws only 60 μA from its supply.

2.3.2 Gas Sensor

MQ-7 gas sensor is used to detect carbon monoxide (CO) concentration in the air. MQ-7 can detect CO concentrations from 10 to 10,000ppm. The sensor can operate at ambient temperature from -10 to 50°C. It consumes less than 150mv at 5v. These sensors provide good stability and long life [3].

2.3.3 Humidity Sensor

SY-HS-220 humidity sensor module converts relative humidity to the output voltage. Its operation conditions allowing temperatures range is between 0~60°C. The operating humidity range is between 30~90%RH. This work with 5v power supply and the typical current consumption is less than 3mA.

2.3.4 Light Intensity Sensor

Light Dependant Resistor (LDR) is used as a sensor to measure the light intensity. The resistance of LDR varies in accordance with the amount of light that falls on it. These sensors are of low cost and consume less power. LDR has low current consumption about 3 μA to 60 μA.

2.4 ZigBee Module

IEEE 802.15.4/Zigbee based standard is used for wireless data transmission. Zigbee transceiver operates at ISM 2.4 GHz frequency, 1mW power output and allows data rates up to 250Kbps. Therefore Zigbee modules are used for application that require low power consumption, low data rate and network security [6].

2.5 GSM Module

The real-time data transmission is achieved with wireless transmission module SIM900A.GSM is a circuit switched system that divide each 200 kHz channel into eight 25 kHz time-slots. It operates at the communication bands 900MHz and 1800MHz.GSM makes use of Time Division Multiple Access (TDMA). GSM modem accepts a SIM card and operates over a subscription to the mobile operator [7].

III. Sensor Node for Home Monitoring System

Sensor nodes are designed to collect the raw information about ambient conditions. The block diagram of sensor node for home monitoring system is as shown in Fig.2. It comprises of different sensors as CO gas sensor, LM35 temperature sensor, SY-HS-220 relative humidity sensor, intensity of light sensor. The acquired information from sensor is processed and stored in microprocessor .Microprocessor will pack those data and transmit via Zigbee for further processing. Zigbee transmission module is used because of low power consumption, low data rate and small size. Fig.3 shows the hardware implementation of home monitoring sensor nodes.

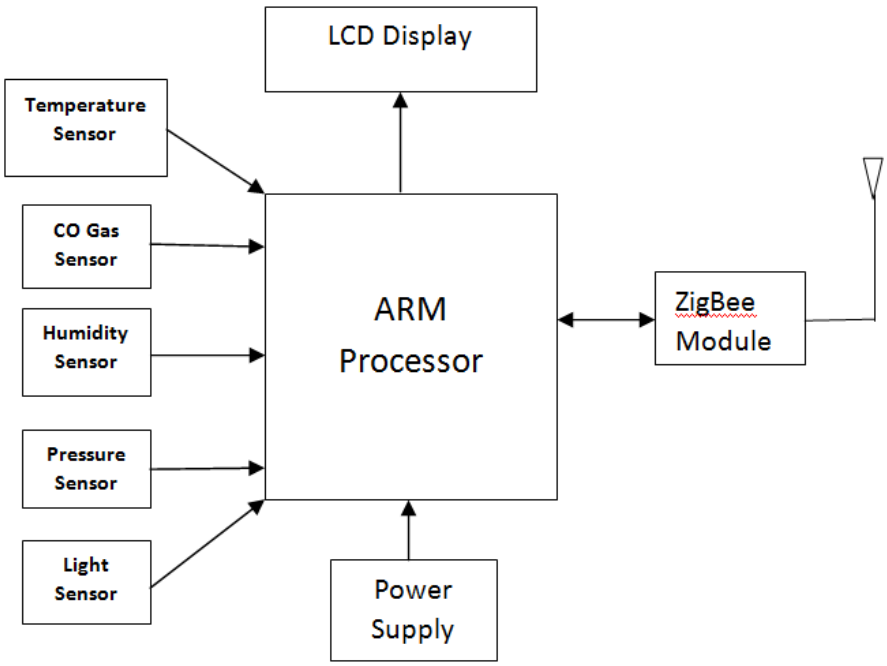

Figure 2.Block Diagram for Sensor Node

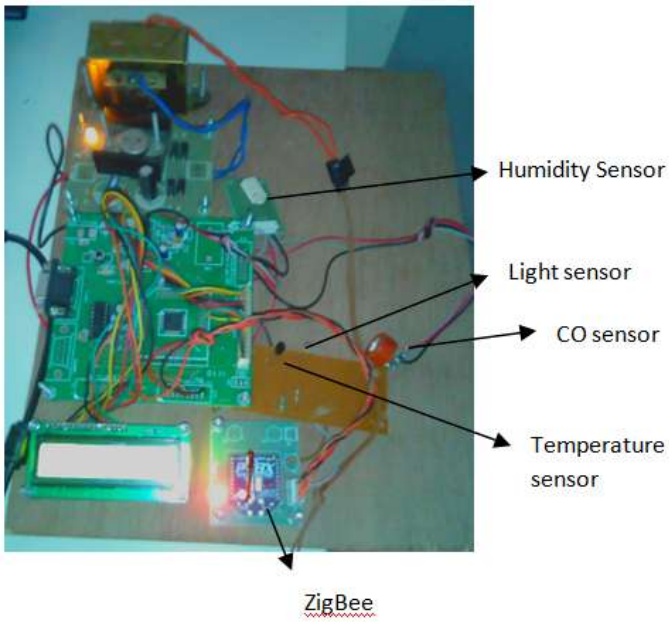

Figure 3 Hardware Implementation of Sensor Node

IV. Implementation

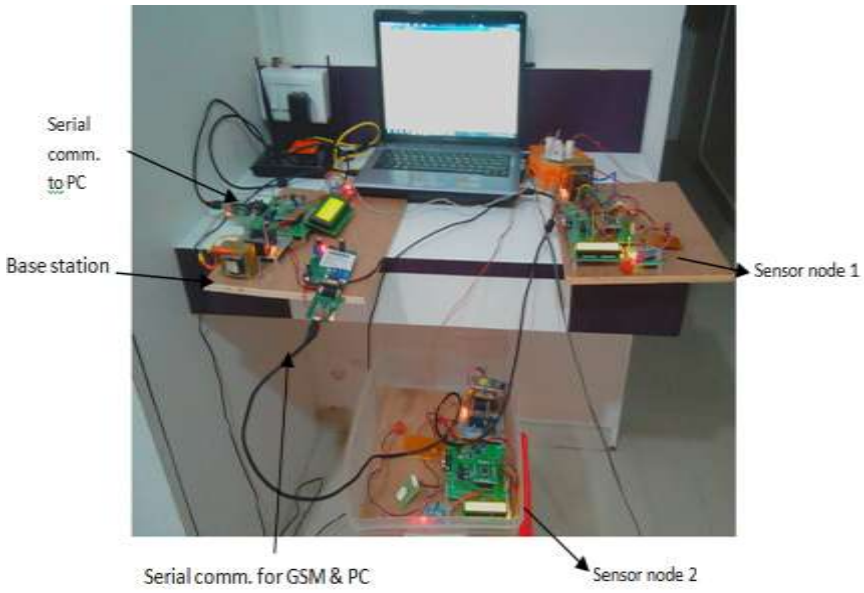

Figure 4 Set up for Home Monitoring System

Wireless home monitoring system is successfully developed, which can able to monitor the parameters such as temperature, CO concentration, relative humidity and light intensity. The wireless transmission is carried out by using Zigbee and GSM modem. The system implementation setup is as shown in Fig.4. All sensor nodes in the home environment are communicating with the base station.

IEEE 108.15.4/Zigbee based standard is used for each sensor node and base station design. After collection of data at sensor nodes it will continuously transmit those data to the base station via Zigbee wireless transmission. On successful reception of data the base station will displays it on LCD display.

The proposed system uses microcontroller LPC 2138. The microcontroller is programmed using Flash Magic software. Keil software programming is used for communication between base station and sensor nodes.

MATLAB software programming is used at local PC side for data acquisition and monitoring. Thus local PC communicates with base station and receives information about the indoor environment. Fig.5 shows a Graphical User Interface (GUI) at local PC, where it displays measurements of all indoor parameters from various sensor nodes.

Finally GSM modem is used for wireless data transmission. GSM and local PC communication is implemented through serial communication. The operation of GSM module is managed by set of AT commands such as AT + CFUN, AT + CREG, AT + CMGF, AT + CPMS, AT + CMGS etc. It sends SMS to mobile user for any dangerous condition has been occurred.

V. Results

Fig.5 shows the Graphical User Interface (GUI) at local PC side which monitors the indoor environmental parameters from different sensor nodes.

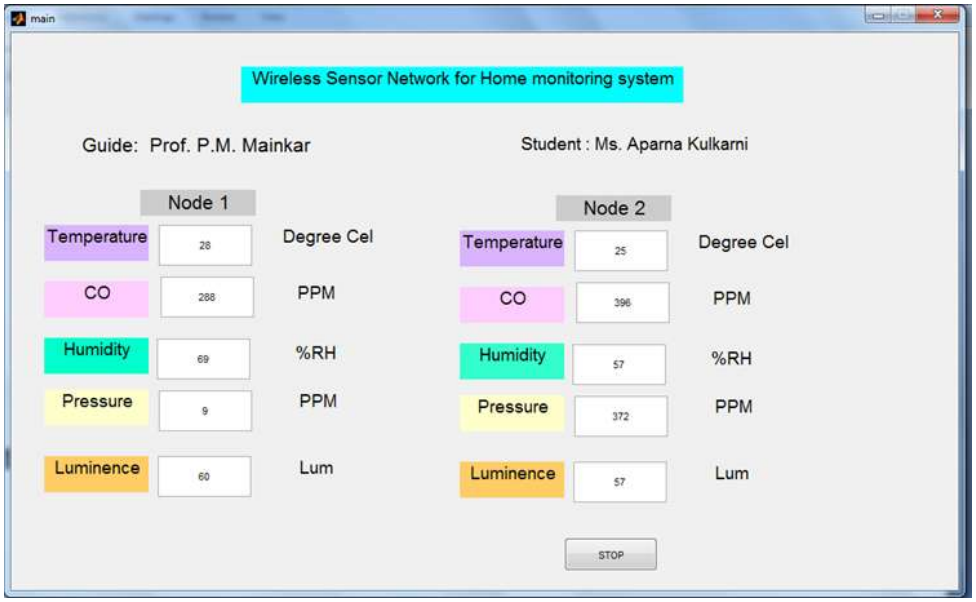

Figure 5 Local PC Monitoring with GUI

After checking for each indoor parameter condition, GSM modem sends alert SMS to mobile user. Fig.6 and Fig.7 shows the screen shot result of different alert SMS for CO level, temperature, humidity and light intensity on user mobile. These SMS are received from the GSM number.

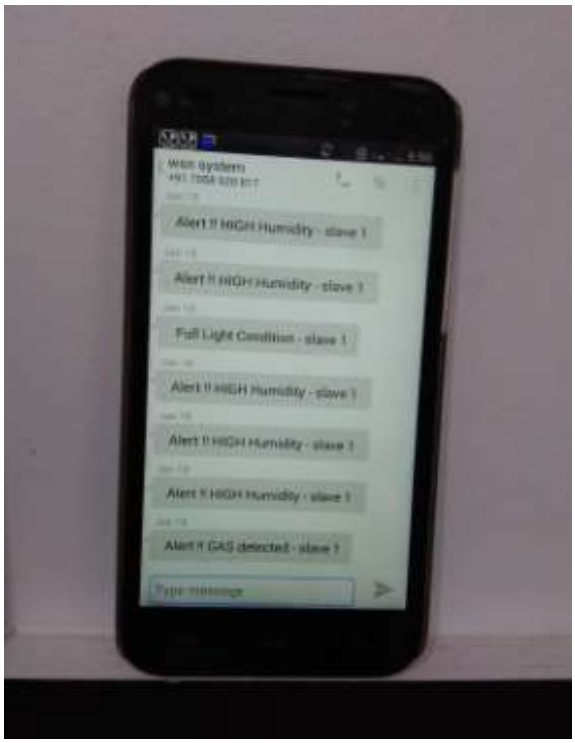

Figure 6 Received alert messages from GSM for humidity,light and gas.

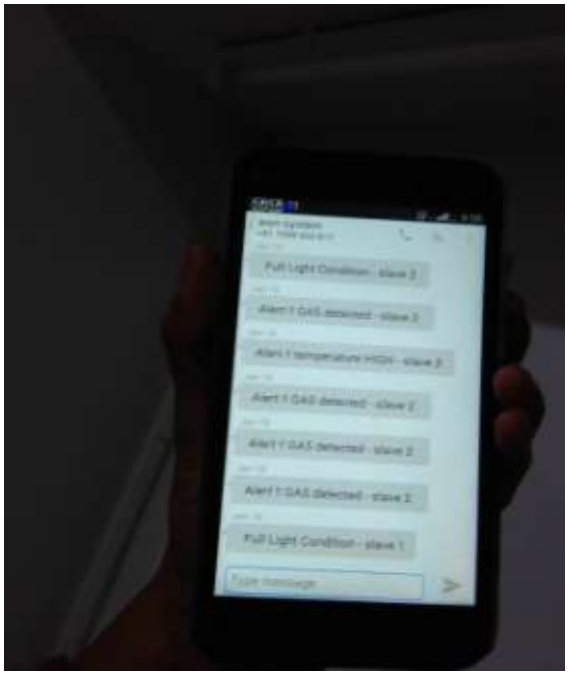

Figure 7 Received messages from GSM for temperature

VI. Conclusion

Wireless home monitoring system monitors the indoor air quality parameters such as CO (carbon monoxide) level, temperature, relative humidity and light intensity. The proposed system able to acquire the information from various sensor nodes located at indoor spaces. It has been shown that after the data collection from sensors, it can be transferred to local PC through serial communication. Further transmission is obtained with GSM modem. This wireless home monitoring system can also be suitable for office, industry environment. The Proposed system able to reduce the health related issues like headache, dizziness, allergic reactions etc. Another advantage is that mobile user can get alert SMS at any location through GSM technology.

The proposed system is simple, easy to operate and flexible. ZigBee based wireless sensor network which can be used to build various indoor monitoring applications. GSM technology provides high security. Thus the main aim is achieved to keep people safe and healthy.

In future this system can be implemented with more number of sensors to measure various environmental parameters. Further system can be implemented by using Wi-Fi connectivity with different ambient sensors for remote gathering and processing of data.

Acknowledgment

I would like to thank “Prof.P.M.Mainkar” for their valuable guidance and support. I am also thankful to the Department of Electronics & Telecommunication of Maharashtra Institute of Technology for providing useful resources.

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