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Wireless Data logger Using ZigBee

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Abstract: ***This paper illustrates environmental parameters monitoring at a remote unit based on Arduino capable of transmitting the parameters to the main unit which later processes for further environmental predictions. This also explains the practical implementation of the wireless communication protocol using ZigBee, data logging, data processing using VB.net.***

Keywords: ZigBee, Arduino, Data logging

1. Introduction

A "Wireless Sensor Network" is a wireless sensor infrastructure for collecting, synthesizing, distributing, viewing, and reacting to information. While a Wireless Sensor Network is well suited to collecting data in hazardous or inhospitable locations, the system has considerable value when situational monitoring must be accomplished over an extended area over a period of time. The Sensor Network can provide situational awareness in many types of applications including disaster preparedness and recovery, emergency response, temperature recording and monitoring etc. Uses of a Sensor Network are virtually limitless since different types of sensors can be connected to the system for different functionalities.

The primary aim of this paper is recording the environmental parameters such as temperature, humidity and flammable gas monitoring of its variations. A Wireless Sensor Network is an embedded, intelligent infrastructure for sensors. The processes to collect, analyze and store the data for later use is called logging. This entire work is about the development of a prototype of Microcontroller based data logging system which can work on wired and wireless network. The testing has been done on wireless network using ZigBee technology [10].

The main objective of this work is to develop a microcontroller based wireless Data logging System. ZigBee will be used as the wireless technology. The entire work is executed in three different phases:

1) In phase I, a Temperature/Humidity/Flammable Gas sensor will be connected to an ADC (Analog to Digital Converter). ADC will be interfaced With the Microcontroller. The sensor data will be collected through ADC for digital conversion.
2) In phase 2, the converted digital data will be taken and processed by the Microcontroller itself. After processing the microcontroller will send the data through ZigBee transmitter module to the ZigBee receiver module attached to the computer.
3) In Phase 3, another ZigBee receiver device will collect the data and send the data to computer via Com Port. A simple application will run to show the actual sensor data like Temperature, Humidity, Flammable Gas, etc.

2. System Architecture

ZigBee wireless sensor nodes mainly consists the sensor unit, monitoring and controlling unit consists of microcontroller (MCU), ZigBee modules, and other components. Micro-controller is responsible for collecting environmental information (such as temperature and humidity) and does analog to digital data conversion if required. Microcontroller is also responsible for controlling and managing the entire nodes. ZigBee modules are responsible for the communication between different nodes.

Sensor unit is the basic unit of wireless sensor network. Sensor unit is used for sensing the environment temperature and humidity values, collecting information and converting to digital signals and monitoring unit is comprised of data acquisition module and data processing module. Data acquisition module receives the data from sensor unit and data processing module makes the decisions according to the environment conditions.

A. System Design

The system may be classified into following two sections.

- Wireless Sensor Nodes
- Base Station GATEWAY

Typically, the hardware of one sensor node is described as shown in Fig.1.

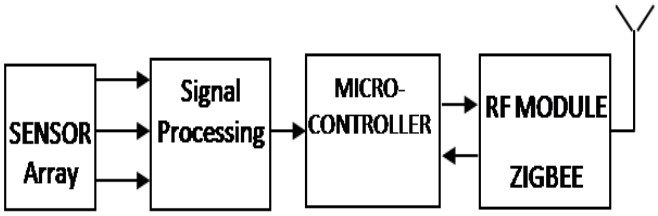

Figure 1: Block diagram of the Wireless Sensor Node

In order to monitor the values of environmental parameters observed at remote location of the room, a PC based Base station is developed and presented in Fig.2. As depicted in Fig.2. The base station consist of the ZigBee module as the wireless receiver. The parameter values which are already calibrated at the sensor node is read serially into the PC and displayed on the monitor on specifically designed windows.

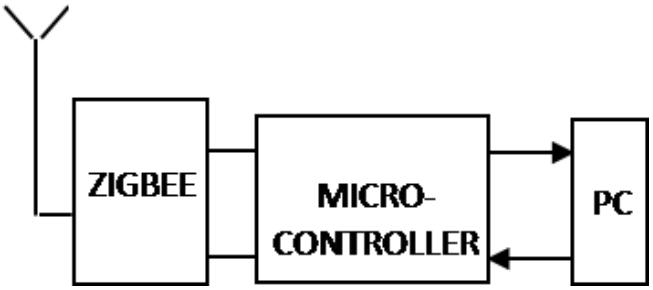

Figure 2: Block diagram of the Base Station-GATEWAY

This monitoring system involved capturing sensor values of various parameters associated with indoor air quality by using different sensors. The system consists of processing unit, which is nothing but Arduino board. We used sensor node, which is nothing but boards containing Arduino board and all sensors together with ZigBee. Web server can either be the hardware or the software that helps to deliver Web content that can be accessed through the Internet. In system architecture Web portal is considered as a future work and is not part of the system in this thesis. Sensor Node is nothing but combination of Arduino, sensor board & ZigBee module. It is part of wireless network and directly talks with coordinator and also with other routers.

Graphical user interface (GUI) is developed on computer side for user-friendly environment using VB.net. This GUI is having numerous functions, the detailed description of which is given in coming chapter. Depending upon requested task corresponding command is given to coordinator mote through Universal Serial Bus (USB). We have used high-level data communication protocol and have specific frame structure for reliable inter-communication.

Coordinator node consist of Arduino board and ZigBee module. We have set up ZigBee module to work as coordinator by using X-CTU software. Arduino board is programmed in Arduino programming language (based on wiring). Coordinator will broadcast this command packet using ZigBee wireless network.

Wireless sensor network consist of sensor node, which are nothing but bundle of Arduino board, Sensor shield and ZigBee module. Sensor shield consists of numerous sensors that measure concentration of various parameters present in air inside house. Depending upon request sensor node send back requested data to coordinator through ZigBee network. Coordinator forward this data to computer through USB and GUI will either display it or saved it on disc as per user request.

B. Design and implementation of Sensor Node

This system is nothing but a multiple boards with Arduino board, sensors and then ZigBee module.

The DHT-11[3] is a low cost humidity and temperature sensor with a single wire digital interface. The sensor is calibrated and doesn't require extra components so you can get right to measuring relative humidity and temperature. Interface circuit of sensor consists of resistor of 10KOhm as shown in Fig.3.

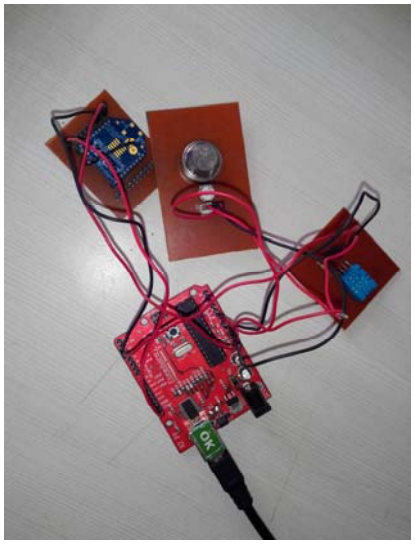

Figure 3: Sensor Node

MQ-2[2] is Semiconductor Sensor for Flammable Gas. Sensitive material of MQ-2 gas sensor is SnO2, which with lower conductivity in clean air. When the target Flammable gas exist, the sensor's conductivity is higher along with the gas concentration rising. MQ-2 gas sensor has high sensitivity 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.

C. Design and implementation of Base Station

This is nothing but an Arduino board and ZigBee module. The Arduino board used at Base Station is MEGA 2560. Arduino connected to PC through USB port i.e. Serial 0. ZigBee module is connected to Serial 1. Data received on Serial port is stored and displayed on screen by use of Graphical User Interface (GUI) developed by VB.net. The interface circuit of Base Station is as shown in Fig. 4.

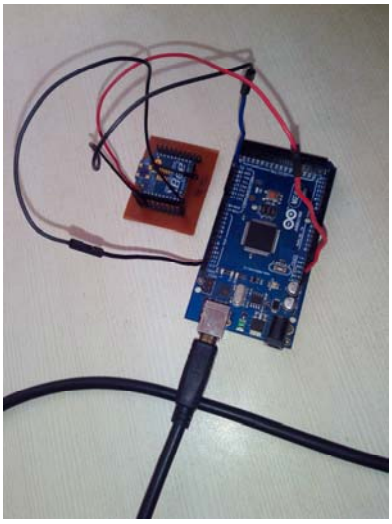

Figure 4: Base Station GATEWAY

3. Major Factors Affecting Indoor Air Qualities

We know that various parameters affect quality of indoor air, so it is very important to learn origin of such parameters as well their effects on human health.

a) Effect of Humidity and Temperature

There is no "ideal" humidity level and temperature suitable for all building occupants. Many factors, such as personal activity and clothing may affect personal comfort. Acceptable relative humidity levels should range from 20% to 60 % year round. Levels less than 20 % in the winter and greater than 60% in the summer should be considered unacceptable. Elevated relative humidity can promote the growth of mold, bacteria, and dust mites, which can aggravate allergies and asthma[6].

b) Effect of flammable gasses

This term applies to a special group of combustible gases that ignite easily and burn rapidly. To avoid an explosion, atmospheric levels must be maintained below the lower explosive limit (LEL) for each gas, or purged of oxygen. Generally measured as 0-100% of the lower explosive limit or in part per million range. Combustible gas monitors are designed to alarm before a potential explosive condition occurs.

4. Evaluation of the Monitoring System

a) Temperature

Fig. 5. shows the RealTime graph of temperature by reading the last ten values from the database. As observed from the graph the maximum and minimum values of temperature can be easily identified. The graph showed a steady state of temperature during the experiment with a current reading of 29 degree Celsius.

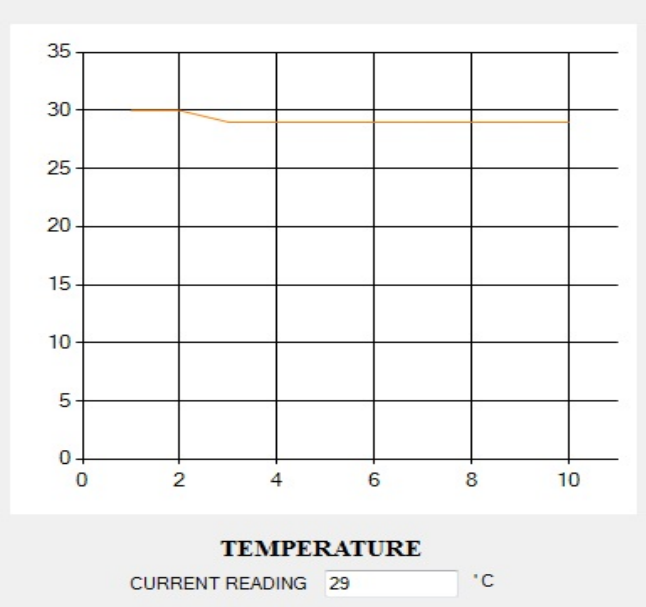

Figure 5: RealTime Graph of Temperature

b) Humidity

Fig. 6. shows the RealTime graph of humidity by reading the last ten values from the database. As observed from the graph the percentage humidity in the air present can be easily identified. The graph shows a current reading of 53% of humidity in the air during the experiment.

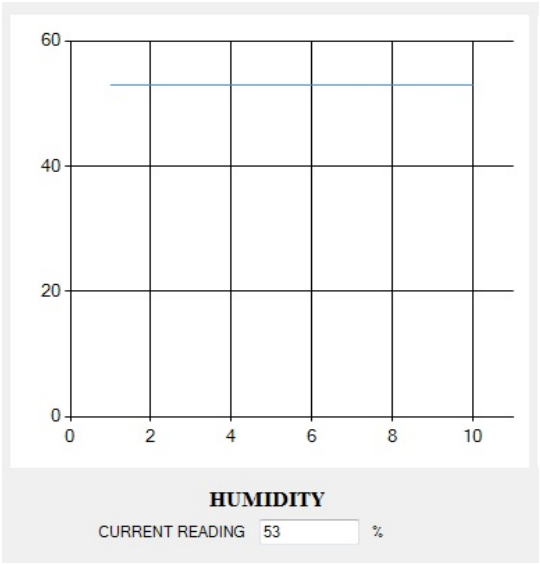

Figure 6: RealTime Graph of Humidity

c) Flammable Gas

Fig. 7. shows the RealTime graph of Flammable Gas by reading the last ten values from the database. As observed from the graph the maximum and minimum contents of the flammable gas being measured in air can be easily identified. The experiment showed a current reading of 765 ppm for flammable gas.

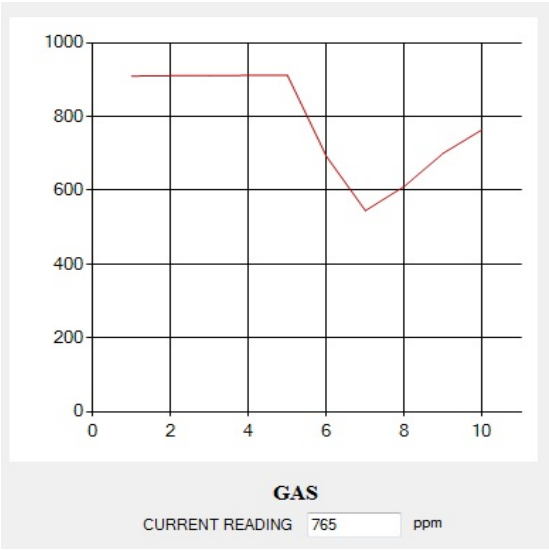

Figure 7: RealTime Graph of Flammable Gas

5. Conclusion

A low cost Environmental Parameter Monitoring System (EPMS) is developed to give clearer and more detailed view of indoor air quality and will be beneficial in many low cost applications. Also such system is in reach of all individuals irrespective of economical class. This system is extension for all available environmental parameter monitoring system, which are working on the principle of place-to-place gas detection i.e. without using wireless network to monitor gas detection over a larger area. In addition to that, this system provides some additional features like continuous data monitoring from more than one place, gas detection in hazardous areas, monitoring at different parts of the building

at the same etc. than available environmental parameter monitoring systems.

Sensor nodes can reconfigure remotely over a wireless network and most of the processing done in software on computer side in order to reduce memory space at sensor nodes. This process also reduces communication load.

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