Environmental Parameter Analysis and Control Using Multi Point Sensor Network
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Abstract— Wireless Sensor Network (WSN) technology is becoming increasingly popular, particularly as applied to a variety of monitoring and tracking applications. Recent developments and advances in both information processing and wireless sensor technologies have provided environmental management systems with capabilities of real-time remote location monitoring. WSN enables monitoring and management of a large set of environmental data including climatic, atmospheric, plant and soil parameters that influence cropland growing environments. Real-time sensor data collection is used for accurate illustrations of current conditions while forecasting future conditions and risks. The real time information from the fields can provide a solid base for farmers to adjust strategies at any time. Instead of making decisions based in some hypothetical average condition, which may not exist anywhere in the reality, a precision farming approach recognizes differences and adjusts management actions accordingly. The prototype sensor network was built on Arduino open source hardware with a seamlessly integrated ZigBee RF module and configured to operate within the ZigBee mesh network standard. This paper provides the implementation of monitoring and controlling of temperature, humidity and flammable gas using ZigBee.

Keywords: ZigBee, Arduino, mesh network

I. 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 variations at multiple locations and controlling it using control system according to user application. A Wireless Sensor Network is an embedded, intelligent infrastructure for sensors. 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. The data transmission over the wireless network is established using mesh network including four nodes.

The main objective of this work was to develop a microcontroller based multipoint wireless sensor network. ZigBee was used as the wireless technology.

II. SYSTEM ARCHITECTURE

This system mainly consists of the sensor unit, monitoring and controlling unit. Sensor unit is the basic unit of wireless sensor network. Sensor unit consists of sensors for sensing the environmental parameters such as temperature and humidity, flammable gas values, collecting information and converting to digital signals. Arduino microcontroller is used for computation and temporary storage data, while ZigBee is used for transmitting the data to base station. Monitoring unit is comprised of Arduino microcontroller used for temporary storing data, ZigBee for receiving the data from sensor unit and Graphical User Interface (GUI) for monitoring data received by the sensor units. Visual Basic 2008 is used to create the GUI for this project. Fig. 1. Shows the general architecture of multipoint wireless sensor network.

![Fig. 1: Block diagram of the Multipoint Wireless Sensor Network](image)

A. Design and implementation of Sensor Network

This system is nothing but a multiple Arduino boards, sensors and ZigBee modules.

The DHT-11 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. 2.

MQ-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.

B. 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. 3.

III. ZIGBEE MESH NETWORK

ZigBee technology employs mesh routing to setup a route between the sensor node and the base station. Mesh routing allows data packets to traverse multiple nodes in a network to route data from a source node to a destination base station. Routers and coordinators can participate in establishing routes between source and destination devices using a process called route discovery. The Route discovery process is based on the AODV (Ad-hoc On-demand Distance Vector) routing protocol.

A. AODV (Ad-hoc On-demand Distance Vector) routing protocol

AODV generally used for ad-hoc networks, is widely used in Wireless Sensors Network (WSN) is an improvement on Destination-Sequenced Distance Vector (DSDV) algorithm. It is reactive routing protocol that creates routing paths between the nodes only if demanded by the source node.

Routing under the AODV protocol is accomplished using tables in each node that store the next hop for a destination node. If next hop is not known, route discovery must take place in order to find path. Since only a limited number of routes can be stored on a router, route discovery will take place more often on a large network with communication between many different nodes.

IV. EVALUATION OF THE MONITORING SYSTEM

A. Temperature

Fig. 5. Shows the four Real-time line graph of temperature at four sensing locations 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 32 to 33 degree Celsius.

Fig. 6. shows two line graphs of temperature, blue colored line graph is the Average Temperature graph which is average of all temperature line graph in Fig. 5. The line graph of average temperature is at 31 degree Celsius. Yellow colored line graph is Threshold line which set by user according to user’s application. Here threshold line is set to 29 degree Celsius.
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Fig. 6: Average and Threshold Graph of Temperature

B. Humidity

Fig. 7 shows the RealTime line graph of humidity at four sensing locations 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% to 60% of humidity in the air during the experiment and which is normal during this seasons.

Fig. 7: RealTime Graph of Humidity at Four Nodes

Fig. 8 shows two line graphs of Humidity, blue colored line graph is the Average Humidity graph which is average of all humidity line graph in Fig. 7. The line graph of average humidity is at 56%. Yellow colored line graph is Threshold line which set by user according to user’s application. Here threshold line is set to 59%.

Fig. 8: Average and Threshold Graph of Humidity

C. Flammable Gas

Fig. 9 shows the RealTime line graph of Flammable Gas at four sensing locations 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 960 ppm to 980 ppm for flammable gas.

Fig. 9: RealTime Graph of Flammable Gas at Four Nodes

Fig. 10 shows two line graphs of flammable gas, blue colored line graph is the Average Flammable Gas graph which is average of all flammable gas line graph in Fig. 9. The line graph of average flammable gas is at 754 ppm. Yellow colored line graph is Threshold line which set by user according to user’s application. Here threshold line is set to 880 ppm.

Fig. 10: Average and Threshold Graph of Flammable Gas

D. Analysis and Control

Regularly gathered data can be used to improve indoor environmental conditions for various indoor premises and storage units. The user of the monitoring program can use the accumulated data to determine the actual conditions in monitored areas, assess the effect of those conditions in monitoring areas, and evaluate the capabilities of the current Environmental parameters control system.

If the gathered data goes above or below threshold points set by the user for particular application, then corresponding control mechanism is used to control the environmental condition. For assessing the robustness of our
system we controlled Temperature and Humidity by the use of portable air conditioners, humidifiers and dehumidifiers and found that the indoor environmental conditions changed according to the set values.

V. CONCLUSION
The Environmental Parameter Analysis and Control Using Multipoint Wireless Sensor Network proves to be an efficient and easy way for controlling the indoor environmental parameters with Real time monitoring facility which is capable of storing a database of a month of past data. This software designed with VB is optimized to store data that is well processed for avoiding redundant data storage.

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