Wireless Sensor Based Remote Controlled Agriculture Monitoring System using ZigBee

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Abstract

The main objective of the present paper is to develop a smart wireless sensor network (WSN) for an agricultural environment. Monitoring agricultural environment for various factors such as temperature and humidity along with other factors can be of significance. The advanced development in wireless sensor networks can be used in monitoring various parameters in agriculture. Due to uneven natural distribution of rain water it is very difficult for farmers to monitor and control the distribution of water to agriculture field in the whole farm or as per the requirement of the crop. There is no ideal irrigation method for all weather conditions, soil structure and variety of crops cultures. Farmers suffer large financial losses because of wrong prediction of weather and incorrect irrigation methods.

Sensors are the essential device for precision agricultural applications. In this paper we have detailed about how to utilize the sensors in crop field area and explained about Wireless Sensor Network (WSN), Zigbee network, Protocol stack, zigbee Applications and the results are given, when implemented the zigbee network experimentally in real time environment.

Keywords – *sensors, Zigbee, Micro-controller(89C52), 2x16 LCD , ADC (0808).*

I. INTRODUCTION

WSN(Wireless sensor networks) can eliminate the cost of installation, maintenance and eliminates connectors. Potential benefits includes fewer catastrophic failures, conservation of natural resources, improved manufacturing productivity, improved emergency response, and enhanced homeland security. The ideal WSN is networked and scalable, consumes very little power, is smart and software programmable, capable of fast data acquisition , reliable and accurate over the long term, costs little to purchase and install, and requires no real maintenance. In order to use the optimum sensors and wireless communications link requires knowledge of the application and problem definition. While Battery life, sensor update rates, and size are other major design considerations. Examples of low data rate sensors include temperature, humidity and peak strain captured passively.

Wireless sensor networks are an important pervasive computing technology invading our environment. Over the years, research into WSN technology has matured to the extent that the ZigBee, based on IEEE 802.15.4, has emerged as a communication and networking standard to cater to the unique needs of WSN. It's a low-power , low-data-rate (250 kbps), fault-tolerant, easily scalable, short-range (100 m) wireless protocol for embedded electronic devices called ZigBee based sensor node system similar to IEEE 802.15.4 standard-based WSN products and systems are now available to suit a variety of applications, including environment monitoring, precision agriculture, home and building automation, healthcare, traffic management, and so on.

II. LITERATURE SURVEY

A. Wireless Sensor Network Historic Perspective

In recent years, as one of the most important applications for WSNs, a number of investigations have been conducted by scientists in realistic agricultural settings. Beckwith, Burrell et al. deployed a sensor network in an Oregon vineyard. 48 nodes were involved in the network and run over a period of more than 6 months, reporting temperature every five minutes. The collected data were converged in a centralized way and could be released on a map and retrieved on a per-sensor basis. Moreover, when the temperature decreased below 0^0c, alarms could be sent out in time, indicating a risk of frost.

The NAV (Network Avanzato per il Vigneto – Advanced Vineyard Network) system was reported by A. Matese et al. The system was a wireless sensor network designed and developed with the aim of remote real-time monitoring and collecting of micro-meteorological parameters in a vineyard. "The system includes a base agrometeorological station (Master Unit) and a series of peripheral wireless nodes (Slave Units) located in the vineyard. The Master Unit is a typical single point monitoring station placed outside the vineyard in a representative site to collect agrometeorological data. It utilizes a wireless technology for data communication and transmission with the Slave Units and remote central server. The Slave Units are multiple stations placed in the vineyard and equipped with agrometeorological sensors for site-specific environmental monitoring, which store and transmit data to the Master Unit. Software was developed for setup and configuration functionality. A graphical user interface operating on the remote central server was implemented to collect and process data and provide real-time control. The devices were tested in a three-step process: hardware functionality and data acquisition, energy consumption and communication. The NAV system is a complete monitoring system that gave flexibility for planning and installation, which fully responded to the objectives of the work in terms of energy efficiency and performance." "Phytophtora is a fungal disease which can enter a field because of a variety of sources. The climatological conditions within the field play a great part in the development and associated attack of the crop. Humidity is a crucial factor in the development of the disease as well as the temperature and whether the leaves are wet or not. [6]" For this reason, Baggio deployed a WSN to monitor humidity and temperature in order to better fight phytophtora in a potato field. However, only the pilot study was reported, and the full-size network has not been deployed yet.

An in-fie1d soi1 moisture and temperature monitoring system was reported by Hui Liu et al. The system consisted of the soi1 monitoring wireless sensor network and remote data center. The sensor node was deveoped using JN5121 modu1e and IEEE 802.15.4/ZigBee wire1ess microcontroller. The sink node for data aggregating was based on ARM7 p1atform to meet the requirements of high-performance. And a gateway was used for long distance data transmission. The alarm subsystem determines several alarm strategies in advance based on relevant production knowledge and experience. Alternatively, alarm thresholds are set up for several key parameters. once the measured values of these parameters exceed the alarm thresholds, alarms in SMS format are automatically sent by the system to the designated mobile phones normally owned by farmers or relevant farming technicians.

III. BLOCK DIAGRAM

A. *Monitoring Section*

The monitoring section is consists of microcontroller AT89C52, ADC 0808, sensors like Temperature sensor, Soil Moisture sensor, Humidity sensor, Fire sensor and Water level sensor, Zigbee transceiver and DC Motor.

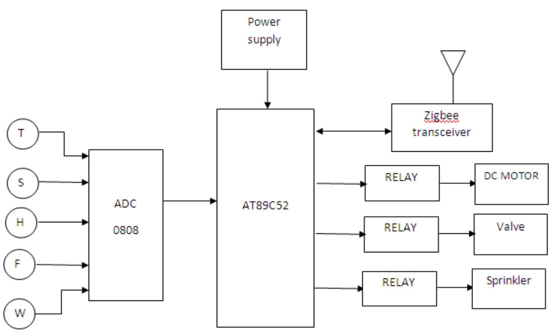

Fig3.1:Block Diagram of Monitoring section

The monitoring section is placed in the agriculture field and the sensors senses the temperature, soil moisture, water molecules in the air, and whenever the fire is occurred and it senses the data in the analog form and it converts into digital signal by using the Analog to Digital Converter and then connected to the microcontroller. The information is then passed to the controlling section through the zigbee transceiver.

B. *Controlling Section*

The controlling section consists of microcontroller AT89C52, LCD, Buzzer, Zigbee and keys to controller.

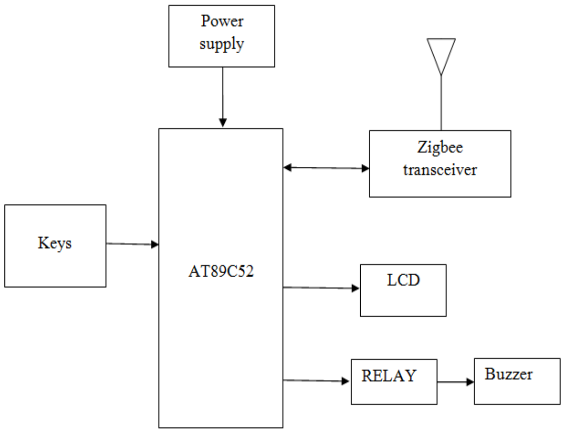

Fig 3.2: Block Diagram of Controlling Section

The keys are used to control the monitoring section whenever the fire is occurred in the agriculture field when soil moisture is dry or wet water level in the tank when is high or low or , medium then the monitoring section sends the message via Zigbee transceiver and from there sent to microcontroller and then message is displayed on the LCD.

IV. BLOCK DIAGRAM DESCRIPTION

The wireless sensor based remote controlled agriculture monitoring system consists of 89C52 micro controller, Zigbee, regulated power supply, 2x16 LCD, buzzer and Sensors.

A. *Microcontroller*

The AT89C52 is a low-power, high-performance CMOS 8-bit microcomputer with 8K bytes of Flash programmable and erasable read only memory (PEROM). The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard 80C51 and 80C52 instruction set and pinout. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C52 is a powerful microcomputer which provides a highly-flexible and cost-effective solution to many embedded control.

Features:

- Compatible with MCS-51™ Products
- 8K Bytes of In-System Reprogrammable Flash Memory
- Endurance: 1,000 Write/Erase Cycles
- Fully Static Operation: 0 Hz to 24 MHz
- Three-level Program Memory Lock
- 256x 8-bit Internal RAM
- 32 Programmable I/O Lines
- Three 16-bit Timer/Counters

B. ADC (ANalog to DigitaL Converter):

The ADC0808 data acquisition component is a monolithic CMOS device with an 8-bit analog-to-digital converter, 8-channel multiplexer and microprocessor compatible control logic. The 8-bit A/D converter uses successive approximation as the conversion technique. The converter features a high impedance chopper stabilized comparator, a 256R voltage divider with analog switch tree and a successive approximation register. The 8-channel multiplexer can directly access any of 8-single-ended analog signals. The device eliminates the need for external zero and full-scale adjustments. Easy interfacing to microprocessors is provided by the latched and decoded multiplexer address inputs and latched TTL tri-state outputs. The design of the ADC0808 has been optimized by incorporating the most desirable aspects of several A/D conversion techniques. The ADC0808 offers high speed, high accuracy, minimal temperature dependence, excellent long-term accuracy and repeatability, and consumes minimal power. These features make this device ideally suited to applications from process and machine control to consumer and automotive applications.

C. Zigbee

ZigBee is a low-cost, low-power, wireless mesh network standard. The low cost allows the technology to be widely deployed in wireless control and monitoring applications. Low power usage allows longer life with smaller batteries. Mesh networking provides high reliability and more extensive range. ZigBee chip vendors typically sell integrated radios and microcontrollers with between 60 KB and 256 KB flash memory.ZigBee operates in the industrial, scientific and medical (ISM) radio bands: 868 MHz in Europe, 915 MHz in the USA and Australia and 2.4 GHz in most jurisdictions worldwide. Data transmission rates vary from 20 kilobits/second in the 868 MHz frequency band to 250 kilobits/second in the 2.4 GHz frequency band.

D. Sensors

1) ***Humidity sensor**:* The humidity sensor we are using is HS200. It is normal upto 60% in the water molecule in the air. If it reaches 80% then there may be fall of rain.
2) ***Fire sensor**:* Here the fire sensor we are using is LDR (light dependent resistor) and it used to sense the fire. It can sense the fire upto 10mts from where the fire is occurred.
3) ***Soil Moisture sensor**:* Here we are using the soil moisture sensor to detect whether the water molecule is present or not.
4) ***Water level sensor**:* Water level sensor is used to know the water level in the tank.

E. LCD (2x16):

A liquid crystal display (LCD) is a thin, flat display device made up of any number of colour or monochrome pixels arrayed in front of a light source or reflector. Each pixel consists of a column of liquid crystal molecules suspended between two transparent electrodes, and two polarizing filters, the axes of polarity of which are perpendicular to each other. Many microcontroller devices use 'smart LCD' displays to output visual information. LCD displays designed around LCD NT-C1611 module, are inexpensive, easy to use, and it is even possible to produce a readout using the 5X7 dots plus cursor of the display. They have a standard ASCII set of characters and mathematical symbols. For an 8-bit data bus, the display requires a +5V supply plus 10 I/O lines (RS RW D7 D6 D5 D4 D3 D2 D1 D0). For a 4-bit data bus it only requires the supply lines plus 6 extra lines (RS RW D7 D6 D5 D4). When the LCD display is not enabled, data lines are tri-state and they do not interfere with the operation of the microcontroller.

V. EXPERIMENTAL RESULTS

Shows the experimental setup of monitoring and controlling section respectively. In controlling section, the sensing unit gathers the data and sends to the monitoring section using the Zigbee node. The monitoring section also consists of the AC power supply to the tri ac driver in order to run a motor to pump the water . The controlling section consists of buzzer that indicates .

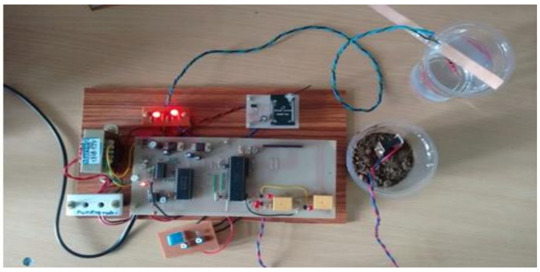

Fig 5.1 Transmitter Section

Fig 5.2 Receiver Section

Fig 5.3 Sensor Output Display on LCD Screen

If the water level is high or low in the tank then the buzzer indicates by ringing and shows the result on the LCD screen which is in the controlling section. If the water molecule in the soil is not present and it is also indicate on the LCD screen.

Fig 5.4 Shows That Soil Moisture Is Dry

The above figure results when the water level is high in the tank and there is no water molecule present in the soil. By this we can switch on motor and closing the valve by using the switches present in the controlling section.

VI. CONCLUSION

Sensors are the essential devices for agricultural applications. Utilization of the sensors in agricultural field area and Wireless Sensor Network (WSN), Zigbee network, Protocol stack, zigbee Applications and the results are discussed. Monitoring the crop field area without human interaction is implemented in real time with the help of Zigbee network. The fundamental concept is to provide a highly enabled monitoring and controlling of agricultural field. The sensing and monitoring of the agricultural field is done for efficient growth of the crop in the field and controlling is carried out to protect the crop field.

Utilization of sensors in the crop field area is discussed and this gives the proposed architecture for real time crop field monitoring with Zigbee wireless sensor network. Analysis of real time readings of temperature, humidity, soil moisture, water level and fire sensor is given by developing them in real time Result shows that Zigbee wireless sensor network is efficient for agricultural field monitoring.

FUTURE SCOPE

The future work is trying to improve the topology structure to make all nodes communicate with each other, also to improve the stability of wireless sensors in communication by better software and hardware design. Especially, a design of smart irrigation control system based on wireless sensor networks and implement irrigation decision by real-time humidity data and expert data. Moreover, design and implementation of software architecture for the smart monitor system need continuous improvement to meet various real demands change the font style.

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