Wireless Sensor Based Remote Monitoring System for Agriculture Using ZigBee and GPS

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Abstract

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 prediciton of weather and incorrect irrigation methods. In this context, with the evolution of miniaturized sensor devices coupled with wireless technologies, it is possible remotely monitor parameters such as moisure, temperature and humidity. In this paper it is proposed to design, develop and implement a wireless sensor network connected to a central node using ZigBee, which in turn is connected to a Central Monitoring Station (CMS) through General Packet Radio Service (GPRS) or Global System for Mobile (GSM) technologies. The system also obtains Global Positionting System (GPS) parameters related to the field and sends them to a central monitoring station. This system is expected to help farmers in evaluating soil conditions and act accordingly.

Key words: Sensors, ZigBee, GPRS, GSM, GPS

I. Introduction

In the field of soil environmental monitoring, real-time monitoring the temperature and humidity of soil can correctly guide agricultural production and improve crop yield. It also can provide scientific basis for high-precision monitoring and calculating for farmland drought and flood area. Traditional wired communications exist many problems It has broad application prospects in soil environmental monitoring field[1].

The age of the Internet of things comes; wireless sensor networks become the core of networking. In order to achieve greater things on the technical requirements of the Internet of things, we adopt the technology of wireless sensor network based on Zigbee, GPRS and Web Services technology designing a set of low cost, low power Since the function requirement of The Internet of things and temperature humidity monitoring system of soil, this paper uses the overall structure as figure 1 shows.

The system consists of wireless sensor network nodes and network management platform. Zigbee node (1 to n) respectively transmits acquisition of the temperature and humidity data to the Zigbee stations of gateways node. The automatic networking realizes through the many jump routing consumption, flexible automatic networking temperature humidity monitoring system of soil. And the system is a complete set of wireless sensor network induction, acquisition, storage, application, reporting, solution, has a good man-computer exchange interface. Users need not go into farmland, in a corner anywhere in the world, could prompt understand the changing condition of farmland soil temperature and humidity, and scientifically guide agricultural production.

Remainder of the paper is organized as follows. Section II Introduces the General Structure Design Section III. Describe about Wireless Sensor Network Node Design Section IV Gives Network Management Platform Design and finally Section V Describe System Test will test the proposed system.

II. The System Architecture

form between each node and tuner network. Then transmits the data to GPRS through a serial port, also can pass to PC to view real-time data.

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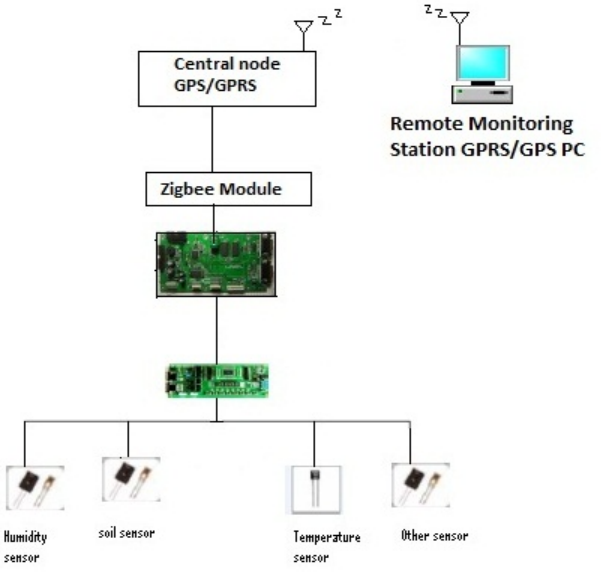

Figure. 1. System Architecture

Running in the PC, the data acquisition terminal software can realize the node management, data query, data storage and release, and the Web Services have identified by sharing data network technology, finally reach The Internet of Things. The whole system designs good human-machine interface, easy exchange[3].

III. Design of Wireless Sensor Network

A. Wireless sensor network node hardware design

Considering the wireless sensor network requirement to implement low cost, low power consumption, high performance and high sensitivity and the anti-interference ability, In this paper, we choose CC2430 chip from TI company for Zigbee nodes , SHT15 chip for sensors, and the power part adopts solar power first.

1)S3C2440

ARM Intelligent Monitoring Center uses Samsung's S3C2440 processor as its main controller, the performance and frequency of which are suitable for real-time video image capture and processing applications [2]. Embedded Linux operating system and boa embedded web server run on the main controller to manage various types of equipments including sensor networks, GSM / GPRS dual band module, USB cameras and so on[3].

2) Temperature sensor

SHT15 is small-sized, calibration, muti-function, intelligent sensor from the company of Switzerland sensiri-on. It can measure relative parameters such as temperature, humidity and temperature measuring range is -40^{0}C~123.8^{0}C, Resolution is 0.1, response time is less than 3s. SHT15 is intelligent new sensor with free of calibration, free of debugging and almost no outer circuit. The system uses 32-bit RISC processor Samsung S3C2440 with various features and peripherals. It's based on ARM 920T core and supports embedded Linux, WinCE, VxWorks and other embedded operating system. All the properties meet the requirements of the remote monitoring system.

3) Humidity sensor

Humidity measurement instruments usually rely on measurements of some other quantity such as temperature, pressure, mass or a mechanical or electrical change in a substance as moisture is absorbed. By calibration and calculation, these measured quantities can lead to a measurement of humidity.

4) Soil sensor

The soil sensors collect information on soil temperature and soil moisture in the outdoors environment.

B. Zigbee communication protocol realizing

The digital frequency part, the direct sequence spread spectrum (DSSS) technology, not only can easily realize 802.15.4 short-range wireless communication standard compatible, and greatly improve the reliability of wireless communications[10]. The protocol stack design is precise and reliable, including very important AES processing technology, CSMA/CA energy-saving technology, etc[4].

In the past, due to the low consumption, we more used star topology in the networking. But the coverage and the efficiency will be limited by the structure of the network by star, and failure of Cluster nodes can lead to the failure of the network structure. Relative to the star network, the scope preventing ordinary lithium battery power supply time short and cannot continue ,making a foundation for using the tree topology. of physical of tree network is bigger, the number of nodes for more. In this paper, we use the solar power supply.

Internal protocol, between layer and layer, realize information communication through the API, API provides the interfaces to 802.15.4 protocol stack management and data services[11]. Direct executive function directly executes those operation codes that realize a MAC; Callback function accesses date through the parameters of the function, only is effective during the implementation. These API functions execute in MAC environment.

IV. Design of Network Management Platform

A. Hardware design of gateway node

The gateway node, as a information management and localization of wireless sensor network platform, need have quicker processing speed and strong information management functions. In this design, we focus the core

GPRS building wireless sensor network gateways hardware platform.

1) Zigbee station

In this paper, we embed Zigbee coordinator node into the gateway, as a fully functional devices, collecting all nodes data. Communication between Coordinator and GPRS is through serial, also can directly communicate with the PC, realizing real-time data checking and monitoring[4].

2) GPRS/GSM

This system uses SIM100-E GSM / GPRS dual-band module for voice transmission, messages and data services. It provides wireless interface and communicates with the ARM Intelligent Monitoring Center through the RS232 interface. We write AT commands into the serial device file and control the GPRS module to achieve functions such as the SMS / MMS mode automatic alarm to the managers when an exception occurs with the field monitoring data[3].

3) The solar energy power supply

In this experiment, according to the current, voltage and other data measured from gateway and the application requirements, we designed the solar power for gateway node .using the 12V voltage, experiments proved the solar power supply system is stable and reliable.

4) GPS

In this Global positioning system (GPS) is used for finding the location of agriculture field location.

The whole arrangement shown below figure 2

Figure. 2. Agriculture monitoring system

B. Software on the Internet of Things

1) Acquisition terminal

Acquisition terminal program gets RF data in the gateway based of nodes through a serial port, USB port, then temporarily stores in local, can be checked conveniently. There are monitoring and controlling the maps and historical data query functions, In the specified operating or provisions specified duration, acquisition terminal will upload data to a WEB database server.

2) Web Data base server

AtosServer runs in the server, being responsible for receiving all the acquisition terminal (regional) data, and according to the area code, sets all data in the database. Then it provides a WEB server functions. System adopts B/S structure; the user can visit at anytime through specific terminal server.

3) Access server

PC terminals service program can be used for access servers, obtains a latest data of each district at anytime and anywhere, and master WSN dynamic data as soon as possible[1].

V. SYSTEM TEST

A. Test Plan

In 800square meters, we distributed six temperature humidity sensor nodes, each node can achieve routing functions. Soil temperature humidity sensor node is set into soil for 8cm, completes the data collection, sending. Then the nodes will be dormant until the next one sampling period.

B. Testing Result

The communication between the nodes in the distance is about 15m, after launching system for 1min, node binding can be completed, forming self-organizing networks. When getting to the sampling time, they can complete sending data in 10s. query and management information can be got on acquisition terminal, as shown 3

Figrure. 3. Acquisition terminal module

VI. Experimental Results

We can also send data to the remote server with the static IP address through the GPRS; delay shall not exceed 1min. Fig. 4 shows the control panels interface of the

proposed system. The control panel contains three sections which are Sensor Ports, Current Temperature and Set Maximum Temperature. The Sensor Ports set the connection between computer and the wireless temperature sensor. For communication to be done, the end user must select the communication port from the drop down menu. Besides, the Current Temperature section displays the retrieved temperature data. There are two types of temperature data which are the data retrieved directly from the sensor, and the data extracted from the database. The upper textbox in this section contains the former type of the data. This data contains other values than temperature and it changes for every second. For the purpose of this system, this data is sent to the database and extracted to generate the temperature value only. This extracted temperature value is shown in the lower textbox of this section[5].

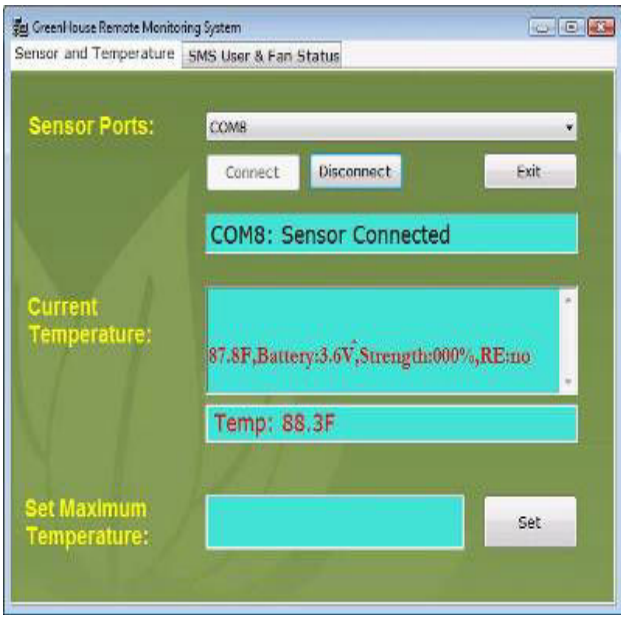

Figure. 4. Soil sensor and temperature sensor control panel interface

The data collected from the physical layer is processed by each manager for storage in the database, and is presented on the GUI to users via the Web server. Figure 5 below shows a Web GUI provided to users, where (1) is a result of monitoring data, where the data coming in through the sensors is displayed where this server is installed by the streaming service through the information manager. (2) is a result of the location monitoring service, which shows that the current location data of the collected server system is mapped on the map with red markers. (3) and (4) display environmental and soil data stored in the database through the sensor manager. Finally (5) shows data acquired from environmental sensors as a graphic form by averaging them[6].

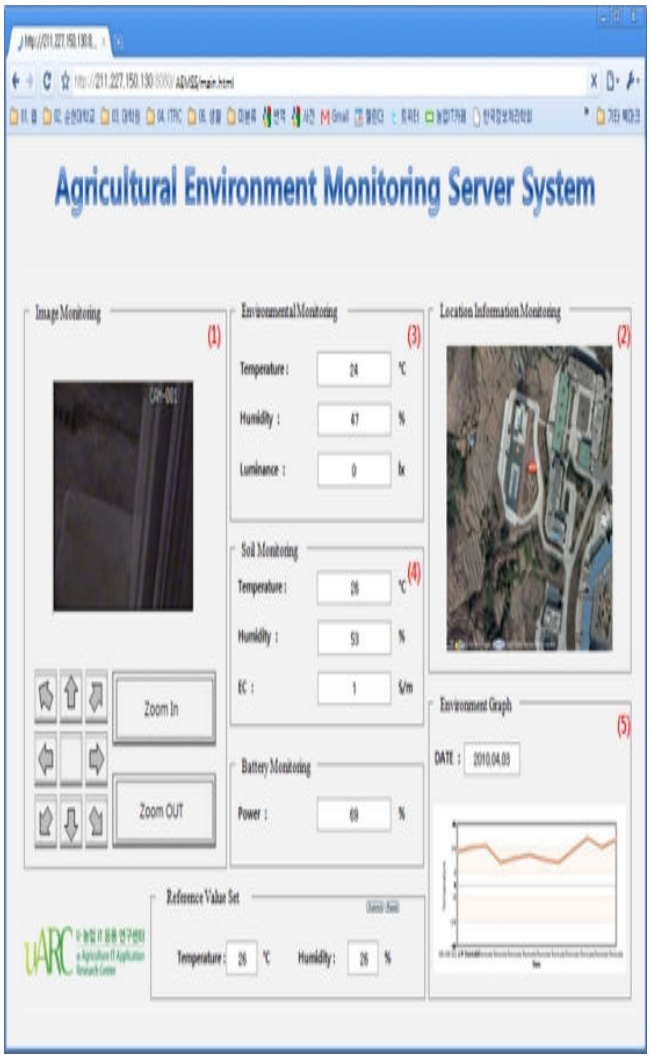

Figure. 5. Web GUI for Agricultural environment monitoring Server system

VII. Conclusion

In the specific application needs of soil environmental monitoring system and analysis those problem existing in monitoring system, we designed and implemented a wireless sensor network based on the soil temperature humidity monitoring system. The system can realize rapidly automatic networking and real-time data acquisition, transmission, display. With the characteristics of low cost, low power consumption, flexibility networking, without cabling, friendly interface, etc. Through GPRS technologies and Web Services technology, we can realize the function of the data networking, remote monitoring, it shows that the system can meet the requirements of the temperature and humidity of soil environmental monitoring

and unified management. In future, we can monitor the ground water level using appropriate sensor. Further the research could also be enhanced to produce a system that can monitor the whole weather condition for a large area like state or country.

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