Research on Online Monitoring System of Crop Growth Environment Based on 6lowpan Technology

Kele Xu[1, a], Yanrong Liu[2, b]

[1]Electronic Information School, Xianyang Vocational & Technical College, Xi'an, 712000, China

[2]School of Information Engineering, Shaanxi International Business College, Xi'an, 712046, China

[a]email:Xhlyr1904@Sina.com, [b]email:Xhlyr1904@Sina.com

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Abstract: in Order to Quickly and Comprehensively Obtain the Parameter Changes in the Process of Crop Growth, Meet the Demand for Information in Agricultural Production, and Improve the Grain Yield, a Crop Growth Parameter Monitoring System Based on 6lowpan Technology Was Designed and Developed. the System Adopts 6lowpan Architecture to Realize Point-to-Point Communication between the Internet and the Wireless Sensor Network. It Does Not Require a Specific Gateway for Protocol Conversion or Protocol Bearer, Thus Realizing Real-Time Monitoring and Control of the Agricultural Environment, Reducing Energy Consumption and Shortening Delay. Time. the System Uses Multiple Soil Moisture Sensors and Infrared Temperature Sensors to Perform a Full-Scale Real-Time Observation of the Environment and Conditions of Plant Growth. Each Observation Point Transmits the Data to the Monitoring Center through the 6lowpan-Based Wireless Network. the Monitoring Center Can Record and Analyze the Data, Evaluate the Growth Status of the Crop, and Timely Report the Evaluation Result to Relevant Users through Sms. Good Guide to the Purpose of Production. It Has Been Verified by Practice That the System Can Achieve Stable Data Transmission and is Suitable for Real-Time Monitoring of Crop Growth Parameters.

1. Introduction

The wireless sensor network (WSN) has the advantages of compact structure, easy layout, easy maintenance, low price and high measurement accuracy, which is very suitable for the monitoring and control of the facility agricultural environment. In 2002, Intel pioneered the establishment of the first wireless sensing vineyard in Oregon. Sensor nodes were distributed in every corner of the vineyard, and soil temperature, humidity or the amount of harmful substances in the area were checked at intervals to ensure Grapes can grow healthily and gain a good harvest [1]. In recent years, researchers at home and abroad have studied this field and obtained certain research results. Among them, the typical results are: the intelligent network system that implements WSN by wireless communication to realize the distributed multi-point of farmland environmental information.[2] Using long-distance farmland environmental information collection system using packet wireless service and network technology [3]; applying WSN to crop precision irrigation system and crop water condition monitoring system [4], applying WSN to greenhouse environment Information collection, using WSN for the collection and transmission of farmland data. The above research results have important application value and practical significance, but there are also deficiencies. There is no point-to-point communication between the WSN and the Internet in the system, that is, the user cannot monitor the environmental parameters of a specific area in real time, and cannot send control commands to a specific control sensor node to drive the temperature, humidity, etc. Real-time control of the agricultural environment; the WSN in the system cannot directly access the Internet, that is, the system needs to perform protocol conversion or protocol bearer through a specific gateway to realize communication between the WSN and the Internet, increasing energy consumption and processing delay time, and also increasing system instability. In view of the shortcomings of the existing system, this paper proposes a real-time monitoring system for

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agricultural environment based on 6LoWPAN wireless sensor network. The point-to-point communication between the WSN and the Internet is realized, and the user can monitor and control the agricultural environment parameters in a specific area in real time; the WSN in the system directly accesses the Internet, and does not need a specific gateway for protocol conversion or protocol bearer.

2. .The Main Functions and Architecture

2.1 Main Functions

The system realizes the monitoring and control of environmental conditions in nurseries, farmland, greenhouses, etc. According to the requirements of environmental monitoring, the system has the following functions:

1)Perception, sampling and transmission of agricultural environmental information.

The sensor node can receive and interpret commands from Internet users, and timely transmit the collected agricultural environmental information data to the Internet user terminal through the wireless sensor network and the Internet for researchers to conduct online or offline data mining and analysis.

2)Access and control of data.

The data access to the monitoring area can be divided into two methods: on-site and remote. When performing initial configuration and on-site maintenance tasks, the system needs to be debugged on site; during the operation of the system, ordinary agricultural workers are not restricted by geographical location.[3]The Internet provides point-to-point access and control of sensor nodes.

3)Energy saving of sensor nodes.

Depending on the growth cycle of the crop, the monitoring system needs to operate continuously on its own battery for several months without intervention. The energy consumption of sensor nodes is mainly used for data reception and transmission. Therefore, the data transmission amount of sensor nodes should be minimized to reduce the energy consumption and prolong the system survival time.

4)Control of the agricultural environment.

The sensor node is used to control the switch of temperature, humidity and other regulating devices to realize the real-time control of the agricultural environment. Through the WSN and the Internet point-to-point communication, the user sends a command to the sensor node with a specific IP address to drive the switch of the environmental regulating device to realize the agricultural environment.

2.2 Architecture

The system consists of five parts: 6LoWPAN wireless sensor network, 6LoWPAN gateway node, transmission network, Internet end user and database, as shown in Figure 1.

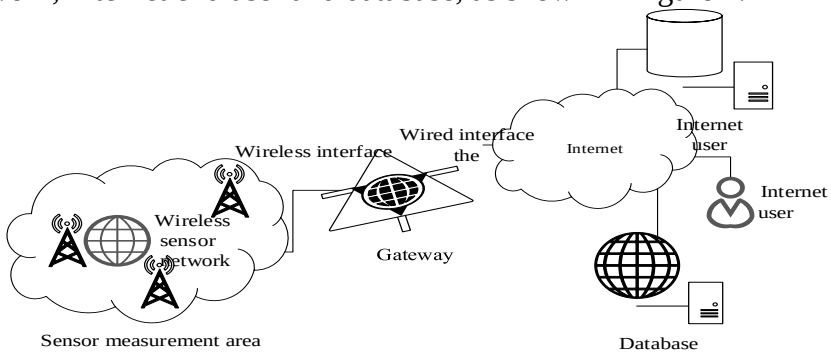

Fig.1 System Architecture

2.3 Hardware Framework

The hardware framework of the 6LoWPAN gateway in this system consists of three components: wireless transceiver, microprocessor and wired network interface. The function of 6LoWPAN gateway node is to connect WSN with the Internet, to realize the streamlining of the protocol stack and the routing and forwarding of data packets. The 6LoWPAN gateway receives Internet packet data from the wired network interface, the microprocessor streamlines the data packet, and sends the streamlined data packet to the wireless sensor network through the wireless transceiver; likewise, the 6LoWPAN gateway receives the sensor node from the wireless transceiver. The streamlined data packet, the microprocessor restores the reduced data packet to a complete data packet, and sends the complete data packet to the Internet through the wired network interface. The hardware configuration of the wireless transceiver, microprocessor and wired network interface used in this system is [5]:

1) Wireless transceiver:

The CC2420 supports the IEEE802.15.4 standard; it is fabricated in a 0.18 um CMOS process; the data transfer rate is 250 kbps; the RAM is divided into 3 banks, a total of 368 bytes, of which bank0 is 128 bytes, which is used to store the data to be sent, bank1 It is 128 bytes for storing data received by CC2420, bank2 is 112 bytes, it is used to store some information such as CC2420's 16-bit network address, 64-bit IEEE address and key; 50 registers, state and configuration There are 33 registers for setting the working mode of CC2420. There are 15 command registers. Write the command words of a specific format to different command registers, and perform the corresponding actions.

2) Microprocessor:

The core is ARM920T 32-bit processor, clocked at 203 MHz; memory is 64 MB Nand Flash and 64MB SDRAM; 1 LCD controller; 4 PWM-enabled timers and 1 internal clock; 8 channels of 10 bits ADC; 1 touch screen interface; 1 USB host interface, 1 USB device interface; 2 SPI interfaces; SD interface and MMC card interface; 117-bit general-purpose I/O port and 24-bit external interrupt source.

3) Wired network interface:

16-bit Ethernet controller; supports IEEE802.3 Ethernet standard with ISA interface; RAM is 4 Kbytes; 10Base-T connection port with low-pass filtering, supports ABase auto of 10Base2, 10Base5 and 10Base-F Retransmission; maximum current is 55 mA (V); full-duplex operation; support for external EEPROM.

2.4 Software Framework

The software framework of the 6LoWPAN gateway node consists of two levels: hardware abstraction layer and protocol layer. The hardware abstraction layer includes a wireless hardware abstraction layer and a wired hardware abstraction layer, and its functions are:

1) Wireless hardware abstraction layer: receives data from a wireless interface (ie, a wireless transceiver) and submits the data to a protocol layer for processing; receives data from the protocol layer, and transmits the data through the wireless interface;

2) Wired hardware abstraction layer: receives data from the wired interface and submits the data to the protocol layer for processing; receives data from the protocol layer and sends the data out through the wired interface.

2.5 Sensor Node

1) Hardware Framework

The sensor node hardware framework in this system consists of three components: a wireless transceiver, a microprocessor and a sensing unit. The sensor node receives data from Internet users through a wireless transceiver, and the microprocessor processes and interprets the data, and The information data sensed and collected by the sensing unit is encapsulated and sent to the Internet user through the wireless transceiver.[6]

2)Software Framework

The software framework of the sensor node consists of three levels: hardware abstraction layer, protocol layer and application layer.

The functions of the hardware abstraction layer are: 1) receiving data from the wireless interface and submitting the data to the protocol layer for processing; 2) receiving data from the protocol layer and transmitting the data through the wireless interface.

The function of the protocol layer is:

1) The protocol layer receives the data packet from the hardware abstraction layer, and determines whether it is the destination node according to the destination address of the data packet. If yes, the data packet payload is submitted to the application layer for processing, otherwise, according to the routing information, The hardware abstraction layer forwards the data packet to the next hop node;

2) The protocol layer receives data from the application layer, encapsulates it, and forwards the data packet to the next hop node through the hardware abstraction layer according to the routing information. The function of the application layer is: receiving data from the protocol layer, interpreting the received data as a corresponding service request command, and if querying the service request, submitting the collected environmental data to the protocol layer for processing, if it is controlling the service request, The corresponding adjustment device switch is executed, and the status information of the execution result is returned to the protocol layer processing.

2.6 System Energy Saving

Since the sensor node has limited resources, and the energy consumed by processing the data is several orders of magnitude smaller than the energy consumed to transmit the data [18], the power consumption of the sensor node is mainly used for data transmission. The system achieves energy savings through the following three aspects:

1) 6LoWPAN wireless sensor network proposes a compact IPv6 protocol stack suitable for sensor nodes, which can compress UDP/IPv6 header to 4 bytes [6], which greatly reduces the data transmission amount of sensor nodes, thus saving sensor nodes. energy of;

2) The link layer of the 6LoWPAN wireless sensor network adopts the IEEE802.15.4 standard [7]. The IEEE802.15.4 standard is considered to be an ideal implementation technology for wireless sensor networks due to its low cost, low power consumption and high transmission quality. In the IEEE802.15.4 standard, there are two types of sensor nodes: a full-featured node that implements the route forwarding function and some functional nodes that do not implement the route forwarding function. In general, full-featured nodes only account for a small portion (less than 10%) of all nodes in the 6LoWPAN wireless sensor network, and most of the sensor nodes are only used to collect and transmit/receive data of the node, thereby saving the work of the entire network. Consumption, extending the life of the network;

3) In the IEEE802.15.4 standard, the duty cycle of the sensor node is less than 1% [6], that is, the sensor node is in a dormant state most of the time, thereby greatly saving the energy of the sensor node. At present, many commercial sensor nodes (such as sensor nodes using CC2420 RF chip as wireless transceiver) support IEEE802.15.4 standard, and can directly apply sensor nodes supporting IEEE802.15.4 standard to the system to realize system energy saving and extend system life.

2.7 Monitoring Center Design

The main function of the monitoring center is to analyze, manage and display the data uploaded by the data nodes. At the same time, the monitoring center also implements the control of the Sink node by SMS, and informs the farmers.

1) Data function

There are many nodes monitored by the monitoring center. The data uploaded by each sensor must use different formulas to perform the physical quantity inversion. Different individuals in the same type of sensor also have differences. The monitoring center needs to set different correction coefficients for different sensor individuals.[7] Because of the large amount of data involved, SQL Server is required to manage sensor data. The area detected by the monitoring center is very large,

and each sensor node is marked on the map in an intuitive way, so that the farmer only needs to select the location of the sensor node while selecting the data. Choose Map Server's open source Geographic Information System (GIS), which combines data and maps and uploads the results to the Internet.

2) Control and notification functions

In addition to a series of operations on the data, the monitoring center can also control the Sink node and notify the user. The GSM/GPRS Modem in the monitoring center can realize the transmission and reception of SMS (SMS) while transmitting GPRS network data, and send the command to the Sink node through SMS. After the Sink node parses the command, it can do it for different commands. Different responses [7]. The monitoring center can also send a text message to the mobile terminal to send the information to the relevant farmers.

3. Test Results

The field data is displayed by wireless sensor nodes and nodes, and the sensor information displayed in the monitoring center is shown in Table 1. Through on-site debugging, wireless sensor nodes can accurately collect physical values of temperature, humidity, and photosynthetically effective radiance, and implement a 6LoWPAN-based wireless sensor network. Through this network, each sensor node can transmit data to the node accurately and without error. Through the network, the node can transmit the merged data to the monitoring center in real time. The monitoring center will analyze the data and display it using the GIS system, and can also control the node by using the short message system to guide the production work of the farmers. This system can effectively collect, display and publish farmland information, which is a good guide for agricultural production.

Table 1 Sensor Information

Time (min)	Temperature (^{o}C)	Soil moisture (%)	Photon (μmolm^{-2})
0	25.8	28.9	1059.3
1	25.8	28.9	1059.8
2	25.8	28.9	1061.7
3	25.8	28.6	1061.8
4	25.7	28.6	1096.7
5	25.8	28.9	1096.8
6	25.8	28.8	1097.5
7	25.9	28.5	1099.4
8	25.8	27.9	1112.7

4. Conclusion

In view of the shortcomings of the existing agricultural environment monitoring system, this paper proposes a real-time monitoring system for agricultural environment based on 6LoWPAN wireless sensor network. The wireless sensor network of this system does not need a specific gateway for protocol conversion or protocol bearer can directly access the Internet, and The point-to-point communication between the wireless sensor network (WSN) and the Internet is realized, and the user can monitor and control the agricultural environment parameters in a specific area in real time. We have verified the inter-system test. The test results show that the system can monitor and control the agricultural environment in real time, which verifies the practicability of the system.

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