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Research Article

Study on Food Information Online Monitoring System Utilized Wireless Sensor Network

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Abstract: The farmland information monitoring generally has the characteristics of complex environment, more monitoring point and wide coverage. Wireless sensor networks technical is the main means to realize variables information collection of agricultural environment network. In order to solve the problem of reliable real-time transmission, a farmland information online monitoring based on wireless sensor network has been designed, which the ZigBee wireless communication technology was used. Monitoring data of different farmland regions are transmitted through the GPRS network to the monitoring center securely and reliably. The use of data monitoring center is aimed at collecting data for processing. The results show that the online monitoring system of field information can automatically complete the data acquisition and transmission throw GPRS network, the data can be sent to the data server with high stability, high reliability, punctuality, meeting the basic requirements of on-line monitoring of farmland information.

Keywords: GPRS, network structure, wireless sensor network, ZigBee technology

INTRODUCTION

Agricultural product quality and safety incidents broke out, so consumers and safety of agricultural proposed new requirements (Luo *et al*., 2009). The urgent need for new management models and techniques to guarantee quality and safety of agricultural products and people's health. Things is an important part of the new generation of information technology, it is through radio frequency RFID tags, sensors, GPS and other IT equipment in accordance with the agreed protocol and the articles connected to Internet, interactive, communication and information, to achieve the objects of the intelligent recognition, positioning, tracking, monitoring and management (Alireza and Ali, 2008). In recent years, the rapid development of networking technology has been applied to the traffic, intelligent fire, safety, industrial monitoring, environmental monitoring and many other fields (Elbeltai *et al*., 2007).

In agricultural information collection facilities, the domestic agricultural production environmental monitoring, fertilizer and water testing, heavy metal detection sensor equipment, data collection terminals in kind, function, sensitivity, stability (Zhang *et al*., 2012; Gg *et al*., 2012). Cost has not yet reached large-scale application of the Internet of Things requirements need to be further towards miniaturization, precision, sensitivity development; crop performance information perception sensor body also heavily dependent on imports, the cost is high. Therefore, agricultural information collection is need to focus on the development of agricultural research networking technology (Rahimi-Vahed and Mirzaei, 2007).

In order to solve the low cost of field information, low power, reliable real-time transmission problem, we designed a farmland information online monitoring based on wireless sensor network, which is used to realize real-time collection of field information air temperature and humidity, light intensity, rainfall, etc. Monitoring data of different farmland regions are transmitted through the GPRS network to the monitoring center securely and reliably. The use of data monitoring center is aimed at collecting data for processing. The results show that the online monitoring system of field information can automatically complete the data acquisition and transmission throw GPRS network, the data can be sent to the data server with high stability, high reliability, punctuality, meeting the basic requirements of on-line monitoring of farmland information. By accessing the Internet or the existing mobile network via a wireless gateway, remote monitoring and scientific management of agricultural crop information can be achieved and rational decisions based on agricultural information.

HARDWARE DESIGN

An overview of wireless sensor networks: According to the wide coverage of large farmland and many monitoring parameters, combined with the characteristics of the Internet of Things architecture,

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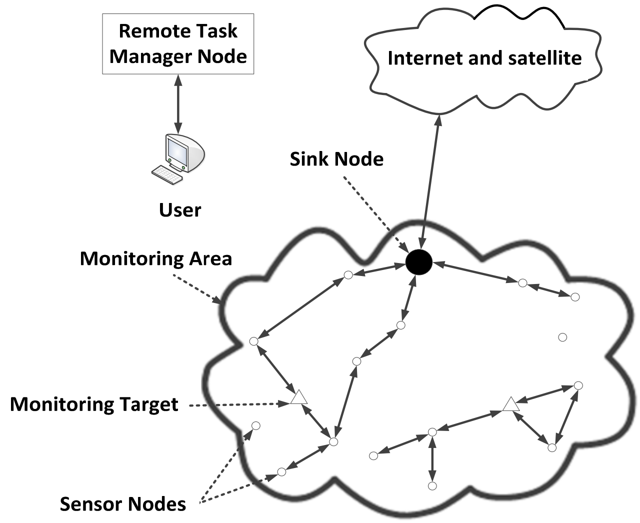

Fig. 1: The structure of system

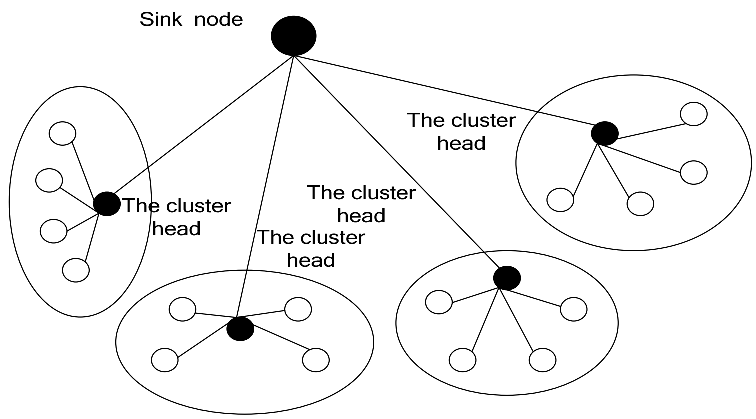

Fig. 2: The cluster head node and sink communication, forming a two magnitude star network

the structure of farmland information online monitoring system based on wireless sensor network is shown in Fig. 1. The system is divided into three layers: the sensing layer, the transport layer and the application layer. The sensing layer mainly uses the ZigBee technology to build wireless sensor network which is a comprehensive coverage of the monitoring area to achieve sensing data acquisition and transmission (Aggarwal and Yu, 2002).

In a cluster, cluster formation adjacent node dynamic, random cluster head. The LEACH algorithm of cluster head election, to the probability threshold T set a node as cluster head (n), expressed as (4) shows, in a cycle, if a node has been elected cluster head, makes T (n) = 0, this node will not be elected as cluster head, otherwise, the T (n) probability was elected (Anu *et al*., 2008).

$$T_{(n)} = \begin{cases} \dfrac{p}{1 - p \times [r \bmod (1/p)]}, n \in G \\ 0, else \end{cases} \tag{1}$$

LEACH algorithm makes the nodes in the cluster and the cluster head communication directly the cluster head node and sink communication, forming a two magnitude star network, as shown in Fig. 2.

Design of gateway node hardware: The gateway node not only collects the farmland data information from the wireless sensor network, but also sends them through the GPRS module to the data monitoring center and receives the control commands from the data monitoring center. Therefore, the data processing tasks is arduous accomplished by the gateway node requires a mature network protocol support and high hardware resource. In addition, in order to reduce the power consumption of the gateway node, TI's ultra-low-power microcontroller MSP430F149, the module CC2530F256 supporting protocol ZigBee2007 stack and the GPRS module SIM900 supporting TCP/IP protocol from the SIMCOM company are selected (TI Semiconductor, Inc., 2010). The specific hardware interface circuit is shown in Fig. 3. The gateway node

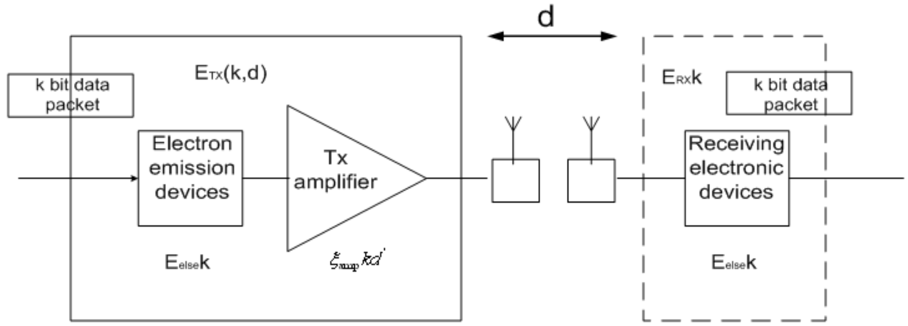

Fig. 3: Gateway node hardware interface circuit

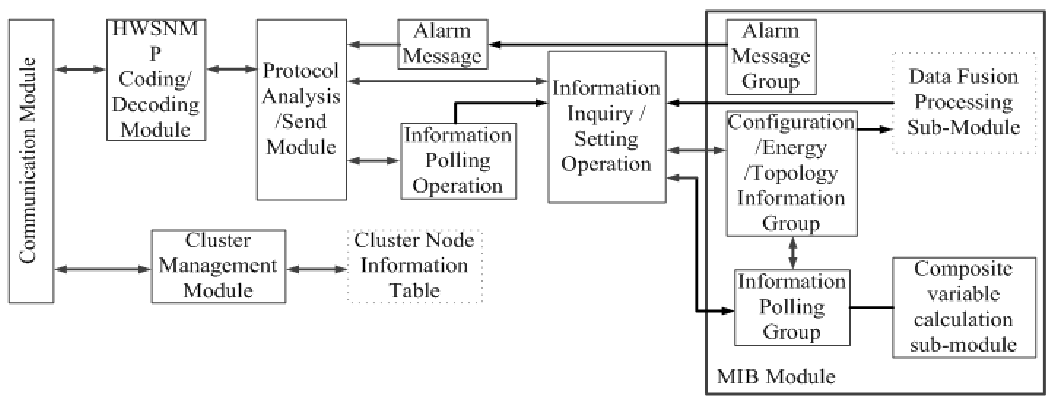

Fig. 4: Hardware structure diagram of the terminal node

is composed of the control module, GPRS module and ZigBee module. The control module MSP430F149 has two serial ports, respectively UART0 and UART 1. The control module communicates with the GPRS module by UART0. The control module communicates with the ZigBee module by UART1.

Design of the terminal node hardware: The terminal node of the ZigBee network mainly uses the sensors to collect farmland data information with a simple preprocessing by processor unit and transmits them by the wireless transceiver module to the router nodes. According to its features, the hardware structure of the terminal node is shown in Fig. 4. The terminal node is made up of ZigBee unit and sensor unit. ZigBee unit is mainly composed of the CC2530F256 module and RF power amplifier modules. The CC2530F256 module completes the protocol stack data processing and wireless transceiver function. The RF power amplifier module further amplifies the signal power for increasing the signal transmission distance. The sensor unit is composed of temperature and humidity sensors, light intensity sensor and rain sensor. The sensor unit communicates with CC2530F256 module by the simple GPIO buses. Under the control of the CC2530F256 module, the sensor unit acquires temperature and humidity sensors, light radiation intensity, rainfall data information. They are transferred according to a certain data format combination coding and transmitted by the ZigBee monitoring network.

DESIGN OF SYSTEM SOFTWARE

Design of gateway node software: The gateway node mainly achieves data conversion of ZigBee network and the GPRS module, so the key is coding of the control module MSP430F149 of. In order to timely receive new data, the processor has better interrupt response handling mechanism, selecting the interrupt method to complete reading the serial data. In addition, their priorities are determined based on two serial interrupt received and the amount important information data. Therefore, set the serial port UART0 interrupt priority than UART1 interrupt. The control module MSP430F149 uses the idea of modular programming, the main program flow chart of the gateway node is shown in Fig. 5. The main program is a big cycle, according to the priority order, GPRS communication module interrupt things before ZigBee communication interrupt events precedence. When GPRS communication interrupt response, the processor receives from the command center to monitor the data transmission and the appropriate action in accordance with the command data; when the ZigBee communication module interrupts, the processor receives the ZigBee network to transmit data collected

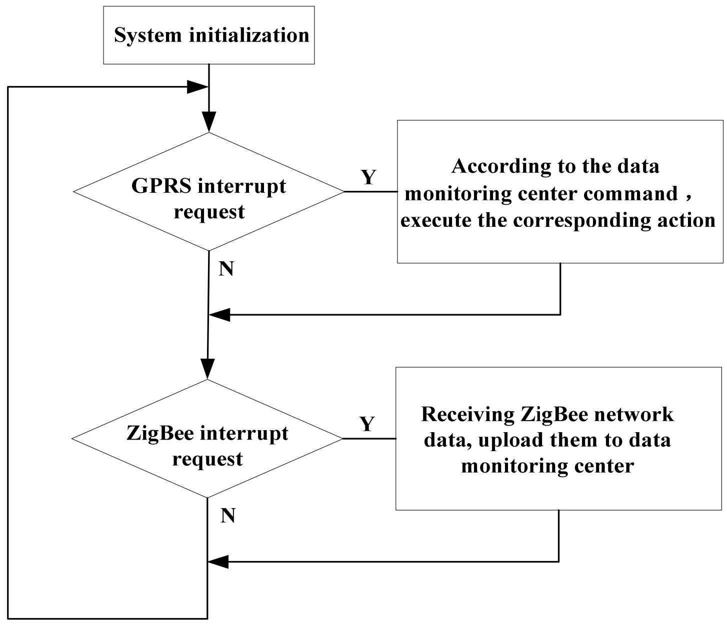

Fig. 5: Main program flow chart of the gateway node

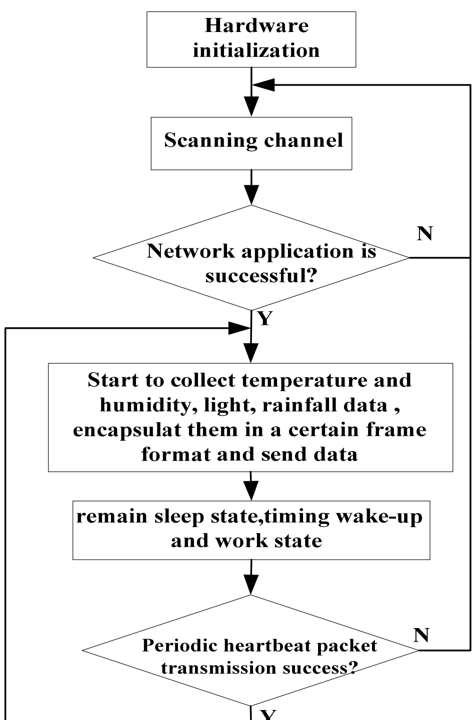

Fig. 6: Software program flow chart of the terminal node

and uploaded to the Data Monitoring perform to the appropriate processing center.

Design of terminal node software: After the gateway node starts, initialize the hardware and the protocol, select the appropriate channel to create a ZigBee network. When a node applies to join the network, the gateway node is responsible for the allocation of a 16-bit short address and allows it to join the network (Monika, 2000). The software program flow chart of the terminal node is shown in Fig. 6.

After the terminal node starts, initialize the hardware and protocols, then circulates scanning channel ZigBee network to send a request to join until the application succeeds. When the terminal node joins the network, the terminal node is assigned with a unique 16-bit network address and the 16-bit address gets registered with the network terminal node bound coordinator. The terminal nodes sequentially acquires farmland temperature and humidity, light intensity, rainfall data, packs and sends them to a gateway node according to a certain frame format. Then terminal nodes enter into sleep mode, wake terminal node timing mode, put it into working condition. Finally, send a periodic heartbeat packet to determine whether the terminal nodes is in the net, if it is, repeat the data collection and transmission process, otherwise re-apply the net.

EXPERIMENTAL RESULTS

Inter-node transmission quality test: Experimental tests consist of a ZigBee network gateway node, two nodes and a router terminal nodes and the distance between adjacent nodes is less than 50 m. Setting terminal node sends data to the gateway node every 10 min, the continuous transmission interval is 1000, a single transmission packet size is denoted by N bytes, the gateway node number of correctly received data packets are denoted as M, the average intensity of the received signal between is recorded as W dBm, packet

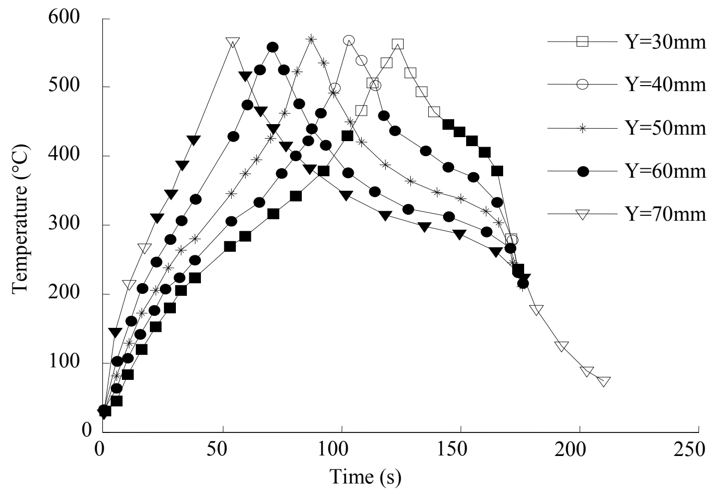

Fig. 7: Standard instrument display monitoring results

Table 1: Node transmission quality test results with 0dBm transmission power

Test No.	Deformation temperature (°C)	Strain rate (s^{-1})
1	250	0.0005
2	250	0.0010
3	250	0.0020
4	300	0.0005
5	300	0.0010
6	300	0.0020
7	350	0.0005
8	350	0.0010
9	350	0.0020
10	400	0.0005
11	400	0.0010
12	400	0.0020

error rates between nodes are referred to as Y, 50A represents the environment in the open area, the distance between adjacent nodes is less than 50 m, 50B represents an environment under obstructions, neighboring nodes the distance is less than 50 m, the terminal node at the transmission power at 0 dBm, the transmission quality measurement results with terminal nodes and the gateway nodes are shown in Table 1.

Test results show that different communication environments and the size of a single packet on the system will affect the communication quality. In more complex communication environment conditions, in order to reduce the packet error rate, the distance between nodes can be reduced or the packet size can be reduced according to some coding scheme. According to the statistical test result, the distance between adjacent nodes in a ZigBee network is within 50 m, when the node transmits data packets are small, reliable transmission of data between nodes can be achieved, reducing system power consumption and prolonging the network life cycle.

Remote data transmission test: System test selects 100 m * 100 m flat region as an experimental test site, the test time is 10 h, ambient temperature is between 14~20°C, relative humidity of 40 to 60%. The test is based on whether the acquisition and verification from wireless sensor network transmission errors of farmland temperature data can meet the needs, that is to say, it depends on the correctness data acquisition and transmission. Temperature test data comparing the data monitoring center management software and standard instrument display monitoring results are shown in Fig. 7.

CONCLUSION

WSN as a new information acquisition and processing technology, with low power communication technology, sensor technology, the rapid development of MEMS technology and embedded system technology, in today's society of information technology, economic and social development play an increasingly important role. The farmland information monitoring generally has the characteristics of complex environment, more monitoring point and wide coverage. Any information technology develops to a certain stage, will produce and survivability, safety related issues, in view of the special nature of WSN, study on the survival of topology control is the basis of survivable, network topology is to design it can prolong the lifetime of network, to continue to provide essential services at individual nodes of early death, when the fault/intrusion tolerance capacity to the limit, but also by virtue of renewable technologies to return to work.

ACKNOWLEDGMENT

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