Design and implementation of monitoring information system based on wireless sensor network technology

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ABSTRACT

Wireless sensor network node includes: the perception component, embedded processor, memory, and communication software components this several parts. Wireless sensor network is composed of one or more base stations (Sink node) and a large number of deployed in the monitoring area. This paper proposes design and implementation of monitoring information system based on wireless sensor network technology. The monitoring system is composed of sensor network terminal node, a number of small amounts of the sink node, a gateway node and the background monitoring system.

Keywords: Wireless sensor network, Monitoring system, network node.

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INTRODUCTION

Wireless sensor networks need to convert analog sensor output signal into digital signal, can choose an integrated micro controller AD conversion function. In addition, the nodes of wireless sensor network in addition to complete the data acquisition function, also completed the data forwarding and routing functions, thus to handle ability, program space and data space enough.

The sink node and sensor nodes in wireless sensor network system is composed of data acquisition and transmission, although a single node function is limited, the collected data is not accurate enough, but a large number of certain computing ability, storage ability and communication ability of nodes to cooperate with each other, constitute a highly survivable network system, the gathering data the accuracy and breadth can be greatly improved, returns the data can be used as the user reference.

Wireless sensor network is as a virtual database system, and support the kind of SQL query [1]. All data types on the sensor network, sensor data, including various types of static data are a field of relational tables; the system relation table has a Sensors table. While the implementation, it is composed of two parts, as a part of database front end, receiving a query and control the general command, and event based query, at the same time by TinyDB according to the sensor network energy automatic adjustment cycle to execute query.

Wireless sensor network has not unified communication protocol platform like Internet, must according to specific application to the study of sensor network technology. It is one important character of wireless sensor network is different from the traditional network system, large scale. In order to improve network reliability, usually deployed in the target area of a large number of sensor nodes, sensor networks may contain up to thousands or even tens of thousands of sensor nodes. Large scale sensor networks can also through different perspectives to obtain greater signal-to-noise ratio, so as to improve the monitoring accuracy.

2. Design and construction of wireless sensor network
Each of the ZigBee monitoring networks has a gateway node and a plurality of soil temperature and humidity data

acquisition node. Monitoring network adopt star type structure, the gateway node as a base station for each monitoring network. The gateway node has dual functions, one is to act as a network coordinator role, responsible for the establishment and maintenance of the network automatically, data collection; two is as a monitoring network and monitoring center interface, the transmission of information and monitoring center [2]. This system has the function of automatic networking, wireless gateway has been in the listening state, a new wireless sensor nodes added will be network automatic discovery, when the wireless routing to node information to the wireless gateway, wireless gateway for addressing and calculate the routing information, update the data forwarding and Equipment Association table.

The hardware system of wireless sensor network consists of three sensors, processing and communication, spanning multiple domains, and international research on wireless sensor network field is only a short period of a few years, most of the present research and design are in mature modules in the field of integration, and no processing chip the use of dedicated, in the power consumption of the system, chip area, the node area, processing ability, space program, data space etc have been greatly restricted, as is shown by equation (1).

$$x(t) = \sum_{j=1}^{n} c_j(t) + r_n(t) \tag{1}$$

In wireless sensor networks, only the transmission range of all nodes is set to the same value. The only way to reduce power consumption, increase the capacity of the network is the transmission range is set to maintain a minimum network connectivity. The most suitable probability theory to solve the CTR problem is a geometric random graph theory. Because of the long side of the critical transmission range is MST, probability from the probability distribution of the longest edge of the MST can be deduced from the CTR solution, as is shown by equation (2).

$$\|x - x_e\| = \left[(x_1 - x_{1e})^2 + (x_2 - x_{2e})^2 + \cdots + (x_n - x_{ne})^2 \right]^{1/2} \tag{2}$$

The basic architecture of the wireless sensor network system includes three parts, the first part is the wireless transceiver chip, its responsibility is the digital information into high frequency wireless signal sent and will restore the high-frequency wireless received signal into digital information. Wireless transceiver chip, IEEE 802.15.4 can provide the best solution for wireless sensor applications, this is because the IEEE 802.15.4 specification may be the main and may be the only practical standard.

No need for additional hardware based wireless sensor localization of RSSI, and the wireless communication chip itself has a receiving signal strength calculation function, location does not require additional hardware, does not increase the hardware cost and size of the nodes, so the RSSI ranging based on network localization in wireless sensor network is a method commonly used. In the actual application due to multipart propagation, reflection, non line of sight, the gain of the antenna and other issues will be ranging for RSSI errors, which causes large location errors, as is shown by equation (3) [3].

$$p = \begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} f\dfrac{X}{Z} \\ f\dfrac{Y}{Z} \end{pmatrix} \tag{3}$$

WSANs a large amount of data, real-time communication requirements, this is because a large number of nodes are densely deployed and share the same channel, easily lead to congestion and interference, so that the information delivery delay and loss increase, transmission rate, network reliability variation. So the researchers with multiple channel communication to resolve the competition and conflict in order to improve the network performance, the advantage of this method is: can reduce the average transmission delay of data packets in the network; multi channel communication allows multiple nodes in the vicinity use different channel communication, can effectively reduce the competition back off and communication interference.

According to the geographical location information event area, set up the sink node to the optimal path event area, to avoid flooding the query message, thereby reducing the routing overhead. But the traditional GEAR routing mechanism due to the lack of sufficient topological information, the phenomenon of. Wireless sensor network routing mechanism considering two hop node information, greatly reducing the probability of routing voids appear,

reduce the average energy consumption of each successful query.

Clustering algorithm is based on the specific application requirements of wireless sensor networks, according to some rule or method will be divided into multiple clusters network can communicate with each other and coverage of all nodes, and in normal function when the change of network updating cluster structure and maintenance of the network. The main purpose of clustering algorithm is obtained by initializing cluster structure, high connectivity, coverage degree of all nodes, update the cluster structure when the change of network, to ensure that the perceived information correctly transmitted to the sink node, and can use less computation and communication overhead to construct and maintain a can cover the entire network logic topology structure.

3. Design and implementation of monitoring information system based on wireless sensor network technology
Zigbee communication module of wireless sensor network monitoring information system designed in this paper in the wireless network module CC2420 low power and high performance is achieved, which work in the global 2.4GHz band. CC2420 is a standard IEEE802.15.4 RF transceiver, stable performance and low power consumption. CC2420 selectivity and sensitivity index exceeds the requirements of IEEE802.15.4 standard, to ensure that short distance communication effectiveness and reliability.

WSN has the features of strong expansibility, real-time and good concealment, making it very suitable for moving target tracking and positioning, to provide real-time location information of objects being tracked for the command center. The target localization using WSN can be divided into the detection, localization, the report in three stages [4]. In the detection phase, each sensor node randomly "start" to detect possible target and the target is calculated after its distance to the goal, also including the node position and the distance between the object and content to the network broadcast information, as is shown by equation (4).

$$H_e = -\sum_{l=0}^{L-1} P(l) \log_2 p(l) \tag{4}$$

Sensor network node software including four nesC language components: sensor node directory and mode manager, the query processor, memory management and network topology manager. The sensor node is responsible for recording the attribute list for each node. The query processor is responsible for query processing, attributes using sensor directory to store the information of sensor nodes can be obtained.

Wireless sensor network, they are rooted in the global information grid (global information grid, GIG). The global information grid is connected by a global network, end to end a series of information capacity, the relevant procedures and personnel, according to the researchers, all in the decision-making personnel and support staff requirements to collection, processing, storage and management information, as is shown by equation (5).

$$L^2(R^2) = \bigoplus_{j \in z} \bigoplus_{\lambda=1}^{3} W_j^{\lambda} \tag{5}$$

Designed in accordance with the programming are ideas of component-based TinyOS system. The physical layer design of two components (PhyP, PhyC), two interface operation through a standard defined by: data access interface (PD), management interface (PLME). Component PhyP is a main component of the physical layer, it has to send data, receive initialization component, the three basic functions of data. The MAC design of two elements: MacC, MacP, where MacP is the executive member of the main. There are two kinds of equipment in the MAC layer: the coordinator node and non coordinator node. The coordinator node is responsible for the establishment of the network: the establishment of the network number (PANID), the nodes of the short address, and produce the beacon frame payload part.

Wireless sensor networks generally do not need to point to point communication support between any two sensor nodes; sensor nodes do not have globally unique identifier, without addressing the IP internet [5]. Users often don't care about data acquisition in which a node, and the spatial position of the concerned data, thus can take the space position addressing. In this sense, sensor network usually takes the data itself as a query or transmission clues, so the sensor network is a data centric network.

4. Comparison and discussion of the experiment
The system takes the MCU as the control core, the wireless sensor node (RFD), wireless routing node (FFD), a

wireless gateway (FFD), monitoring of four parts center, through ZigBee network, transmission between monitoring center, wireless gateway information moisture and controlled by GPRS [6]. Each sensor node by temperature and humidity sensor, automatic collecting soil moisture information, and combined with the preset humidity limit analysis, determines the need for irrigation and when to stop. Each node through the solar battery power supply, battery voltage is monitored at all times, once the voltage is too low.

An important guarantee for the wireless sensor network communication security and system security, where is the chip, sleep mode set, through collaborative software and hardware to achieve the effective management of the power consumption of the system; fourth, and radio frequency communication and sensor data acquisition and related instruction, especially the part of the communication protocol, can greatly improve the communication performance, these instructions highlighting the microprocessor as the core role.

The TinyDB program can be run in the TinyOS simulation tool Tossim, and then the improved routing protocol with the original routing protocol in TOSSIM for simulation, design and implementation of the direct usage and application of IEEE802.15.4. The IEEE802.15.4 standard has become the de facto standard for wireless sensor, and the protocol development in their respective hardware platform. With the IEEE802.15.4 standard as an example, using the direct call method in TinyOS system, the CC2420 RF chip to design and realize the standard environment, as is shown by figure1.
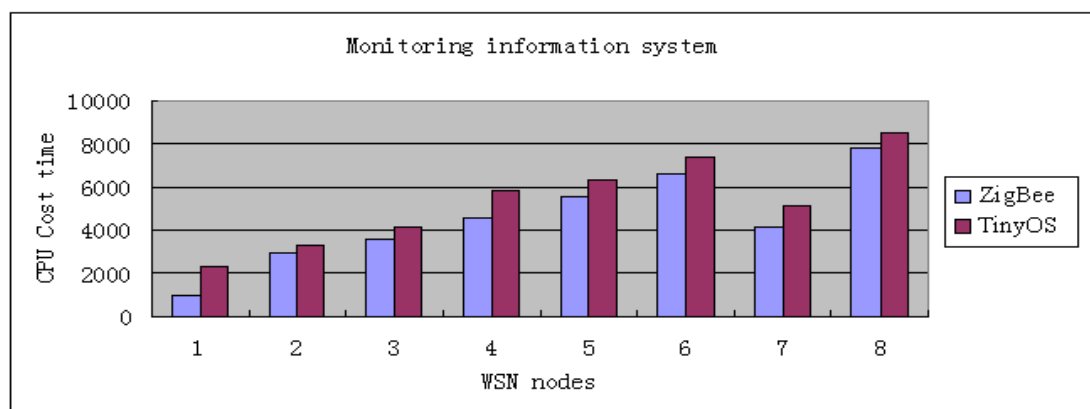

Fig. 1. Comparison results of monitoring information system based on wireless sensor network ZigBee with TinyOS

The wireless sensor network test is a multi-channel self-organizing wireless network, can realize the automatic network, automatic routing query, automatic data acquisition and transmission, the software must be able to realize multi hop self-organizing function. In addition, the sensor nodes must be extremely low power consumption, and low power consumption in low power hardware design on the outside, more important is the low power design software.

CONCLUSION

Large scale deployment of sensor nodes in wireless sensor network monitoring system, the WSN usually have higher node redundancy, network link redundancy and data redundancy provides strong fault tolerant ability for the whole system. The paper proposes design and implementation of monitoring information system based on wireless sensor network technology. In addition, it is with the help of individual nodes with mobility in sensor nodes to adjust the network topology. Features include query optimization, receiving, verification request, receive the query management and query result, send control commands, connected with the wireless sensor network, database and user interface etc.

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