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The Remote Data Monitoring Design Based on Wireless Sensor Network

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Abstract

The wireless sensor network is a kind of self organized and distributed network that is composed by a large number of micro sensor nodes which have the ability of sensing, computing and communication. Through GPRS terminal, transmitting the data from the wireless sensor network to the remote host computer, so as to realize the remote access of the detecting data at the spot. In this paper, it takes the introduction of the wireless sensor network technology as the breakthrough point, with the help of introducing the architecture of wireless sensor network, discussing the remote data monitoring platform design based on wireless sensor network.

***Keywords**: wireless sensor network; remote data monitoring*

1. Introduction

Wireless Sensor Network (WSN) is composed by a large number of low-cost micro sensor nodes that are deployed in monitoring area, through wireless communication mode to form a multiple hops self-organizing network system, whose purpose is to deal with the collaboration and perception, collection and processing network coverage area of the perceptual object information, so as to send to the observer.

2. Brief Introduction to Wireless Sensor Network Technology

Wireless sensor network can artificially arrange or randomly deploy many sensor nodes through, the airplane dispensing in the monitoring area, these nodes can construct wireless network by self-organized method to have automatic construction, through a variety of sensors integrated on the nodes, int he way of cooperation to perceive, collect and transmit the specific information in the monitoring area, so as to achieve the acquisition, processing and analysis of the information at any location and at any time in the monitoring area.[1] The wireless sensor network is composed by a large number of sensor nodes, which are integrated with sensor module, data processing module and wireless communication module. Wireless sensor network has the advantages of self-organization, low power consumption, low power consumption, low cost, fast deployment and strong expansion. It is suitable for the special time and special environment, which can have a broad application prospect.

3. The Architecture of Wireless Sensor Network

3.1. Sensor Network Structure

In a typical wireless sensor network, generally, it includes Sensor Node, Sink Node, Taskmanager Node in the wireless sensor network. [2] The architecture of wireless sensor network can be shown in Figure 1. According to the existed position of sensor nodes, it can be divided into Anchor Node, Beacon Node and Unknown Node. The position of

Anchor Node is known, the Unknown Node can be found out the position by calculating the distance between the Anchor Node, then through the relevant calculation, or using other positioning algorithm. The network, which is composed of self organization can transfer the data to the Sink Node through the method of hopping. Finally, through the Internet or satellite, transmitting the data in the whole area to the remote Taskmanager Node to allocate and manage the sensor network.

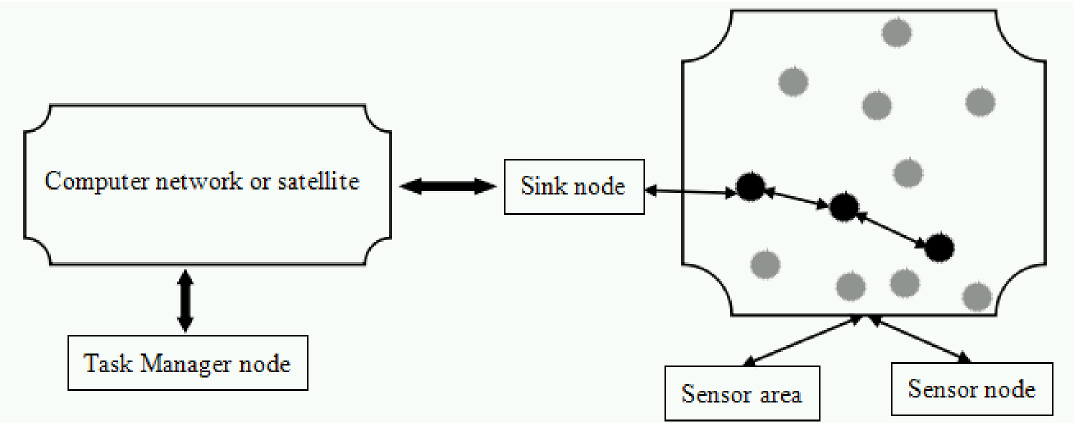

Figure 1. The Architecture of Wireless Sensor Network

In sensor network, the vast majority of sensor nodes are usually a micro embedded system, which has relatively weak computing power, storage capacity and communication ability by carrying the limited energy battery to provide power. From the view of the network function, each sensor node can take the dual function of the traditional network in the terminal and router, in addition to the local information collection and data processing, it also can deal with the other nodes to transmit data to store, manage, fusion and forwarding and so on, at the same time, it can complete some specific tasks cooperated with the other nodes. [3] In common sensor nodes, there is a class of special nodes, namely, beacon nodes, which are equipped with a global positioning system, or manually arranged in the detection area so that it can know its own position. In addition, because it has the task of locating the unknown nodes, compared with the unknown nodes, the beacon node has some special software and hardware performance. The processing ability, the storage capacity and communication ability of the sink node are relatively strong, with higher power. It can connect the sensor network with the external public network, which can realize the communication protocol conversion between two kinds of protocol stacks, and release the monitoring tasks of the Taskmanager nodes.

3.2. The Composition of Sensor Nodes

Sensor nodes are generally composed by four modules, namely, sensor module, processor module, wireless communication module and power supply module. The sensor module can be responsible for monitoring the information collection and data conversion, while the processor module can be responsible for controlling the whole sensor nodes, storing and transmitting data sent by the other nodes. While the wireless communication module can be responsible for communicating with the other sensor nodes in a wireless way, so as to exchange the controlling information and collect data. Moreover, the power supply module can be responsible for providing power energy for the operation of the sensor nodes, which often use the mini-size battery. [4] The architecture of sensor node can be shown in Figure 2.

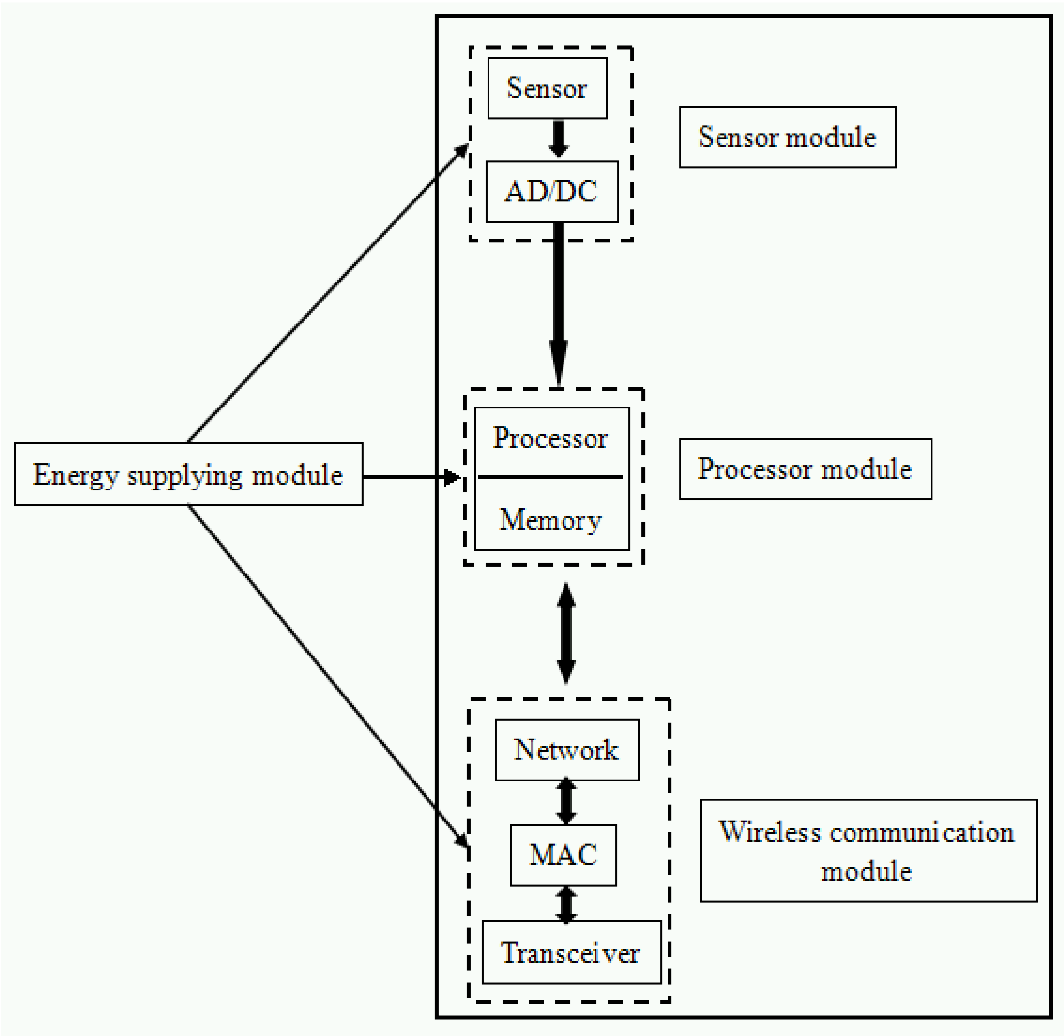

Figure 2. The Architecture of Sensor Network Node

4. The Overall Design of Remote Data Monitoring Platform Based on Wireless Sensor Network

4.1. The Overall Architecture of the System

The whole system is made up of three parts: wireless sensor network node, GPRS terminal and PC, and the system structure diagram is shown in Figure 3. It can complete the task of collecting data through the multiple wireless sensor nodes that are in the detecting area. Among them, the coordinator node and router node are only responsible for data transmission and receiving, and the terminal equipment node is placed in the sensor which is used to monitor the area, and the collected data is transmitted to the coordinator or directly sent to the coordinator through the router. The coordinator is connected to the GPRS terminal through the serial port. The GPRS terminal transmits the data in the wireless sensor network so as to send to the GPRS network according to the data format of the GPRS network. The internal gateway of GPRS/Internet can transfer the GPRS network data format to Internet data format, while the remote host computer can acquire the transmitted data through the PC software, which can have real-time display over the interface and store the data in the database. PC software sends data acquisition commands to the wireless sensor network, which can monitor the operation state of the wireless sensor network nodes deployed in the monitoring area at the same time.

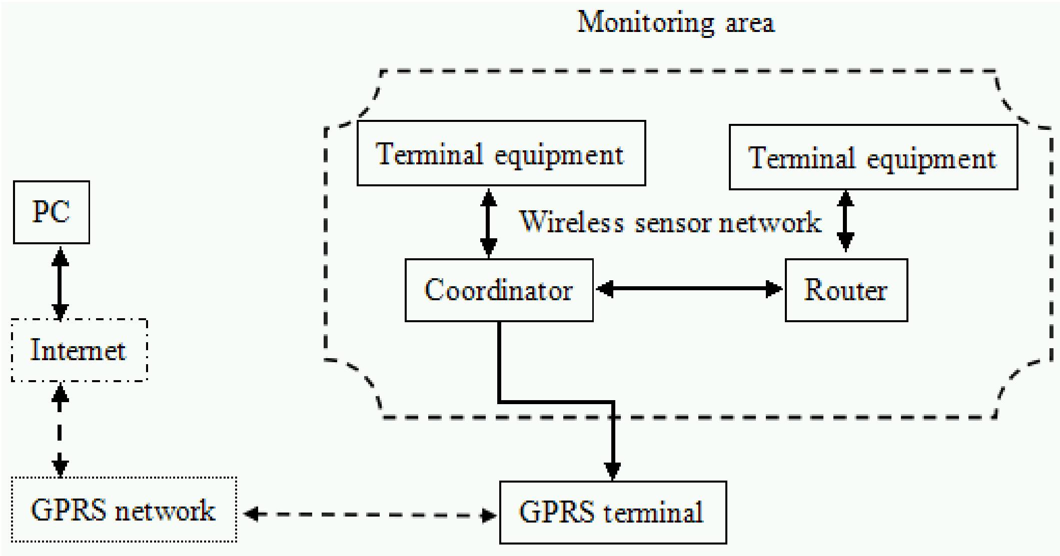

Figure 3. The Overall Structure of Remote Data Acquisition Platform

4.2. The Structure of Hardware and Software of Wireless Sensor Network Node

Wireless sensor network nodes can be divided into three types of nodes: coordinator, router and terminal equipment. Among them, the coordinator is responsible for establishing the network, the router is responsible for sending the data, while the terminal equipment completes the data acquisition of the monitoring area and transmits the data to the coordinator or directly transmitted to the coordinator through the router.[5] Usually, the wireless sensor network node is a micro embedded system powered by battery, therefore, the ability of data processing, storage and communication is relatively weak. The typical wireless sensor node is composed by four parts, namely, the sensor module, the processor module, wireless communication module and power supply module. However, according to the different application requirements, the hardware composition of the sensor nodes of of each module is slightly different.

The coordinator node is responsible for establishing the network, sending and receiving data, and connecting with the GPRS terminal through the serial port. And the GPRS module is powered by the same power supply, non battery powered. Router node is responsible for forwarding data, not for data acquisition, so there is no sensor module, the use of battery powered. The terminal node is responsible for collecting data. The sensor module includes various types of sensors, using battery powered.

In wireless sensor network, the Zigbee protocol stack is run by Microchip, it can complete the required function through being modified. Microchip's open source protocol stack is for the sake of facilitating the development of the user, which can provide a Zigbee based wireless sensor network for the three types of devices, namely, Coordinator Template.c, which is for the coordinator node, the Router Template.c, which is for the router node, as well as RFD Template.c, which is for the terminal device. These template programs are the main programs of the application layer, which is responsible for calling the underlying function, at the same time, main program of the application layer is responsible for scheduling the entire operation of Zigbee protocol stack.On the basis of providing the template program, according to the different types of nodes, by using APL layer provided by Zigbee protocol stack of Microchip and API of NWK layer to go on with the second time development, so as to finish the related functions that the program needed[6-7].

Among them, there is only one coordinator node in the whole network, the node is mainly responsible for the establishment of the network, which can allow the sub nodes to join, send the specified format data acquisition commands, receive the data from the terminal node sensor and maintain the status of other router nodes and terminal nodes in wireless sensor networks (normal operation or failure with nodes). Besides, the basic form of the network, allowing the sub node to join the program, and the other functional modules can use API function provided by Microchip Zigbee Stack to code, While the written function can be placed in the appropriate place of the protocol stack main function without disrupting the normal operation of the protocol stack as the premise.

The program of router node should be much simpler than the program of the coordinator node, on the basis of the router template program provided by Microchip, it can add the status of node and send the code, for the acquisition command sent by coordinator, it can make analysis and send commands to their sub-nodes, so as to realize multi-cast function. The router node can send the address of its terminal node to the coordinator, so that the coordinator can obtain the information of all the nodes in the current network. The router node also can send a heartbeat packet to the coordinator, so as to allow the coordinator to learn that the router is in normal working condition.

4.3. The Gateway Module of Wireless Sensor Network

The gateway module of wireless sensor network is a crucial module in wireless sensor network, which can be responsible for the wireless sensor network to obtain the monitoring data of physical quantities to transmit to the Internet, so as to achieve the purpose of data acquisition, which can greatly expand the scope of application of wireless sensor network. Only the gateway module can work normally, can the data be transmitted to the outer network, therefore, users can get the collected data from the remote monitoring field through connecting the computer software platform of Internet.

EXPERIMENT ANALYSES

RIHA's reliability and validity is verified by simulation experiments. This section mainly analyzes two aspects of its performance: hiding information acquisition ratio and energy consumption.

We set the distance between the nodes is 80*m*, the maximum transmission power is 0*dBm*, energy consumption is 17.4*nW*, the minimum transmission power is -24*dBm*, energy consumption in transmission process is 8.5*nW*, the transmission frequency is 2400*MHz*, path attenuation index is 2.5, random Gauss noise from environment is 5 in the simulation. Assuming the hidden information is: 0011 0101 0110 0111 1110 1010 1011 1111.

RSSI without repeat hidden information code transmission is shown Figure 4. The horizontal axis is the number of received packet, and the vertical axis is the RSSI correspond with the packet. From the figure we can see the change of RSSI clearly. The upper limit of RSSI is 170 and the lower limit of RSSI is 160. Thus the RSSI higher than 170 is 1, and less than 160 is 0, we can obtain the hidden information for this group RSSI is: 0011 0101 0110 0111 1110 1010 1011 1111, which is the same as the hidden information is sent.

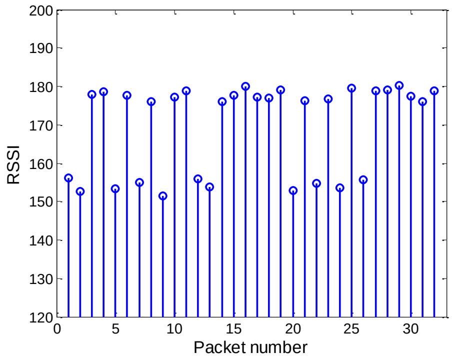

Figure 4. RSSI without Repeat Hidden Information Code Transmission

In Figure 4, each hidden information code transmits 3 times. The source node uses each hidden information code corresponded transmit power 3 times. The destination node uses filtering algorithm to process the obtained RSSI, and obtains the hidden information. The mean filter algorithm is used in the simulation that is average every three RSSI, the value higher than 170 is 1, less than 160 is 0. We obtain the hidden information 0011 0101 0110 0111 1110 1010 1011 1111, which is the same as without redundant hidden information code.

In these experiments, the hidden information acquisition rate is 100%. When the packet transmission correctly, the receiver can extract the hidden information completely. The simulation results prove the correctness of RIHA. Packet loss did not occur in the simulation, in actual situation the data may lose due to conflict or other reasons. The efficient filtering algorithm and reasonable data processing technology are used. The receiver can recover the hidden information through redundancy checking and correct errors in transmission to improve the accuracy of hidden information acquisition further.

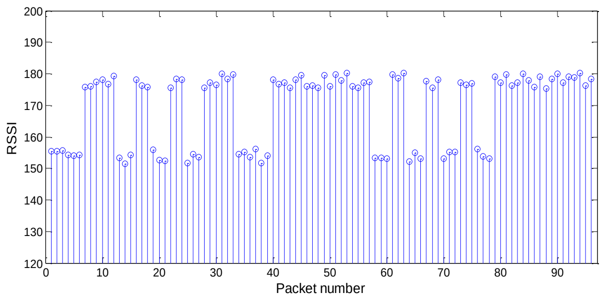

Figure 5. RSSI with 3 Repeat Hidden Information Code Transmission

Next, we analyze the energy consumption of RIHA. Figure 5 compares the energy consumption of nodes with or without hidden information. The horizontal axis is the packet number, and the vertical axis is the energy consumption. The blue dashed line represents the energy consumption without hidden information transmission, in which the sender selects transmission power randomly. The red solid line represents the energy consumption with hidden information transmission.

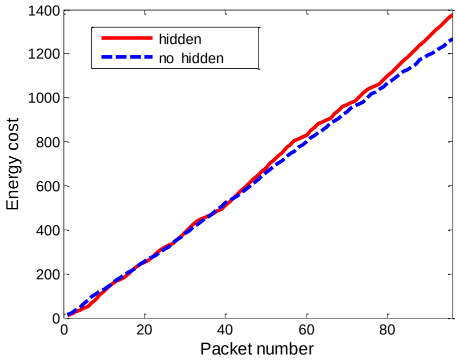

Figure 6. Comparison of Energy Consumption

As can be seen from the Figure 6, energy consumption of hidden information transmission almost the same as no hidden information transmission in the first half, and increases in the last half slightly. It related to the encoding rule and data to be transmitted. In this simulation, the middle part and the last part of hidden information have several 1 multiply, so that the node has to transmit information with maximum power continuously, which leads the increase of energy consumption. Sending more 0 in hidden information will make its energy consumption lower than no hidden information transmission. That is to say the network energy consumption depends on the original data, whether transmission hidden information has little effect on it.

5. Conclusion

Wireless sensor network can have a wide range of applications in both national security and national economy. In the future, sensor network will develop itself to the integration of sky, sea, land and underground sensor network, which will eventually become the interface of the real world and the digital world. Moreover, it can deepen itself to each aspects of human lives, just like Internet that can change the way of people living.

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