The Research on Data Transmission Application Based on ZigBee Wireless Network

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Abstract: Wireless sensor network is an emerging network technology that integrates sensors, embedded systems, communications and networks, which has incomparable advantages in traditional technologies such as low power consumption, reliability transmission, and adaptability. and has broad application prospects in the fields of environmental protection, medical treatment, logistics, security, industrial and agricultural production, and military. ZigBee technology has the features of power consumption, low cost, short distance, low speed and so on. It has great performance in the application of wireless sensor network and has achieved more and more attention. Applying ZigBee technology to wireless data acquisition and control systems not only eliminates the cumbersome wiring, but also can be used in many special applications. With the increasing application of ZigBee technology, the exchange of information between the sensor network and the Internet through the ZigBee gateway to realize the remote transmission and processing of data has become a research hot spot in this field. This paper introduces the concept and technical characteristics of ZigBee wireless network, and combines the characteristics of network transmission in China to illustrate the practical application of ZigBee wireless network and data transmission technology with examples.

1. Introduction

The traditional wireless sensor network usually works outdoors, and is powered with batteries. It mainly transmits environmentally-aware information, which has no highly real-time requirements. Based on the consideration of cost, the network node has single functions, small wireless transmission power, and limited channel monitoring and anti-interference ability, which is susceptible to interference and finally resulting in communication failure. With the improvement of living standard, people have higher requirements for data update frequency, data velocity and reliability of wireless sensor networks, but the traditional wireless sensor networks can not meet the growing needs of people. Wireless sensor network must meet the needs of users for network transmission bandwidth and real-time data transmission while requiring low energy consumption. For example, the application of wireless sensor network in the underground garage of shopping malls and intelligent security systems. In the applications of intelligent security, the network is usually arranged in an indoor environment. The wireless communication range covered by the wireless sensor network is easily interfered by other similar frequencies, and the wireless sensor network needs to monitor the status information of each detection point in real time. It has high demands on the anti-interference and real-time performance of wireless sensor networks. There are various methods of traditional wireless sensor network communication. This paper has researches on the ZigBee protocol stack. It has analyzed the remote data acquisition and control system based on ZigBee technology and summarized its basic architecture mode. Also, a design method of multiple gateway transmission system based on ZigBee network has been proposed for the shortcomings of centralized data transmission system.

2. Application of Wireless Sensor Network

The introduction of wireless sensor network specifications has rapidly promoted a deeper application research on wireless sensor networks. At the current stage, wireless sensor network

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contain perceptual nodes such as seismic, magnetic, and thermal sensing functions. These sensing nodes are able to monitor a variety of environmental indicators around them, while the continuous development of microelectronics and embedded technologies has led to the improvements in computing power and carrying energy levels of the sensing nodes. Therefore, wireless sensor network has been widely used, and the application fields are mainly reflected in the aspects as below：

2.1 Military Application

Military field is one of the earliest application areas of wireless sensor network. From the early network adoption to the real-time battlefield monitoring, it has exerted great practical application value. The wireless sensor network has the characteristics of rapid deployment, randomness and fault tolerance, which allows it have broad application prospects in remote sensing military technology. Besides, as the dense deployment rules of wireless sensor network for one-time and low-cost nodes, even if the enemy destroys the relevant wireless sensor network, it will not cause serious military losses.

2.2 Application of Internet of Things

By deploying various sensory nodes in each corner and object, a huge wireless sensor network has been constructed to acquire information of the material world and to perceive relevant changes in the material world. With the continuous advancement and development of the Internet of Things technology, the combination of Internet of Things technology and wireless sensor network technology has become more and more close, which makes it widely used in tests of advanced technologies and some other areas.

2.3 Environmental Monitoring

The autonomous coordination capability of wireless sensor networks has been widely used in various environmental monitoring. With the development of social economy, people's requirements for the quality of the natural environment are getting higher and higher, and the degree of attention is also gradually increasing. In the meanwhile, people need to collect more and more environmental indicator data information to monitor the environment. Environmental monitoring personnel develop environmental protection strategies in advance by analyzing the environmental indicator data collected by the wireless sensor network.

3. ZigBee Network Structure

ZigBee technology is mainly used for low data transmission rates and transmission distances are not very far between various communication devices. ZigBee protocol is simpler and more practical than Bluetooth technology, high-speed personal area network or 802.11X wireless LAN. Due to the band and frequency hopping technology has been used, which is very similar to Bluetooth technology. Compared with this, the ZigBee protocol is simpler than Bluetooth and has a lower rate, including lower power and cost. ZigBee has a transmission radius of up to 400 meters. Less power consumption and better reliability. Furthermore, a single ZigBee wireless module can interconnect with 254 nodes. If a routing node joins, the maximum network capacity can reach 65,535. The physical layer is the lowest layer of the IEEE802.15.4 protocol that provides an interface between the wireless channel and the MAC layer through hardware and RF firmware. The physical layer mainly accomplishes the following tasks: turn on and off the wireless transceiver, energy detection of the current channel, receive indication of link quality, idle channel estimation, channel frequency selection, data transmission and reception. The physical layer determines the communication frequency of ZigBee, and two operating frequency ranges of physical layer (2.4GHz and 868/915MHz) are specified in IEEE802.15.4. Different modulation modes are specified for different frequency bands, so the data transmission rates are also different. One physical layer management entity is also included in the physical layer. The management entity provides an interface to the physical layer management service by calling the physical layer management

function, when it's also responsible for maintaining the target database including the basic information of the domain network managed by the physical layer. The structure of physical layer and service interface are shown as in Figure 1.

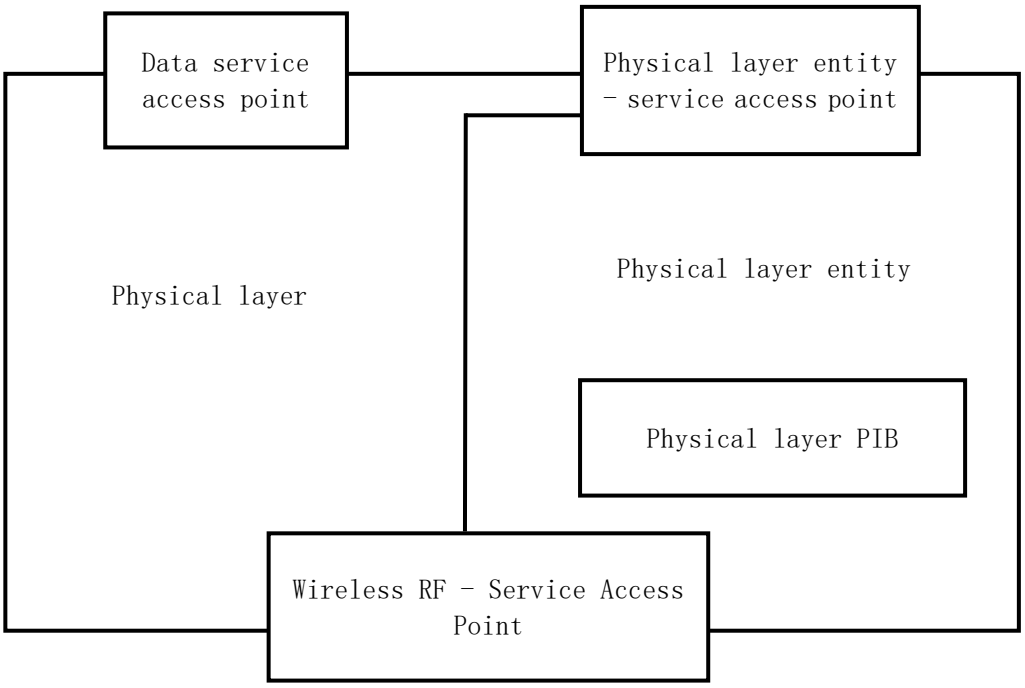

Figure 1. The reference model of physical layer

The physical layer provides physical layer data services through data service access points and also provides physical layer management services through physical layer entity service access point. The structure of physical layer data unit is composed of a synchronization header, a physical layer header, and a physical layer payload. ZigBee network nodes can be classified into two functions of FFD (Full function device) and RFD (Reduced function device) according to functional integrity. FFD can be used as a coordinator, router, and terminal device to support any topology. One FFD can communicate with multiple RFD or FFD devices.RFD can only be used as a terminal device. One RFD can only communicate with one FFD, without ant other routing or forwarding functions.

4. The Practical Application of ZigBee Wireless Network and Data Transmission Coordination Technology

4.1 Application of Transformer Monitoring Sensor

The problem often encountered in daily life is that the fluorescent lamp at home will appear flickering and fainting in a certain period of time, and the electrical appliances at home will also have unstable buzzing. This is the unstable performance of the power supply at home. As we all know that the standard civilian voltage in China is 220V. When the electricity line exceeds the load, the current and voltage shared by each household will be affected, which will cause other electrical appliances to be unstable and even affect the normal operation of the transformer. We use the characteristics of ZigBee wireless network technology to develop a remote voltage and current monitoring device, then install a wireless sensor at the output of the transformer, send the data collected by the sensor to the DTU device, and finally send the data collected by the DTU to the power management platform through the data transmission technology. Later, the electricity engineer will arrange the corresponding processing methods with the data.

4.2 Application of Transmission Line Troubleshooting

The vast land in China is the major problem that restricts the maintenance of power lines., hundred kilometers of power transmission roads are usually accompanied by uninhabited rolling

hills. In the past, the old-fashioned line fault investigation relied on electricians to measure with their feet. We often see lots of power maintenance workers working hard. Network engineers can consider introducing advanced technology to help electricians eliminate power line obstacles. A large local area network can be constructed between two substations based on ZigBee wireless network technology, an optical cable can be laid on the route of the power transmission line as a the main transmission line, and a DTU device for collecting data information can be set every ten kilometers, then install several microwave sensor devices between two DTUs. Considering the special environment in the wild, the sensor can be considered to be powered by button batteries and introduced into the solar circuit board for charging, and the microwave sensor exchanges data through the radio microwave signal.

5. Conclusion

Wireless sensor network can be widely applied in military, medical, home, industrial, environmental monitoring, intelligent transportation and some other areas because it can complete data sensing, collection and processing in the monitoring area at any time and any place. In the meanwhile, it puts out more stringent requirements on the reliability and real-time performance of network data transmission. Combined with the article, we will find that the application of ZigBee wireless network and data transmission technology in the electricity system can let the electricity system in China run more smoothly and save the power energy in China to a greater extent, and also provide convenient maintenance for electricity lines. However, due to the constraints of economic conditions and objective natural environment, it’s still not been able to realize the widespread popularization of ZigBee wireless network and data transmission technology in China. The road to revitalize China by applying science and technology is still a long way to go.

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