

System Architecture and Application of Wireless Sensor Network

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Abstract Wireless Sensor Network technology is a kind of new data gathering and transmission technology, which combines with wireless communication, sensors, embedded computing and distributed information processing. It has the great potential with various applications in military defense, industrial automation and transportation. This paper mainly focuses on the developing present situation and trend of wireless sensor network routing protocol, its research hotspot and difficulty. It analyzes the application of wireless sensor network in various fields, pointing out the potential problems, and puts forward some improvement methods. Theoretical guidance is provided for further research and expanding the application range of wireless sensor network.

Keywords Wireless Sensor Network • Architecture • Application • Method

1 Introduction

In information society, the production, acquisition, transmission, storage and handling of information are the important parts of information science (Akyildiz et al. 2002). Various kinds of sensors are the major media which we access and use information resources. The progress of microelectronics technology, wireless communication technology, computer technology and internet technology, promoted the rapid development of sensors with low power consumption and multiple functions,

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which have various integrated modules for data acquisition and processing, wireless communication, power supply, etc. The ways of data acquisition of traditional sensors have shifted from mono-style, wired transmission to intelligent, networked and wireless transmission, which have become the major technology of data acquisition.

2 Brief Introduction of Wireless Sensor Network

Wireless sensor network (WSN) is a self-organizing network in a monitored area, linked by wireless communication with many jumps formed from a large number of randomly distributed mini-nodes integrated with sensors, data processing modules and wireless communication modules (Sun Li-min et al. 2005). The main goal of WSN is collecting and dealing with information among the monitoring region which we are interested in by the cooperation of various sensors carried by nodes, such as temperature, humidity, light intensity, pressure, noise, size of moving object, speed and direction, etc. The transmission of the data to observers is wireless multihop through specified protocols (Zeng Peng et al. 2007).

Nowadays wireless sensor network can be roughly classified into three categories: wireless broadband network, wireless ad hoc network and WSN. WSN appliance is a highly relevant network system. It often has different network forms due to the different application and demand. Generally speaking, WSN has four features: self-organization, reliability, application of correlation and data-centric.

3 System Architecture of Wireless Sensor Network

3.1 *Architecture of Sensor Node*

Depending on applications, the WSN nodes have different configurations. But usually it composed of four parts: sensor module, processor module, wireless communication module and power module (Kottapalli et al. 2006).

Sensor module is responsible for collecting the required information within the monitoring area and data conversion and its types determined by the physical form of monitoring data signal; processor module is responsible for controlling the whole node, storage and processing the received data. It provides hardware support for the operating system and upper application software; wireless communication module is responsible for the wireless communication among nodes, transmission of data and controlling information; the power module provides energy for the node's normal work, usually by using micro batteries, solar battery, etc.

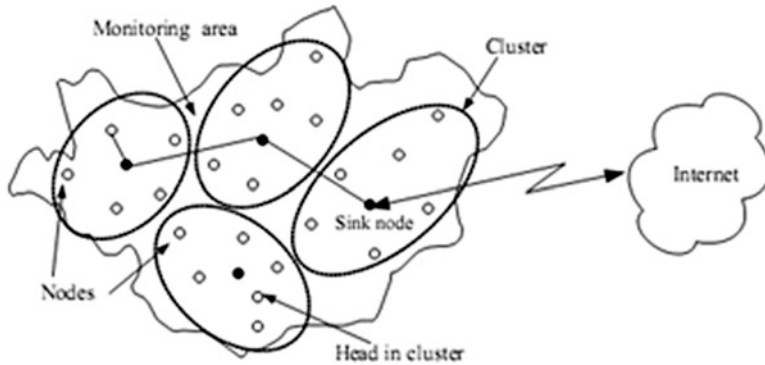


Fig. 1 Architecture of sensor network

3.2 Architecture of Sensor Network

Like the architecture of nodes, the architecture of WSN based on sensor network applications is also a variety of different. Basing on the function division, sensor network usually can be divided into the following three types of nodes: sensor node, sink node and management node, as shown in Fig. 1. The network is composed of massive sensor nodes random deployed in the monitoring region by the way of self-organizing. According to the certain protocol rules when monitoring data, finishing transmission by each sensor node hop by hop, and then gathering on the special node after the multi-hop routing. At last, arrive at the management node by internet and satellite. And the administrator achieving the configuration management to WSN by the node, issuing control command, etc. (Ruiz et al. 2003).

3.3 Protocol Stack Architecture of Sensor Network

Nowadays researchers have developed many types of protocol stacks for sensor network. Generally sensor network protocol stacks take the five-floor protocol in internet, which include physical layer, data link layer, network layer, the transport layer, the application layer and added the platforms with WSN characteristics, such as the energy management platform, mobile management platform and task management platform, etc. These platforms make sensor nodes work high efficiently under the priority of low power consumption.

Position layer and time synchronization layer were added in the improved module to provide the information support of the MAC protocol based on the time multiplex or the routing protocol based on the geographical location. Meanwhile network management, topology control, energy control and much other mechanism were presented to optimize and manage the agreement process.

3.4 Architecture Characteristics of Sensor Network System

System architecture means a lot for wireless sensor network. Although a WSN is a network system highly related to applications, which under different application requirements can be different in terms of the hardware and software of network nodes, network protocol as well as other relevant technologies. By considering some common features of WSN and providing a reference “system” and “framework” to developers, can greatly shorten the WSN development time and reduce its complexity. According to the different emphases, nowadays WSN system architecture includes dynamic protocol stack supporting system, stratified system, Self-adaption system, self-restore system, multitasking system and agent system, etc.

4 Application of Wireless Sensor Network

Sensor network has a broad prospect for applications. It can be widely used in many fields. Such as military, environmental supervising and prediction, medical, intelligent household, urban traffic, space exploration, safety supervising, etc.

4.1 Military Application of Wireless Sensor Network

In military field, sensor network will become a necessary part of system C4ISRT (Command control communication computing intelligence surveillance reconnaissance and targeting). Its goal is to design a battlefield command system combining the functions of commanding, controlling, computing, intelligence, surveillances, reconnaissance and positioning. This attracts the attention in military developed countries. Because sensor network is composed of intensive, low cost and random distributed nodes. Self-organizing and the ability of tolerating mistakes so that it will not lead the collapse of the whole system when some nodes are suffering malicious attack (Nogueira and Loureiro 2005). Just on this point, conducting real-time supervising on our army troops, equipment and supplies, Surveillance conflict zone, reconnoitering local terrain and laying out position attack target and access loss, etc.

4.2 Industrial Applications of Wireless Sensor Network

Development with computer, communication and network technology, the development of industrial communication technology has gone through the periods of analog instrumentation control systems in the 1960s and 1970s, distributed control systems (DCS) in the 1980s and 1990s, and the field bus control systems (FCS) at the end of the twentieth century, moving in the direction of intelligent

and networked. With the development of monitoring system, reduce the cost of investment and use of communication technology for industrial development of the urgent requirements. Under this circumstance, the low cost, using friendly and wide perception and other features of wireless sensor network catch people's attention. By applying these features, people can use the lower investment costs to monitor the whole industry progress, and using it as the foundation of implement optimized control to improve quality of products to realize the goal of reducing the leakage problems and increasing the energy efficiency.

4.3 Other Applications of Wireless Sensor Network

The environment science is used in a wide range. Traditional data acquisition methods cannot meet people's need any more. WSN provide convenience for data collection in a complex environment, such as tracking migration of birds, monitoring raw water, air and solid changes in composition. It also provides a great help for fire prevention, flash flood prediction (Steffan et al. 2005). Wireless sensor network plays an important role in medical and health caring field. Doctors can keep handling the patients progressing and deal with it in time when special sensor node be installed in patients body; it also can provide reference data for daily health research and new medicine development under the condition of without influencing the normal life.

5 Problems and Improving Methods of Wireless Sensor Network Application

5.1 Physical Manipulations of Sensor Node

Future sensor network will have hundreds and thousands of sensor nodes. It's difficult to monitor and protect each of them. Thus each node is a potential point to be attacked physically and by logic. In addition, sensors usually are deployed in no-human environment which make it more convenient for the attacker to capture sensor nodes. When captured the sensor node, the attacker can modify or get its information or code, modify its program code and load into sensor node. Obviously, the ordinary sensor node has great security holes. Since it's an unavoidable issue of security that sensor node can be easily physical manipulated, other technical solutions must be provided to improve the security performance of a WSN. An example is the node to node identity authentication, Another example is developing a new key agreement so that even a small amount of nodes are manipulated, attacker can not or difficult to obtain node information from other nodes is derived the key information. In addition, the sensing node can authenticate the legality of the software and other measures to improve the safety performance of the node itself.

5.2 *Information Wiretap*

According to the characteristics of wireless transmission and network distribution, it's easy for the attackers to get sensitive and private information through the transmission among nodes (Brannstrom and Jungert 2006). Encrypting transmit information can solve wiretaps, but it requires a flexible and strong key exchange and management scheme. What's more, the key management scheme should be easy to deploy and serve limited resources characteristics of sensor node. In addition, key management scheme has to ensure the security of the whole network to not be destroyed when section nodes out of work. Due to the limited internal storage resources of sensor node, it's impractical to realize the end-to-end security among nodes. While in sensor network, hop-hop information encryption can be realized in sensor network, thus sensor node only has to share the key with neighbor nodes.

5.3 *On Privacy*

Sensor network is designed to collect information. Attackers may get this sensitive information by the way of wiretap, adding forged illegal nodes, etc. An attacker can derive valid data from large amounts of acquired data if the attacker is able to obtain the relevant algorithm for acquiring limited information from completed information. Then the attacker can export the valid information through access a lot of useful information. The normal sensor private problem, which is unlikely obtain information through sensor network, but through remote monitoring of WSN by the attacker, so that to get large amount of information and work out the private problem with specific algorithm. Making sure the sensor information on network is visited only by trusted entity is the best way to solve this private problem, which can be achieve through data encryption and access control. Another way is to limit the granularity of transmit information on network, since the more detailed information, the more easily to leak the privacy, For example, a cluster node can achieve the data anonymous by dealing with the massive information received from the neighbor node and transmission results only.

6 Conclusion

Wireless sensor network have the characteristics of self-organization, miniaturization and external perception ability, etc. These features determine their vast application prospect in business field. For example, sensors embedded in home appliances and embedded systems can form wireless networks which with internet links are able to offer more intelligent and humanizing home environment. Sensor network can be used for space exploration, transmitting sensor nodes in outside

planet with spacecraft, the long-term monitoring of the interest environment, etc. It also can be used in disaster prediction and rescue, warehouse management, factory automation and other fields. Wireless sensor network would gestate new design and application mode.

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