Research on Technology of Wireless Sensor Network

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Abstract Wireless communication and embedded technology have made the wireless sensor network (WSN) possible. The sensors, which are deployed in an environment, are required to collect data from their surroundings, process the data, and send it to the sink. Traditional WSNs collect the data such as temperature and pressure. WSN has potential to design many new applications for handling emergency, military, and disaster relief operations that require real-time information for efficient coordination and planning. The self-organization and cooperation of wireless sensor network have opened up a broad application prospect. However, wireless sensor network has the characteristics of resource limitation and design constraint. Resource limitation means that sensor nodes have limited wireless communication range, limited power supply, low bandwidth, limited computing power, and storage capacity. Design constraint means that the design of wireless sensor network depends on its application purpose and the monitored physical environment. This paper first introduces the concept of wireless sensor and expounds the challenges brought by the characteristics of wireless sensor network. Secondly, this paper introduces the representative research work from the aspects of network standard communication protocol network management technology and data compression technology.

1 Introduction

The sensor node is composed of radio transceiver, microcontroller power supply, and multi-type sensor. Sensor nodes with sensing, computing, and communication capabilities are deployed in the designated monitoring area. These nodes are homogeneous and coordinate to collect and process the information of sensing objects in the monitoring area. WSNs construct efficient connections between the physical world and the virtual computing world, making possible the interconnection between physical objects and logical cells. WSNs meet people's real needs to explore and monitor

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the physical world at a low cost and represent a major advance in the traditional way of perception [1].

Sensor nodes can be randomly placed in the monitoring area. In order to ensure the overall performance of the linear sensor network, the strategies and algorithms applied in the network must be self-organized and different from traditional sensing methods. Sensor nodes do not send all the initial sensing data to sink node, but the collected sensing data is processed, calculated, and fused, and only the data of interest to the user is sent to the sink node. Therefore, wireless sensor network has efficient collaboration [2].

The self-organization and collaboration of wireless sensor networks have opened up broad application prospects. For example, in the fields of space exploration, power monitoring, and also medical treatment and nursing, doctors can monitor and control patients' indicators remotely. The physiological data of high frequency and multiple indicators are helpful for doctors to know the health status of patients more accurately and provide reliable basis for them to make effective treatment plans. Sensor networks can also be used in pollution monitoring and control. In fact, the wireless sensor network can intelligently obtain the effective information of the monitoring environment, giving people a clear and accurate picture of the physical world. Wireless sensor network has been widely used in intelligent transportation, green building, intelligent home disaster warning, and other fields [3].

Different from traditional network systems, wireless sensor networks have design constraints and resource constraints. Specifically, resource-constrained means that sensor nodes exhibit restricted wireless communication range, limited power supply low bandwidth, and limited computing capacity and storage capacity. The design constraint means that the design of wireless sensor network depends on its application purpose and the monitored physical environment. Among them, the physical environment determines the factors such as network topology of network scale node deployment. In general, the network size will depend on the physical environment. Obstacles in the physical world also limit wireless communication between sensor nodes, thereby reducing the connectivity of the network topology. Based on this, research on wireless sensor networks is committed to introduce new design concepts, innovating or improving new algorithms for current network protocol design, aiming to meet design constraints and improve network performance [4]. In the following sections, we will introduce wireless sensor key technologies.

2 Key Technologies of Wireless Sensor Networks

The development and key technologies of wireless sensor network can be broadly divided into three groups. As shown in Fig. 1, there is a separate system for each sensor in the first group. In order to meet the application requirements of sensor network, new operating system platform and storage model were designed and developed. The second group is the communication protocol. The communication protocol not only guarantees the wireless communication between sensor nodes, but also establishes

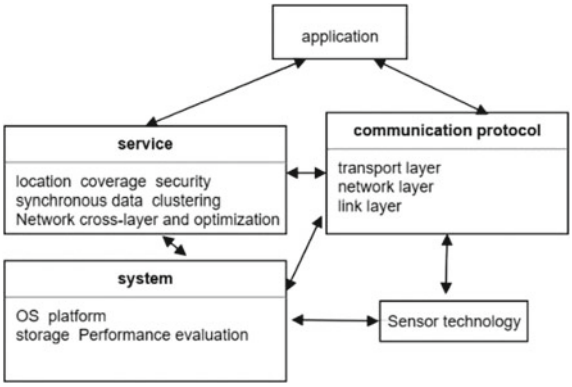

Fig. 1 Key issues of wireless sensor networks

the communication between the upper application and the lower node. The third group is the service research for serving wireless sensor networks, aiming to improve network performance and system efficiency, so as to improve the level of industrial application.

From the perspective of application requirements and network management, the self-organization of sensor nodes is of global importance. Sensor nodes can not only spontaneously organize multi-hop wireless network systems, but also it is possible for nodes to be efficiently distributed and controlled. Due to the limited power supply and storage capacity of sensor nodes, it is of great significance and value to carry out the research on communication protocol and management service to meet the above requirements [5].

The standard communication protocol is generally divided into five layers, specifically, the application layer, the transmission layer, the network layer, the data link layer, and the physical layer. The communication protocols of different layers have important effects on energy consumption, end-to-end delay network congestion, and network throughput. Therefore, the study of efficient communication algorithms has become the focus of the development of the field. The information sharing and interaction between different protocol layers make the cross-layer optimization algorithm possible. Sensor nodes only use batteries to supply energy, so the quota is naturally limited. Once the power supply of the node is exhausted, the node will fail and logically leave the sensor network, which reduces the reliability of the sensor network. The lifetime of the sensor network depends on the effective number of nodes and network connectivity. Therefore, energy efficiency has become the primary index to measure the performance of sensor network algorithm [6].

A great deal of research work is to establish a reliable wireless communication to build an optimized node layout and design a complete data aggregation method to achieve high energy efficiency and good quality of service (QoS) requirements. Moreover, for the communication result pattern, the proposed and implemented data recovery strategy of the congestion control buffer monitoring information confirmation mechanism provides a basic technical guarantee for the reliable transmission

of packets. In addition, the existing research shows that the wireless communication strength depends on the sensor nodes configuration. The sparse configuration scheme will lead to the remote communication between nodes, resulting in high energy consumption. Although the intensive configuration scheme reduces the communication energy consumption, it is easy to cause communication conflicts [7].

3 Network Standard

Different types of sensor hardware is uneven, and how to make a variety of sensor nodes to achieve stable organic combination for sensor network platform development and system design puts forward important research subject. Network standard defines local area network (LAN) for the sensor nodes and the physical media access control protocol in order to meet a variety of network, the IEEE 802.15.4 standard makes the low rate, low overhead, low power, and low complexity of the topological structure of the wireless local area network to become a reality; also, IEEE802.15.4 provides a standard for physical layer and data link layer, and has been widely used in hot fields such as industrial automation of intelligent home environment monitoring.

Based on the IEEE 802.15.4 standard, ZigBee standards have defined the high-level network communication protocol. ZigBee is a kind of simple wireless communication technology and has advantages of low power consumption. ZigBee uses the network topology structure and can connect lots of wireless communication devices at the same time. Safe and energy-efficient wireless communication technology can provide technical support for channel frequency hopping and message passing synchronization, and is applicable to a variety of network topologies, including mesh network, star network, and hybrid network.

4 Communication Protocol

Sensor nodes communicate wirelessly with other nodes through the protocol stack. In order to ensure that, sensor nodes can efficiently and cooperatively conduct intra-network data transmission. A lot of important achievements have been carried out around the design of data link layer and cross-layer network communication protocol of transport layer, such as the sensor transmission control protocol (SCTP), which provides congestion detection for the transport layer as a kind of reliable transport layer protocol, under the condition to meet the reliability requirements of the transport layer, minimizing communication overhead; the pump slowly, fetch quickly (PSFQ) protocol is a scalability and robustness of the ideal transport layer protocol and the agreement to protect the data block transmission, but also provides data recovery strategy in the above results; the congestion detection avoidance (CODA) protocol can alleviate network congestion rapidly and is a kind of energy-efficient congestion control strategy. In conclusion, the network layer protocol is mainly aimed at the

data routing within the network and aims to realize efficient data transmission under the condition of limited energy supply and communication bandwidth [8].

5 Network Management Technology

Network management technology is mainly engaged in node localization topology control time. The mobile-assisted localization (MAL) location algorithm is the root, according to the mobile node and the distance between the static sensor nodes to determine the location of the sensor node immediately. SeRloc algorithm is based on directional antenna. It is equipped with locator node monitoring information and provides location information for sensor nodes. The research is of security positioning algorithm, the algorithm to ensure the safety of the positioning process. In addition, the distributed reputation and trust-based security (DRBTS) protocol can identify false bit information based on the monitoring information of beacon nodes [9].

6 Data Compression Technology

Distributed data compression methods of sensor network are mainly divided into the following four types: distributed source modeling (DSM) technology, distributed transcoding (DTC) technology, distributed source coding (DSC) technology, and compressed sensing (CS) technology. The DSM methods are largely divided into model parameter model method and nonparametric method. Simulation algorithm based on parameter model will perceive the data as a stochastic process, and parameter estimation is optimized to achieve the statistics when sensory data structure of statistics known parameter model. However, when the perception data is sparse or the prior knowledge is fuzzy, the nonparametric model method shows high robustness while the nonparametric model method is mainly devoted to the study of the fitting function of the perception data [10].

A WSN lossless compression algorithm is a kind of lossless compression technology. The technology is based on the same sensor node with no similar cycle and the characteristics of the sensor at the same time. Collecting information is very similar to information preprocessing based on data compression technology. Before compression, the information is compressed more effectively to improve the compression rate and make the energy saving effect more obvious [11].

Based on the original data of temporal correlation and spatial correlation, the data compression method of sensor network based on sequence correlation is carried out considering multidimensional correlation information. An algorithm evaluation model can be designed based on the energy criterion. This algorithm can effectively reduce the amount of data in the network, prolong the network life cycle, and achieve good energy-saving effect [12].

7 Conclusion

With the continuous development of sensor technology, monitoring application based on large-scale sensor network has become possible. However, the research on the availability of large-scale sensor network data and perceived data is still an academic field that has not been deeply studied. Therefore, in the next step, we should take the above characteristics into consideration and propose a more effective and practical algorithm based on the application scenario of sensor network.

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