Design of temperature monitoring and management information system based on wireless communication

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Abstract: Temperature monitoring and data management technology is an effective way to achieve the goal of energy saving and emission reduction, and also an important technical means to achieve efficient operation of related automation equipment. Therefore, the realization of accurate indoor temperature monitoring and data management analysis has been a research hotspot of various research institutions. This paper will design a temperature monitoring and data management information system based on wireless communication technology, which will focus on the analysis of data management in wireless communication technology, and discuss the corresponding data storage, data query and data storage analysis. In the design part, this paper will discuss the design scheme of temperature monitoring and information management system from two directions of hardware and software. At the same time, the architecture of the whole system is proposed. Finally, based on the temperature monitoring and management system designed in this paper, the test results show that the monitoring and management system proposed in this paper has good stability and practicability, and also has good market application value.

1. Introduction

Temperature monitoring and data management has always been the focus of attention and research in many fields. Real-time monitoring and data management system of indoor temperature is helpful for the heating market to further optimize its heating measures, realize the social demand of energy saving and emission reduction, and then realize environmental protection and comprehensive utilization of energy [1-3]. Temperature monitoring and data management of key parts of generators in power system are conducive to ensuring the sTable operation of power system, avoiding large-scale accidents, ensuring the safety of power system and avoiding huge economic losses [4]. However, the traditional on-line temperature detection technology relies too much on wired data network, which brings problems such as complicated wiring, high maintenance cost and many faults. Therefore, it is of great significance to develop an accurate, real-time and effective temperature monitoring and information management system in time.

In order to achieve real-time temperature monitoring and effective information management, a large number of research institutions and researchers have studied it. In order to realize real-time monitoring and management of temperature, the first western country [6-8], led by the United States, put forward on-line monitoring and diagnosis technology, and established a large number of database management systems. This technology has certain advanced nature, but its engineering volume is relatively large. Some universities such as Tsinghua University and Harbin University of Technology [9-12] have developed on-site signal acquisition and so on. The related temperature monitoring instruments for barrier diagnosis have some limitations in the stability and portability of data acquisition. The United States, Japan and Italy [13-15] have proposed the realization of temperature monitoring and data management based on wireless sensor networks. The related research is in the development stage, and it faces many challenges in practical application. In storage, a lot of research focuses on wavelet coding technology, but this technology relies on

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approximate query of large-scale data, which is prone to node failure.

With the development and progress of wireless communication technology, wireless communication technology has been widely used in various fields, including the design of temperature monitoring and information management system. This paper will design a temperature monitoring and data management information system based on wireless communication technology, which will focus on the analysis of data management in wireless communication technology, and discuss the corresponding data storage, data query and data storage analysis. In the design part, this paper will discuss the design scheme of temperature monitoring and information management system from two directions of hardware and software. At the same time, the architecture of the whole system is proposed. Finally, based on the temperature monitoring and management system designed in this paper, the test results show that the monitoring and management system proposed in this paper has good stability and practicability, and also has good market application value.

The structure of this paper is as follows: The second section of this paper will focus on the analysis of data management in wireless sensor networks, and will focus on data storage, data query, data transmission and data fusion technology in-depth study; The third section of this paper will design temperature monitoring and information management system from the hardware and software aspects, which contains the whole temperature monitoring and information. The framework of management system; finally, this paper will make a summary.

2. Data Management Analysis and Research of Wireless Communication Network

2.1 Architecture of wireless communication data management system

The structure of wireless communication network used and studied in this paper is shown in Figure 1. It consists of a large number of sensor nodes, a large number of sink nodes and data task management nodes. Among them, a large number of sensor nodes are located in the random deployment monitoring area of the whole wireless sensor network, which can realize the self-organization of the network by means of free combination. When the data collected by wireless sensor is transmitted to other sensor nodes, the corresponding monitoring data will be processed and analyzed by multiple nodes in the process of data transmission. The processed data will be aggregated to the sink node, and finally the data of the sink node will reach the mission node through the Internet or satellite.

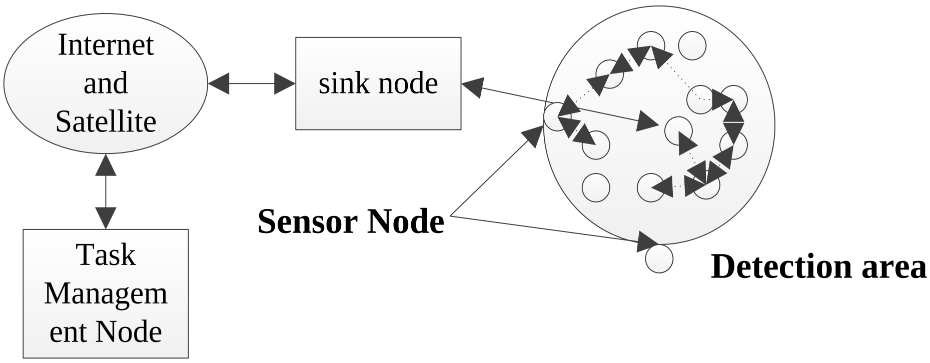

Figure 1: Architecture of wireless communication sensor networks

In the above wireless communication sensor network, the corresponding sensor node is essentially an embedded system, which mainly consists of sensors, processors, wireless communication modules and corresponding power modules. In the corresponding power module, it mainly provides the energy needed for the operation of sensor nodes. The corresponding communication part is mainly responsible for the wireless communication tasks between sensor nodes and nodes, involving tasks such as collecting temperature information, collecting temperature information, exchanging control information and so on. The corresponding composition frame diagram is shown in Figure. 2.

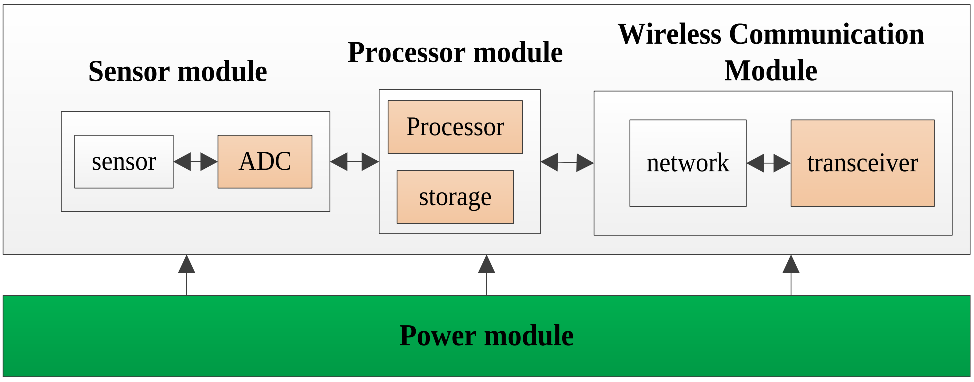

Figure 2: Composition block diagram of wireless sensor nodes

2.2 Storage and query of wireless communication data management

The data storage mode of wireless sensor after collecting temperature data is divided into three kinds, which correspond to external data storage, local data storage and data center data storage.

The external storage structure is a centralized storage structure, and the temperature data collected are stored on the sink nodes outside the sensor network. The sink node receives data passively without the actual right to choose. Local storage is to store all data close to the sensor node that generates the data. When the relevant sensor node receives the query command of the data, it sends the data to the sink node for analysis and processing. External storage is the simplest of the three storage modes, while local storage needs to traverse the entire wireless network when querying actual data, which requires a lot of energy consumption. Data center storage is in the middle of query overhead and other performance aspects. The calculation methods of the total communication information corresponding to the three storage modes are shown in Formula 1, Formula 2 and Formula 3. The corresponding n is the number of nodes in the network, Dall is the number of detected data and Q is the number of queries.

$$Q_{all} = D\sqrt{n} \tag{1}$$

$$Q_{all} = Q_n + D_{ij}\sqrt{n} \tag{2}$$

$$Q_{all} = Q\sqrt{n} + D_{ij}\sqrt{n} + D_{all}\sqrt{n} \tag{3}$$

In the query technology, this paper focuses on the following two query technologies and applies them to the final temperature monitoring and information management system.

2.2.1 Continuous query technology

The query commands are decomposed and a series of sub-queries are submitted to local nodes for execution. The corresponding sub-queries are continuous queries, which need to be scanned, filtered and integrated data stream processing steps. The key technology of this technology is local query technology, which has the characteristics of self-adaptation.

2.2.2 Multi-query optimization technology

In the whole wireless communication sensor network, multiple continuous query operations are carried out at intervals of time. Multiple query optimization is the operation of judging various data. Its main essence is to reduce the transmission times of overlapping parts so as to reduce the number of data transmission.

3. Design and experiment of temperature monitoring and information management system

This section will focus on the analysis of temperature monitoring and information management system design, which includes two levels of software and hardware design. At the same time, the system designed in this paper will be tested in practice.

3.1 System overall architecture

The temperature monitoring and data management information system designed in this paper is mainly divided into two parts. The corresponding sensor node of the lower computer is mainly responsible for collecting the data of the environment temperature or the detection system. At the same time, after collecting the data, the corresponding data are networked and managed for data transmission. The corresponding upper computer data management software is mainly responsible for processing and analyzing the data transmitted. The frame diagram of the corresponding temperature monitoring and data management information system is shown in Figure 3.

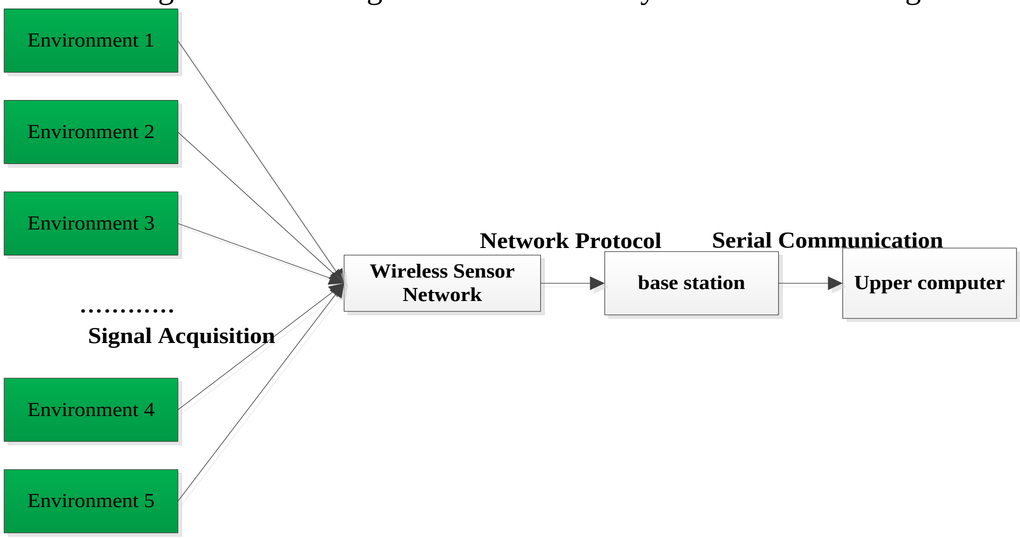

Figure 3: Overall framework of temperature monitoring and data management information system

3.2 Hardware design of temperature monitoring system

In the part of hardware design, the platform used in this paper is a miniaturized hardware platform of embedded system. Its main hardware design lies in the design of nodes and network structure.

In the aspect of system hardware node design, this paper adopts the same hardware design idea on coordinator and temperature detection equipment, and the realization of its function mainly depends on software. The hardware includes sensor module, communication module, data acquisition module, processor and LCD display part. The hardware frame of the corresponding system is shown in Fig. 4. The microprocessor is CC2430, the wireless sensor network module is JN5121, and the temperature sensor is SHT11 temperature and humidity integrated sensor. In the power module, BUCK topology is mainly used. The selected power chip is LTM1117, and the corresponding output voltage is 1.8V, 2.5V, 2.85V, 3.3V and 5V. In the part of LED and switching circuit, RS232 level conversion circuit is mainly used. LCD display part mainly uses 128064 LCD display, using UC1606 driver chip.

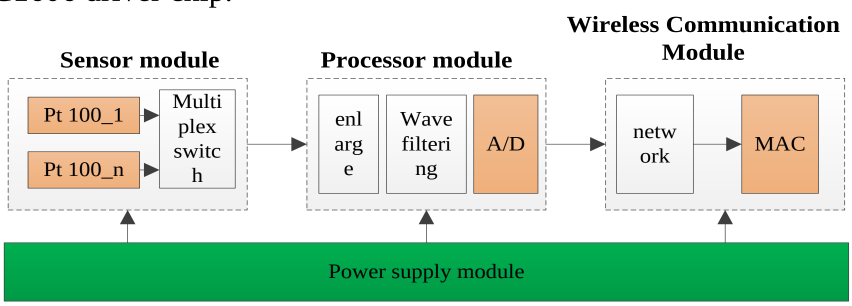

Figure 4: Hardware framework of temperature monitoring and data management information system

3.3 Software design of temperature monitoring system

The software platform of temperature monitoring and data management information system designed in this paper is Jennic ZigBee. The corresponding application framework is shown in Figure 5. As can be seen from Figure 5, the core of the whole software system is the programming of the coordinator. It mainly involves the main functions of coordinator application and the application of functions, such as function AppColdStart, AppWarmStart and so on. The functional relationship in the corresponding coordinator application in the software system needs to be defined and defined concretely. At the same time, the realization of the corresponding communication function needs to configure the parameters of the wireless communication network, assign the network address to the corresponding sub-nodes, and initialize the external hardware devices and protocol stacks.

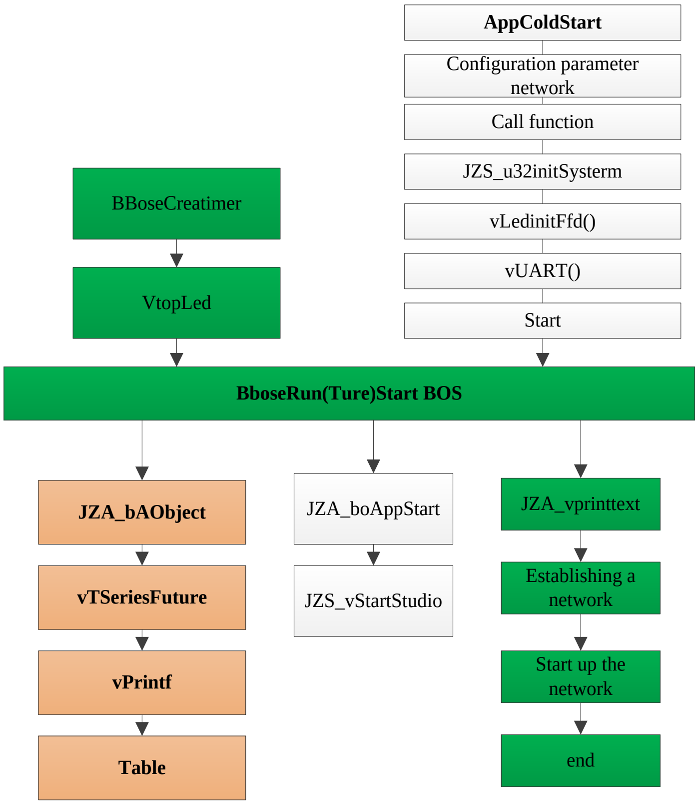

Figure 5: Software block diagram design of temperature monitoring and data processing information system

3.4 Measurements

In order to verify whether the temperature monitoring and data management information system proposed in this paper can work stably and normally, the network system is placed in the campus environment for testing. In the actual test, two network nodes are tested. Their corresponding decibels are coordinator nodes, i.e. upper computer nodes and lower computer nodes, and their corresponding nodes are routers.

The corresponding measurement steps are as follows:

3.4.1 Setting up debugging tools for serial ports

Running the debugging program of serial port in the experimental computer, the corresponding serial port is set to the baud rate of 19200, the test bit is set to none, the corresponding data is set to 8, and the stop bit is set to 1.

3.4.2 Realize networking

Through RS232 interface to connect with the experimental computer, the coordinator and the switch equipment on the sensor are debugged jointly, so that the coordinator is in the running state until the network is established.

3.4.3 Analytical data

The relevant temperature information was collected and compared with the preset information. Based on the analysis results, the corresponding conclusions and suggestions were given.

Based on the above experimental steps, this paper measured the actual temperature and monitoring temperature histogram of a classroom on campus as shown in Figure 6. From the diagram, we can see that the temperature monitoring system proposed in this paper has good real-time and accuracy.

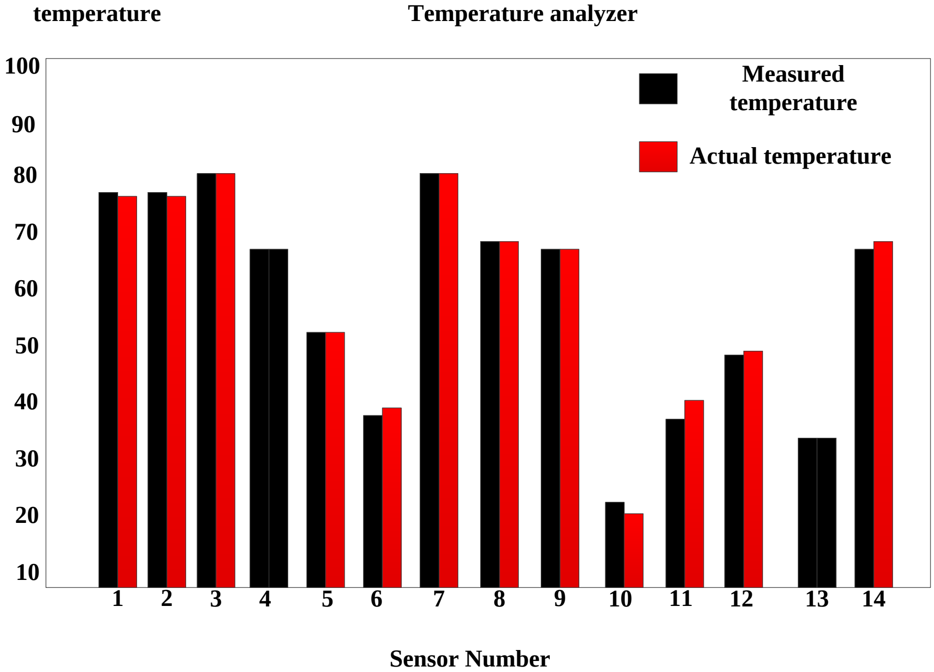

Figure 6: Histogram of comparison between measured temperature and actual temperature.

4. Conclusion

The design of temperature monitoring and data processing information system is an important technology to solve a series of difficult problems in industry and people's life. In this paper, the disadvantages of current temperature monitoring and data processing are analyzed in detail and the advantages of wireless communication technology are discussed. This paper focuses on the analysis of data management in wireless communication technology, and discusses the corresponding data storage, data query and data storage analysis. In the design part, the design scheme of the temperature monitoring and information management system proposed in this paper is discussed in detail from the two directions of hardware and software, and the architecture of the whole system is also proposed. Finally, based on the temperature monitoring and management system designed in this paper, the test results show that the monitoring and management system proposed in this paper has good stability and practicability, and also has good market application value.

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