Application of Wireless Sensor Network in Precision Instrument Laboratory

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Abstract: In order to solve the problem of temperature and humidity monitoring in precision instrument laboratory, a temperature and humidity monitoring system is designed by using wireless sensor network technology. This system uses ZigBee wireless sensor network. The network topology is used in the topology structure. The temperature and humidity data can be accurately collected by ZigBee wireless sensor network. Then the temperature and humidity data can be analyzed and sorted out by the control center test.

1. Introduction

With the development of science and technology, more and more precision instruments and equipment have entered the laboratory.^[1] The routine maintenance and management of precision instrument laboratories is very important. Precision instruments are composed of metal and metal materials. In addition, most precision instruments have large-scale integrated circuits, so the environmental requirements of the laboratory are very demanding. The temperature and humidity of the laboratory have a great influence on precision instruments, especially in terms of error theory, signal analysis and data processing.^[2] The temperature and humidity of the precision instrumentation laboratory must be monitored in real time. The paper describes a real-time monitoring of the temperature and humidity of the laboratory using a wireless sensor network.^[3]

2. Overall Design of the System

The overall design block diagram of the system is shown in Figure 1.



Figure 1 Overall Block Diagram of the System

In Figure 1, the AT91RM9200 (ARM920T) is the control core of the system. The wireless sensor network uses ZigBee technology. The main function of the wireless sensor network is to collect and transmit temperature and humidity data. In the precision instrument laboratory, there are multiple sensor nodes, routing nodes and temperature and humidity sensors, which can monitor the temperature and humidity in the laboratory in real time and ensure the temperature and humidity in the precision instrument laboratory are stable. ^[4]

The wireless sensor network uses a mesh topology. Each node uses the CC2530 F256 full-featured RF transceiver module. The node is equipped with a SHT15 temperature and humidity sensor. The collected temperature and humidity data are transmitted to the sensor node through the RF transceiver module. The final data is transmitted to the gateway node for processing.^[5]

The main function of the upper position is to process and analyze the received data polarity. The GPIO port corresponding to the sensor node must be in a high state. This is only necessary to ensure that the triode is in conduction and a protection circuit is required to ensure that the relay is in the normally open mode. In this way, the temperature and humidity adjustment appliances can be turned on to adjust the temperature and humidity, thereby ensuring the normal temperature and humidity of the laboratory.

3. Monitoring Network Design

The sensor nodes installed in the laboratory can monitor the full temperature and humidity data. The specific circuit structure is shown in Figure 2.

The working principle is that the temperature and humidity data collected by the greenhouse sensor should be converted into a digital quantity by an analog-to-digital converter, and then the digital quantity is transmitted to the data processing module for data processing; The processed data needs to be sent to the gateway node through the network, and the aggregated data is transmitted to the upper position through the gateway node, compared with the set temperature and humidity data, and then the temperature and humidity are adjusted by the temperature and humidity adjustment appliances. ^[6]



Figure 2 Sensor Node's Work Structure

The software program used by the sensor node is the ZigBee protocol. Wireless sensor networks are at the heart of the entire monitoring system.

4. Upper Position Design

The operating system on the machine is the Linux operating system. This system not only supports CAN bus interface but also supports multiple RS 232/RS 485 serial interfaces, and it can also communicate with display devices.

When the ZigBee gateway node is deployed in the precision instrument laboratory, the distance between the required and the upper position cannot exceed 15m. The wireless sensor network receives the temperature and humidity data through the serial port and the control center. The hardware circuit is RS 232C DB-9 type of connector. This connector can realize two-channel asynchronous communication. The specific hardware circuit is shown in Figure 3.



Figure 3. Structure of RS232C Communication Circuit



Figure 4. Main Program's Flow Chart

5. Software Design

In order to ensure that the upper position can correctly display the data information of the

temperature and humidity in the precision instrument laboratory, a software system must be established. Qt is a cross-platform C++-based GUI system that provides users with a graphical user interface.[7] When performing temperature and humidity data management, it should not only display the temperature and humidity data in real time, but also perform history query and standard setting. The flow chart of the main program is shown in Figure 4.

6. Temperature and Humidity Adjustment Circuit Design

Last time, the obtained temperature and humidity data was compared with the set temperature and humidity data. [8] If there is a deviation, the greenhouse adjustment is needed to ensure the stability of the temperature and humidity of the precision instrument laboratory. The specific circuit is shown in Figure 5.



Figure 5. Temperature and humidity adjustment circuit

The control center of this circuit is a relay. The main functions of the relay are automatic regulation, safety protection, and circuit conversion. The hardware circuit is SRD-03VDC-SL-C electromagnetic relay When the temperature and humidity in the precision instrument laboratory are abnormal, the relay automatically controls the heater, dehumidifier, chiller and humidifier to work. If the temperature and humidity data are normal, the relay will automatically turn off the heater, dehumidifier, chiller and humidifier.

7. Conclusion

This paper introduces the detection of temperature and humidity in the precision instrument laboratory through ZigBee wireless sensor network. The overall structure of the system, monitoring network design, upper machine design, software design and temperature and humidity adjustment circuit design are discussed in detail. Through this system, the temperature and humidity of the precision instrument laboratory can be detected accurately and in real time, and the automatic adjustment can be realized when the temperature and humidity are abnormal.

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