Monitoring system based on wireless temperature measuring device

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Abstract. This paper analyzes the current common problems in substation temperature measurement, and the transformer temperature measurement system is designed. The system includes a temperature collection node, a temperature concentrator and a remote monitoring center, which can perfectly realize the functions of temperature collection, wireless transmission and online monitoring. Through the actual application of the software, it can be seen that the various modules are operating normally and have reached the design goals.

1. The first section in your paper

The substation integrates power grids of different regions and voltage levels. As a transfer station for power transmission and distribution, it is a key component of the power system. The safe and reliable operation of substations is the foundation of the normal operation of the power system, and it is also a key guarantee for economic and social growth. Therefore, the safety and stability requirements of the power system are critical to supporting economic and social growth.

The production and transmission of electricity, including consumption, are instantaneous. Therefore, the substation equipment cannot exit the system at will to operate [1]. This requires prediction of the failure of substation equipment, and the problem is wiped out in the bud. The traditional method is to inspect the equipment by substation operators, for example, using a handheld infrared imager to measure the temperature of the equipment. This method has many problems: (1) The operator has limited regular inspection frequency, unable to perform continuous monitoring for 24 hours, and it is difficult to find unexpected problems; (2) When inspecting the equipment, the operator needs to be close to the live equipment, which poses a serious safety hazard.

According to statistics released by the media, in the past 20 years, my country’s power transmission and transformation stations have caused a total of more than 140 fire accidents. Among them, as many as 24 power plants have caused 2 or more cable fire accidents [2-3]. These accidents have caused losses to the national economy. As much as more than 5 billion yuan. According to the statistics of the 2015 National Electricity Safety Production Accident Report issued by the National Energy Administration, 40% of the electric power accidents that occur in substations each year are caused by overheating of high-voltage electrical equipment. If it is discovered in time when the equipment is just heating up, and immediate action is taken, the number of cases of such electrical accidents can be completely reduced. Therefore, it is imperative to take temperature online monitoring measures for operating power equipment, especially for high-voltage power equipment.

The key problems of online temperature monitoring of power equipment in substations are: the heating points of electrical equipment usually exist in high potential locations, which makes the general
temperature sensing method subject to NINON; there are many points in the substation that need to monitor the temperature, but they are often limited. Due to issues such as economy and sensor insulation, it is unrealistic to install a large number of temperature sensors with high cost and complex structure [4]. Therefore, searching for an online temperature monitoring solution with low cost, short project construction period, good adaptability and scalability, and easy maintenance of equipment has become the primary problem to be solved at present.

With the continuous development of wireless temperature measurement technology, it can make the production management of the power system safer and more intelligent, and it has a huge role in promoting the creation of a smart grid. Therefore, this paper proposes wireless temperature measurement technology, which can use information and automation to monitor substation equipment in real time. After a system is completed, it can provide operation monitoring for multiple substations. Through the analysis and processing of the data, the system provides big data support for the state maintenance work of the power system.

2. Another section of your paper

According to the demand analysis of the monitoring software for the primary equipment temperature measurement system of the substation, it can be concluded that the monitoring software should be composed of two parts. The first part is an application program for node configuration, data processing, data analysis, and data storage. The other part is the database used to store data information. The application program and the database run at the same time, which can fully meet the software design requirements.

In this paper, the block diagram of the wireless temperature monitoring system for substations is shown in Figure 1:

2.1. Database systems

This design mainly involves the user and system operation and maintenance database. The user database can store the temperature data information collected by the temperature collection node layer, and the system operation and maintenance database can record the device number of each temperature collection node and the corresponding device details. Whether the data server sends data to the client depends on the temperature value collected by its device compared to the change in the corresponding MySQL database table. The structure of the database is shown in Figure 2.
2.2. Database access

The database server first needs to process the information received by the network card, and then it needs to analyze which temperature concentrator the data comes from, and through a continuous process of writing in the corresponding table in the database server, the storage concentrator can continuously send to update the collected information. The above is the access process of the entire database. Figure 3 shows a schematic diagram of the temperature concentrator accessing the database through the software interface.

Based on the created database, we call the driver corresponding to the database interface provided by the manufacturer for the system, and then review and modify the MySQL database. The database interface application process is shown in Figure 4.
2.3. Data transmission

The general flow of data transmission of the temperature collection node layer, temperature concentrator, and remote monitoring center of the system designed in this paper is shown in Figure 5.

The data transmission process is that the device at the temperature collection node layer sends the collected temperature value and its own device number to the coordinator. After the coordinating node receives the temperature information, it transmits its PAN ID and temperature information to the microcontroller via the serial port. At this time, the microcontroller can make the Ethernet control chip forward the data to the remote monitoring center. After receiving the data, the remote monitoring center will sort the data and store it in different tables in the MySQL database. After the above steps are over. The collection of key points of the equipment by the wireless temperature monitoring system of the substation is over. The work behind the remote monitoring center is to calculate any received data, and finally forward the calculated data back to the temperature concentrator. After the temperature concentrator determines whether the data exceeds the threshold, it decides whether to alarm.
3. Application of temperature measurement system

The deployment of a wireless temperature sensor network is the deployment of a single wireless temperature sensor. The wireless temperature sensor is directly installed on the primary equipment of the substation to be tested, and these scattered sensors are connected through a wireless network to form a wireless temperature sensor network. Using monitoring software to record and analyze various collected data can help substation operation and maintenance personnel to better grasp the legal status of various primary equipment, detect heat-generating equipment in time and carry out inspection and elimination work. Taking a 500kV substation as an example, the typical layout of wireless sensors is shown in Figure 6. It is verified that the interface of the browser to access the system can be displayed normally.

![Figure 6 Block diagram of wireless sensor layout](image)

In the designed system, users of all levels can successfully log in under the login test. And can successfully add and delete power-saving devices in the login state, can view and manage all power-saving devices under a concentrator, can note the electrical equipment information monitored by each node, and can monitor the temperature of a single sensor node. The threshold is sent and set. Finally, in the experimental environment, after verification, it is shown that the system can normally display and monitor the temperature of each experimental point. Its various functional modules are shown in Figure 7.

![Figure 7 system applications](image)
4. Conclusion
In this paper, a temperature monitoring software is designed to measure and monitor the temperature information of various primary equipment in real time. A database is established to manage and save all kinds of data, including primary equipment name, equipment temperature information, sampling time information, temperature abnormality information, etc. In addition, the designed system was applied to a 500kV substation, which verified the feasibility of the designed system.

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