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ПЕРСПЕКТИВНЫЕ НАПРАВЛЕНИЯ СОВРЕМЕННОЙ ЭНЕРГЕТИКИ

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HARDWARE DESIGN OF TRANSFORMER REMOTE MONITORING SYSTEM BASED ON INTERNET OF THINGS

Shang JICHANG, Valery CHERTKOV

(Euphrosyne Polotskaya State University of Polotsk)

The architecture for intelligent monitoring systems in the power industry is considered. The equipment for remote monitoring is described. Based on the research and analysis of dry-type transformers, this paper designs a remote monitoring system for transformers based on the Internet of Things technology and draws the following conclusions: the design scheme with GPRS as the communication means and Arduino as the system carrier is determined.

Keywords: *Internet of Things, Dry type transformer, Remote monitoring, Heat source analysis, Imaging.*

Introduction. As the city electricity demand gradually rises, the transformer load more and more is also high. High load fever caused by the temperature can degrade the transformer's internal components, raising the risk of transformer faults. Transformer faults led directly to the power failure of schools, hospitals, and communities. They indirectly led to the economic loss of the people, To the residents, and the regular operation of the city caused great harm; Therefore, the monitoring of transformer temperature and safety protection is a problem that needs attention at present [1].

Transformers play a very important role in the distribution operation system. According to the operation statistics of the State grid in the past five years, accidents caused by transmission and distribution equipment accounted for more than 50% of all grid accidents in that year, ranking the first cause of faults [2]. Normal transformer is an important prerequisite to ensure the safe and stable operation of power grid [3]. More and more transformers are put into operation in the power network. Transformer failure will directly affect the transmission of electric energy, resulting in large-scale power outage in the power network [4], causing serious losses to factories, enterprises, schools and hospitals.

According to statistics, in developed countries such as Europe and the United States, dry transformers have accounted for 40–50% of the distribution transformer.

In our country, at present dry type transformer accounts for about 20–40% on average in large and medium-sized cities, and in Beijing, Shanghai, Guangzhou, Shenzhen and other large cities, the proportion is more than 50% [5].

In order to better record, distribute and manage electricity consumption, the power supply company will monitor and inspect non-substation dry transformers. Generally, the monitoring items are limited to remote monitoring of the current load, voltage and current. Manual inspection items include whether the devices are intact and whether the environment in the pre-installed box is humid. This has caused a problem: the remote monitoring project is not comprehensive enough, the manual inspection cycle is long, and the transformer lacks a certain degree of anti-theft protection. Therefore, the monitoring of dry type transformer is still a big problem to be dealt with.

The Internet of Things technology emerged at the end of the 20th century, and its core is to realize the connection between things and things, and between things and people [6]. In order to compensate the shortage of the current transformer monitoring, using the Internet of things technology for remote monitoring of dry type transformer from reliable data online, real-time data for the power supply company to provide better support, shorten the inspection period, improve the dry type transformer protection, etc., for the intelligent of the transformer, and the development of the network has a certain significance.

Transformer operation process and parameters

Dry type transformer, which make use of two insulated wire trap on a common core column, the formation of primary side and secondary side circle, and through the electromagnetic induction effect exists between the coil electromagnetic coupling effect, when a lateral line circle on alternating current, alternating magnetic field, iron core at the second side under the action of alternating magnetic field coil produces electromotive force, Provide stable power supply to different types of electrical equipment according to the size of electromotive force. Dry type transformer is studied in this paper.

Demand analysis of transformer remote monitoring system

With the increasing demand for manual inspection of transformers, the demand for real-time remote monitoring of transformer running status is increasingly strong. Aiming at the problem of backward information management, this paper proposes the design of transformer remote monitoring system based on the Internet of things.

The requirements of the remote monitoring system are described below.

1) Description of terminal requirements: the system shall be equipped with real-time data collection function, and the collection objects are surface temperature of dry transformer, image of box door proximity, temperature and humidity in the box, etc. The system needs to be self-powered; The system does not directly or indirectly affect the current running setup; System installation should not change the current equipment

wiring; After the system is suspended or stopped by external factors, it should have a better function of self-awakening and data collection.

2) Requirements description on the server side: The server side needs to have perfect data recording function; You need to have users; Access identification and background administrator management functions; It needs to have certain functions of anti-attack, identification and rejection of illegal sources.

Overall design scheme of monitoring system

The task of the research topic is to realize the design of the transformer remote monitoring system based on the Internet of things. The system is composed of the classical perception layer, network layer and application layer of the Internet of Things system.

In the application of the Internet of Things, it is necessary to select the appropriate communication network of the Internet of Things in the perception layer to build the system, that is, the selection of communication modules. ZigBee, Wi-Fi and GPRS modules can be selected as communication Bridges in transformer remote monitoring. According to the different communication modules, this paper designs monitoring schemes based on GPRS remote wide area network.

Software design of transformer remote monitoring system based on Internet of Things. This system is mainly considered from the perspective of inspection personnel who are responsible for transformer operation monitoring. The system application scenarios mainly include client and transformer running status monitoring.

Transformer operation condition monitoring: User login the client, select the corresponding area, can view the currently selected area of the transformer, click again on the transformer, can view the transformer running state information, also can be set up in the main interface all show all transformer operation information, through the filter, can directly show the temperature or close to the abnormal information of the transformer, when the mouse stay on the transformer, The system displays the location of the transformer. Click the abnormal transformer to display its historical data. Click History to export the data information of the selected transformer.

Abnormal data alarm: after logging into the account, the system can analyze the monitoring data by itself. When the monitoring environment changes, the system will take the abnormal transformer data information as the key monitoring object through the algorithm.

The remote network monitoring improves the efficiency of routine transformer inspection. The inspection personnel can view transformer monitoring data through the monitoring client. Figure 1 shows the system design description.

The terminal collects the transformer operation parameter information and sends the data to the server through the communication protocol. The server parses the received data according to the communication protocol standard, preprocesses the parsed data and stores the data in the database, which is used when the client requests

data from the server. After the client requests data, it also parses the data according to the communication protocol standard. The parsed information is used for sensor data display, information report and graph drawing.

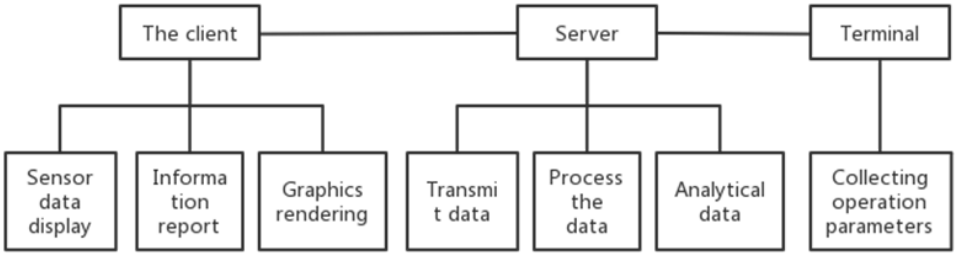

Figure 1. – Transformer remote monitoring system design description

Hardware communication and algorithm design of monitoring system

The communication and algorithm design of the monitoring system is divided into three parts: hardware communication and algorithm design of the monitoring system, server data transfer center communication and algorithm design and client communication and algorithm design. Monitoring system hardware communication and algorithm design includes sensor data acquisition algorithm design, remote monitoring system communication protocol design and monitoring system hardware serial communication.

Four parts of network protocol of remote monitoring system; Communication and algorithm design of server-side data transfer center includes communication network design of server-side data transfer center, security authentication algorithm design, monitoring system hardware and server communication, server data parsing algorithm design and server data transfer database algorithm design. Client communication and algorithm design includes three parts: communication design, data display algorithm design and anomaly recording algorithm design.

Design of sensor data acquisition algorithm

The sensor of the monitoring system hardware needs to go through two parts of data acquisition and data conversion to convert the acquired analog or digital signal into numerical information.

The data collection part includes temperature sensor data collection, humidity sensor data collection, proximity sensor data collection and image acquisition sensor data collection.

Temperature sensor GYMCU90640 infrared temperature sensor, and Arduino equipment through serial port D7, D8 connection; The proximity sensor uses CUM18-M1EI ultrasonic sensor, connected with Arduino 7 analog pin, output 4–20 mA current signal; The humidity sensor adopts HTS40L-XS low-power RS485 temperature and humidity sensor based on SHT30 package, which is connected to the Arduino device through the RS485 expansion board, and the Arduino directly reads the data connected

to the serial port. The image acquisition sensor uses OV7670 sensor, which is connected to the Arduino device through RS485 expansion board, and the Arduino reads the data connected to the serial port.

Considering that the detection blind area of CUM18-M1EI ultrasonic sensor is 50 mm, the effective starting position should be in the blind area, so the detection range is adjusted to 50 mm – 1000 mm. The 4–20 mA current signal is measured, and the forward output is selected, showing a linear proportional relationship, as shown in Figure 2. The closer the distance, the smaller the current.

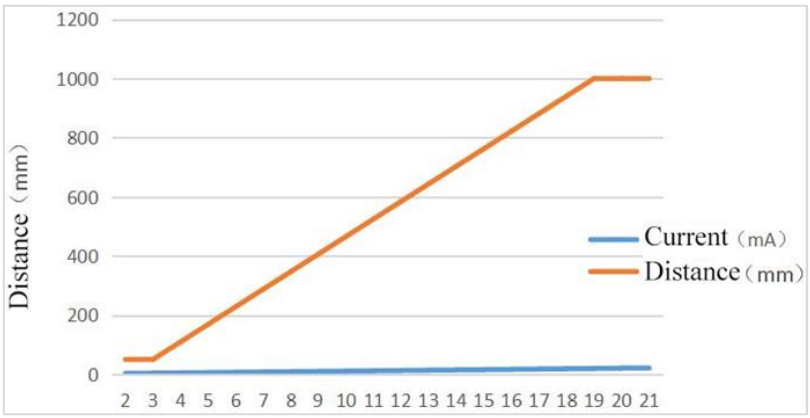

Figure 2. – CUM18-M1EI ultrasonic sensor output current and distance relationship diagram

Monitoring system each module software design. The software is designed according to the following design ideas. The software design of transformer remote monitoring system consists of terminal software design, server software design and client software design. The client program is responsible for displaying environment parameters, temperature data, and proximity information. The server-side program is responsible for storing, processing and transmitting the data collected by the sensing layer. The terminal is responsible for collecting the operation parameters and information of the transmission transformer. Terminals, servers, and clients transmit information through specified communication protocols.

The terminal in the perceptual layer architecture consists of five modules: data acquisition, data conversion, data packaging, data sending and instruction recognition. The data acquisition module completes the basic sensor data reading. The data conversion module converts the read analog signal or digital signal into intuitive digital information; Data packaging module completes the implementation of communication protocol standards; The data sending module completes the task of sending the packaged data to the network layer; Instruction recognition The instruction issued by the server is identified. The server side of the network layer architecture consists of five modules: data receiving, identity authentication, data parsing, database design and information forwarding: data receiving completes the communication with the perception

layer; The identity authentication completes the source and instruction identification of the perception layer and the application layer; Database design to complete the data storage; Information forwarding completes the feedback to the application layer information request. The client in the application layer architecture consists of five modules: data request, data processing, data display, graph drawing and information report: data request completes the communication connection with the network layer and data reading; Data processing to complete the received data analysis work; Data display and graph rendering for the completion of the parsed data display and graph rendering; Information Report Reports real-time and historical data.

Conclusion. Based on the research and analysis of dry-type transformers, this paper designs a remote monitoring system for transformers based on the Internet of Things technology. The design scheme with GPRS as the communication means and Arduino as the system carrier is determined, and the GYMCU90640 infrared temperature sensor encapsulated by MLX90640 chip is used for temperature acquisition and imaging. CUM18-M1EI ultrasonic sensor and OV7670 sensor are responsible for recording the door proximity information and taking images, and HTS40L-XS temperature and humidity sensor based on SHT30 package is responsible for collecting the temperature and humidity of the inside and outside of the box. The system is powered by external power supply, and the system can complete the data acquisition and transmission task in the test part [7].

The system's hardware platform is built, and the whole monitoring system is debugged, tested, and analyzed. The test items include safety, stability test, image acquisition test, and infrared temperature acquisition test. The test results show that the system has high security and stability. It can take photos and image processing, and cloud storage for people close to it. The maximum error between the temperature collected data and the temperature simulation data of the monitoring system is less than 4%, and the minimum error is 0.29%. The maximum error of temperature data collected with FLUKE infrared imaging equipment was 3.01%, and the minimum error was 0.03%. The test system meets the design requirements and can complete the remote monitoring task of a dry transformer.

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