The Real-time High-voltage Switch Position Detection Method

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***Abstract*—This method discloses the real-time high-voltage switch position detection method, which is implemented in accordance with the following steps: installing a coms photoelectric sensor on the video acquisition unit, and installing the video acquisition unit at a specified position on the isolation switch housing; illuminating the inside of the isolation switch through LED devices in the switch detection device, and collecting the action video of the isolation switch as the raw video signal through the video acquisition unit. The video acquisition unit collects the action video of the isolating switch as the original video signal; the coms photoelectric sensor converts the light signal in the original video signal into an electric signal, and then sends the electric signal to the video server for processing to get the RGB spatial area image; the RGB spatial area image is transmitted to the on-line monitoring backstage system, and the movement trajectory of the high-voltage switch is judged through the LK optical flow method to get the actual position of the contacts. This detection method solves the hidden problem of GIS equipment operation and maintenance that the current GIS products need manual observation and the data cannot be transmitted to the background in real time.**

Keywords—Real-time Monitoring, High-Voltage Switch Detection, Smart Electronics

I. Introduction

This method belongs to the field of video sensing [1], image recognition, and photoelectric conversion technology [2], and specifically relates to the real-time high-voltage switch position detection method, and also relates to the real-time high-voltage switch position detection system. With the continuous development of the power system, power system fault analysis and localization are faced with problems such as large data size, complex fault mechanisms, and diverse modeling needs. Among them, the structure of GIS equipment is complex, and during long-term operation, due to unforeseen mechanical or electrical faults, the indication state of the switch contacts' division and closure does not match the actual situation, or the division and closure are not in place. Since the contacts are closed inside the GIS, it is difficult to directly observe their real state, which brings hidden dangers to the operation of the equipment. At present, the monitoring of the contact status of the isolation switch of GIS products requires the power station staff to personally go to the observation window for on-site observation, which is a time-consuming and laborious method, and at the same time, there is the problem of inconvenient location of the observation window. In addition, human observation does not allow for data transmission to the back office, nor does it allow for remote monitoring and real-time analysis. In the switchgear with the function of "double confirmation", micro-switches or attitude sensors are usually used, however, these two technologies cannot directly reflect the actual position of the disconnecting switch, and there are certain hidden dangers. The technical solutions adopted in this method are: real-time high-voltage switch position detection method and real-time high-voltage switch position detection system.

There is no experimental data or theory to support this method" solves the current GIS products need to be manually observed, and the data can not be transmitted to the background of the GIS equipment operation and maintenance of the hidden problems.

This paper introduces the real-time high-voltage switch position detection method and detection system. After extensive testing, the authors verified the improved effectiveness of the method, which effectively solves the online monitoring problem of the opening and closing conditions of the GIS isolation switch contacts, grounding switch contacts and quick-earthing switch contacts, reduces the safety hazards, and improves the efficiency of power station operation and inspection.

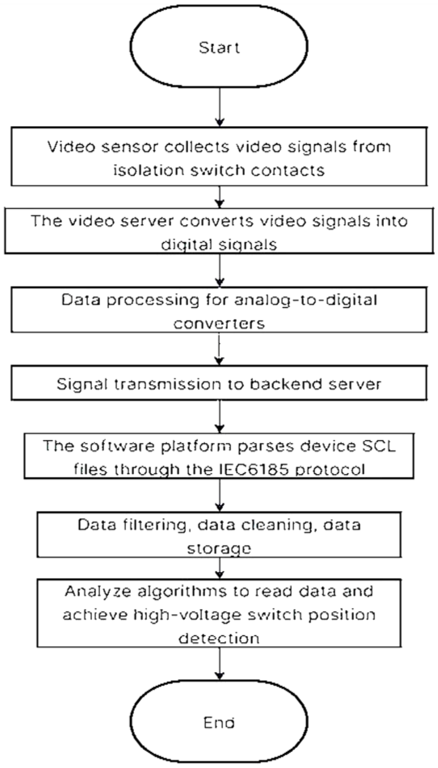

Fig. 1. Flowchart of an embodiment based on a real-time high-voltage switch position detection system

II. METHOD

A. Fundamentals of real-time high-voltage switch position detection methods

This method is a real-time high-voltage switch position detection method, and the main principle is to analyze and real-time monitor the contact position of the isolation switch by installing the video acquisition unit on the GIS equipment, and then the video signal of the isolated switch contacts, which is collected, will be transmitted to the on-line monitoring back-end system through fiber-optic cables [3], as shown in Fig. 1.

B. The basic principle of real-time high-voltage switch position detection system

The basic principle of real-time high-voltage switch position detection system. This method is a real-time monitoring system of isolation switch contact position based on video sensing and image processing technology. The main principle is to analyze and real-time monitor the contact position of the isolation switch by installing video sensors on the GIS equipment, and then delivering the collected video signals of the isolation switch contacts to the on-line monitoring back-end system via fiber-optic cables.

C. Specific implementation of real-time high-voltage switch position detection methods

Through investigation and experimentation, it is found that CMOS photoelectric sensors have low energy consumption and fast processing speed than CCD charge couplers. Therefore, CMOS photoelectric sensors were selected for real-time image information acquisition in the video acquisition unit, as shown in Fig. 2. The installation process includes mounting the video acquisition unit at a designated location on the disconnecting switch housing, isolating the high-voltage SF6 gas through a double-perforated viewing window with a special glass lens, and installing heat dissipation fins before and after the video acquisition unit. The isolation switch is illuminated by LED equipment and the raw video signal of the isolation switch action is acquired in the video acquisition unit. The CMOS photoelectric sensor is used to convert the optical signal into an electrical signal, which is processed by the video server to obtain an RGB spatial area image. The image is transmitted to the on-line monitoring background system to judge the movement trajectory of the high-voltage switch through the LK optical flow method, obtain the actual position of the contacts and the closure degree of the isolation switch, and provide a basis for the operation of the isolation switch.

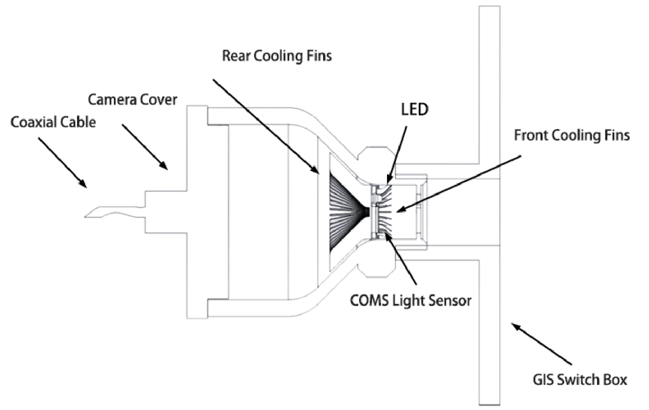

Fig. 2. Overall schematic diagram

D. Specific realization of real-time high-voltage switch position detection system

The physical diagram of this method is shown in Fig. 3 , which is realized through the installation of video sensors, acquisition of raw video signals, conversion of video signals, processing of video signals, on-line monitoring of the back-end system, and specific image recognition and processing algorithms.

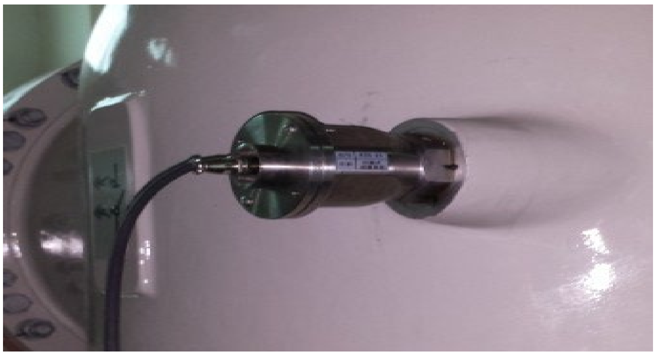

Fig. 3. Actual Installation Diagram

III. RESULT

A. Experimental details

In this part, we compare the manual observation method of GIS products with the real-time high-voltage switch position detection method and system. Firstly, the video sensor is installed, and then through the investigation and experiment on the light-sensitive components, it is found that the energy consumption of the cmos photoelectric sensor is much smaller than that of the ccd charge-coupler [4], and it is better than the ccd charge-coupler in terms of both the data reading and the processing speed, so we use the cmos photoelectric sensor[5] to collect the original video signals, and then we realize the conversion of the video signals with the cmos [6], and then we process the video signals with the ISP [7].and then output the image of RGB[8] space region, the signal is transmitted to the online monitoring system, and then according to the Hariss angle point detection algorithm [9] to select the feature point in the video, and then through the LK optical flow method [10] to calculate the feature point optical flow, the calculation results represent the displacement of the feature point, and in this way, to describe the trajectory of the high-voltage isolation switch. By comparing the current position of the moving feature point and the position at the two points where the switch is completely closed/disconnected, the state of the switch under the current moment is calculated, and the displacement changes in the video are converted into precise digital expressions.

B. Heat dissipation rates for different devices

We add a heat dissipation fin before and after the video capture unit, through the control test, compare whether to add heat dissipation on the body of the video capture unit, the results are shown in Fig. 4, in which the original device is the temperature change of the video capture unit without heat dissipation fins, and the improved device is the temperature change in the present invention after the addition of heat dissipation fins in the video capture unit before and after the invention. As can be seen from the figure, it is clearly found that after adding the heat sink, the video capture unit heating temperature is reduced in the case of running the same time.

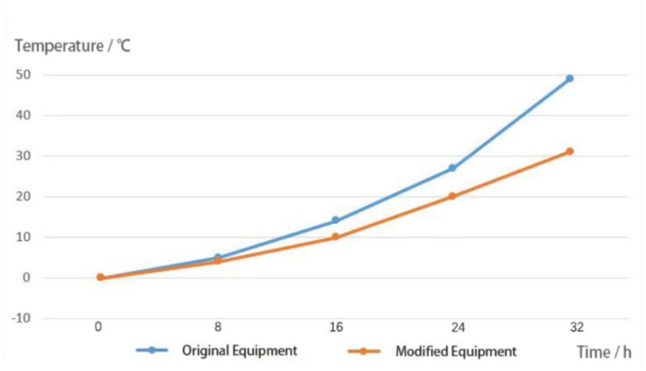

Fig. 4. Linear table of temperature comparison before and after the improvement of the detection system

IV. Discussion

In this paper, the authors use a real-time high-voltage switch position detection method and system, the video sensor is installed in the primary body for collecting video signals of isolation switch contacts, and the video server is used to process the collected video signals and finally deliver them to the online monitoring background system. The online monitoring background system judges the actual position of the contacts through the real-time viewing of the video and the video recognition system, and provides a basis for the determination of the operation of the isolation switch. The video sensor collects video signals from the contacts of the isolation switch and transmits them to the online monitoring background system. After the data processing, analysis and storage, it provides help for the artificial intelligence analysis algorithm [11]. This method can realize all-weather autonomous observation and 24h reaction to the actual position of the disconnecting switch, which effectively solves the problem of online monitoring of the splitting and closing conditions of the GIS disconnecting switch contacts, grounding switch contacts and rapid grounding switch contacts, reduces the safety hazards, and improves the efficiency of power station operation and inspection.

It is proved through experiments that the real-time high-voltage switch position detection method[12] and system can detect the operation of GIS equipment more effectively. However, there are some problems with this method: what can be explained by the temperature change after adding heat dissipation fins before and after the video acquisition unit? What is the impact on the detection results? Whether there is experimental data or theoretical support for the method of the invention "solves the current GIS products need to be manually observed, and the data can not be transmitted to the background of the real-time GIS equipment operation and maintenance of the hidden problems."

V. Conclusion

This method is a real-time high-voltage switch position detection system, which mainly utilizes video sensing, image recognition and photoelectric conversion technologies. The system collects video signals from the contacts by installing video sensors on the isolation switch, and converts the signals into digital and optical signals through a video server and photoelectric converter, and finally sends them to the online monitoring background system. The online monitoring background system realizes real-time viewing, image processing and position judgment of the contact position, which provides the basis for the operation of the disconnecting switch. Compared with current GIS products that require manual observation, this system solves the potential safety hazards and data transmission problems that may exist in manual observation. Through remote online monitoring and intelligent identification, it can realize real-time monitoring of isolation switch contact position and intelligent determination of switch status.

The advantage of this system is that it operates around the real-time monitoring of disconnecting switch contacts, and is also characterized by real-time, remote monitoring, data transmission and intelligent identification, and can provide accurate guidance for operation.

The operation steps of this system are as follows: the video sensor is installed in the observation window position of the isolation switch equipment, the video signal is collected and transmitted to the online monitoring background system via fiber optic cable, the background system carries out the video signal processing, including image correction, denoising and automatic white balancing, etc. The position of the contacts is recognized through image processing and algorithm analysis, and finally the background system monitors the position of the contacts in real time and provides operational guidance and judgment. The final background system monitors the contact position in real time and provides operation guidance and judgment basis.

This system is a solution for real-time monitoring of the position of disconnecting switch contacts using video sensors and image processing techniques. First, video sensors are installed on the disconnecting switch equipment to capture the contact video signal through the observation window. Then, the video signal is transmitted to the online monitoring background system through fiber optic cable for further processing and analysis. Finally, the online monitoring background system can view the video signal in real time and identify the position of the contacts through image processing and algorithms.

This real-time high-voltage switch position detection system provides an efficient and intelligent solution for the operation and maintenance of power equipment, which can effectively avoid the safety hazards and data transmission problems brought about by manual observation, and improve the management efficiency of power systems. The system utilizes video sensing and image processing technologies to achieve real-time monitoring of the position of the disconnecting switch contacts. In this way, the safety and accuracy of disconnecting switch operation can be improved, and the efficiency of power equipment operation and maintenance can be enhanced.

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