Research and Application of Inspecting Mode of Converter Station Equipment in the Background of Smart Grid

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Abstract. The inspection of equipment at the converter station is a basic work to discover equipment defects in time, ensure the safe and stable operation of the equipment in the converter station, and improve the reliability of the operation of the inter-area power grid. It mainly relies on the operation and maintenance personnel to perform periodic and regular periodic inspections. In order to ensure the safety and stability of the operation of the converter station equipment, ensure the patrol personnel arrival rate, realize the goal of scientific, standardized and intelligent inspection. On the basis of manual inspection, the advanced robot patrol system is used to design the intelligence of the converter station. The system was patrolled and the modules of the system's back-end management system were analyzed. The system's patrol management, defect management, equipment management, query analysis and system management functions are introduced in detail and applied to the actual patrol management work. The inspection method is compared with the traditional inspection method, and good practice results are obtained.

1. Introduction

In the rapid development of smart grids, the intelligence of converter stations has become a trend. The intelligent construction of the converter station has become an important part of the smart grid construction. It is necessary to adopt a unified information management system for the details and operation specifications of the specific equipment of each converter station. At the same time, it is necessary to ensure that the inspection personnel on duty actually arrive at the scene and operate according to predetermined standards during the inspection; manual paper records are used. The way, most of the current converter stations in China still use this kind of inspection.

In China, the traditional patrol inspection method of the converter station still occupies a large proportion, that is, the equipment patrol personnel view the equipment through the naked eye, and then collect the patrol information of the recording equipment through the paper report to realize the equipment management. With the promotion and application of new technologies, patrol inspection methods based on barcodes, information buttons, radio frequency identification and other technologies are applied to the patrol operations of converter stations, which effectively improves the patrol quality of converter stations. If an intelligent robot data acquisition terminal is used to collect the patrol data, upload it to the background management system. The functions of the intelligent patrol background management system of the converter station are realized, so as to improve the work efficiency and reduce the labor intensity of the patrol personnel, improving the intelligence level of the converter station.
2. Introduction to robot design ideas
As a mobile carrier, the patrol robot system can be equipped with different detection systems or devices, which can provide a platform for the collection of non-electricity signals of the converter station equipment. Because the working environment of the converter station is relatively special, the electric field and magnetic field interference are strong, so it will have a great influence on the common electronic compass used for the heading angle measurement. The patrol robot system can be equipped with a high-definition night vision micro camera. By adjusting the camera's commutation station, the focal converter station distance, and the wireless network provided by the cloud platform. The hand-held mobile terminal of the maintenance personnel is convenient for the maintenance personnel to analyze and process the thermal imaging photos and heat information in real time, and the alarm signal can be issued when the heat exceeds the threshold, so that the on-site operation and maintenance personnel can find and eliminate major hidden dangers in time, and ensure the converter station. Safe and stable operation.

![Figure 1. The Analysis of inspection structure of high voltage converter station](image)

3. Equipment inspection efficiency improvement measures analysis
Under the background of deepening informatization and increasingly fine management concepts, we must ensure the healthy operation of converter station equipment. On the one hand, we must strengthen the process-based system construction, timely incorporate the specific requirements of equipment inspection into the norms through the form of business processes, and strengthen the system. On the other hand, it is necessary to strengthen the process control of informationization, combine the advanced achievements in the fields of information communication and process control, and realize the efficient integration of data flow and business flow through management and technology.

3.1. The Ways of improving the inspection of converter station equipment
Most advanced inspection methods for converter station equipment inspection operations are based on Geographic Information System (GIS) and Global Positioning System (GPS), and the results of equipment inspections are stored in large databases, mainly in the collection of equipment inspection information. There are some differences in the way; as a typical type of special mobile robot, the research and application of electric power robots are more and more extensive, and gradually play a role in the field of equipment inspection and inspection. At present, the development of information technology is speeding up, and the construction of smart grids gradually realizes comprehensive online monitoring of equipment, which has created convenient conditions for further improving the lean management level of equipment. Therefore, to improve the quality of the patrol of substation equipment, it is necessary to combine the existing resources with the management of the converter station and the actual technology to continuously optimize the patrol measures.
3.2. **Building equipment intelligent patrol platform**

For the ultra-high voltage converter station equipment multi-faceted, layout and equipment features, make full use of Internet technology, intelligent inspection system, Internet video remote monitoring system, automation technology and auxiliary monitoring system and other technologies to build converter station equipment Patrol management platform.

The platform uses NFC recognition, hardware security isolation technology, remote database and video capture to develop a powerful device patrol system with alarm diversification, multi-layer and automatic transcription. The platform is equipped with remote monitoring management system, intelligent inspection management system, inspection robot management system, remote video monitoring management system and online infrared monitoring system, which can realize accurate and real-time collection and transmission of information of the converter station/commutation station. At the same time, it sets functions such as security operation, information processing, online calculation and tabulation, system self-diagnosis and self-recovery function, and main equipment operation monitoring to realize intelligent management of the patrol of the converter station equipment, and its equipment patrol management platform, thus playing a comprehensive role.

4. **Converter station intelligent robot patrol system**

Intelligent robot patrol system with robot as the core, integrated robot technology, non-contact detection technology of power equipment, multi-sensor fusion technology, pattern recognition technology and navigation and positioning technology, can achieve all-weather, all-round, full-automatic intelligent inspection and monitoring, effective Reduce labor intensity, reduce operation and maintenance costs, and improve the automation and intelligence level of inspection operations and management. The intelligent robot patrol system consists of a network distributed architecture, which is mainly divided into three parts: the base station layer, the communication layer and the terminal layer. The base station layer is composed of a monitoring background, a video recording system, and an intelligent control and analysis software system, and is responsible for receiving, processing, judging, and displaying data; the communication layer is composed of a network switch, a wireless bridge, and the like, and is responsible for establishing a network at the base station layer and the terminal layer. The terminal layer includes patrol robots, charging chambers, and fixed monitoring points.

![Figure 2. Structural analysis of intelligent patrol robot](image)

4.1. **Introduction to the intelligent robot tour structure of the converter station**

The robot used for the patrol station of the converter station uses the crawler robot body as the mobile carrier, which is stable in movement and can adapt to different road conditions. At the same time, the module can be omnidirectionally patrolled by installing a modular rotating base and a cloud platform on the crawler robot body. And the secondary grounding network is checked, and the structure is simple. The robot includes a crawler robot body, a rotating base, a dust cover, a cloud platform, a temperature...
sensor, and a navigation camera. The crawler robot body is made of high-strength material to adapt to the complex terrain in the layer; the rotating base is mounted on the crawler robot body and is rotated by the steering gear; the navigation camera is installed in the rotating base for forwarding. The route is recognized when the vehicle is retracted; the dust cover is installed in the main body of the crawler robot, and the driving portion of the crawler robot body and the periphery of the rotating base are enclosed; for inspecting the indoor layer of the converter station, and the temperature sensor is installed therein. The high-definition night vision micro-camera can take pictures of objects in low-definition and return data with low visibility.

4.2. Converter station intelligent robot inspection work principle
The rotating base is mounted on the crawler robot body and is rotated by the steering gear. That is to say, the rotating base can rotate 360 degrees and is driven by the crawler robot body. The navigation camera is mounted on a rotating base for identifying the route as the tracked robot body moves forward or backward. The navigation camera discards the magnetic track and laser navigation method, and adopts a navigation and positioning method based on the visual detection and recognition of the guide line and the positioning mark. By pre-setting the navigation indicator line and the positioning mark, the crawler robot body can automatically recognize the inspection path and the parking position through the visible light camera, thereby reducing the cost and improving the navigation precision. The image transmission system mainly includes an onboard acquisition device, an onboard communication control center, and a mobile terminal control center. The mobile terminal can acquire image information in real time and use it for real-time analysis.

4.3. Converter station intelligent patrol system design
The intelligent patrol system of the converter station provides a convenient, scientific and advanced working platform for the equipment patrol personnel. Thereby achieving:

(1) Management standardization: It is possible to implement the relevant systems such as operation and inspection of the equipment to ensure the effective implementation of the inspection work, to prevent the patrol personnel from being in place, and the patrol data is not true;

(2) Informatization of equipment: The inspection of equipment is incorporated into computer management, making management more efficient. All information has computer management and paperless work. At the same time, it can effectively share information with other existing information management systems of the enterprise, enabling managers to manage the inspection work more efficiently;

(3) Scientific analysis: The system can guarantee the authenticity and effectiveness of all data, and the management of equipment inspection is more scientific. A variety of quantitative analysis methods built into the patrol system to predict possible problems of the equipment, and take corresponding measures in a timely manner; on the basis of the original meter reading function and infrared temperature measurement function of the intelligent robot, expand and increase the appearance of the robot equipment, peer-to-peer Three functions of patrol and security inspection, while adding a number of equipment and wall special patrol during holidays and important power-saving, effectively improving the functional range and utilization of the robot. The equipment is divided into patrol management methods, and the equipment patrol is divided into regular patrols and special patrols. The regular patrols are divided into daily patrols, monthly patrols, and quarterly patrols. The daily patrols are also patrolled according to the characteristics and importance of the equipment, which is more targeted and the operability increases the effectiveness and pertinence of the operation and maintenance personnel equipment inspection, and improves the lean management level of the equipment.
4.4. Intelligent robot tour function

By further expanding and refining the intelligent robot inspection function, the intelligent robot inspection is divided into infrared temperature inspection, equipment appearance inspection, equipment instrument inspection, point-to-point inspection and wall security inspection.

Infrared temperature measurement patrol and equipment instrument patrol according to the cycle inspection specified in the "Ultra High Voltage Converter Station and DC Converter Station Equipment Condition Maintenance Work Standard", automatically start infrared temperature measurement of outdoor primary equipment, record temperature measurement data, pass Compared with setting the alarm abnormal value, an abnormal prompt is issued; the device is periodically photographed and recorded, and the pressure value and the casing oil level abnormality alarm are issued through data comparison. Point-to-point patrols are primarily targeted at devices that require special patrols. If the equipment trips, equipment defects, overload or new equipment commissioning, etc., you can temporarily develop a point-to-point inspection program to increase the flexibility of intelligent robot inspection.
4.5. Patrol mode innovation
Plan the entire station patrol route, and the equipment inspection area is divided into daily mandatory area and non-mandatory area. The daily must-see area is the key equipment, mainly for the core equipment that affects the DC system lockout, such as bipolar commutation, flat resistance, and pole control protection system, and bipolar valve hall, bipolar DC field, requiring operation and maintenance personnel daily. It is necessary to conduct inspections; the non-required inspection areas are divided into three areas: A, B, and C. The inspection is conducted according to the daily inspection periodic table to ensure that the an area is inspected at least once a week, and the B and C areas are inspected at least twice a week.

The whole station equipment patrol uses differential cross-complementing to patrol, making full use of the robot remote video surveillance system to supplement the patrol blind spots, and at the same time, promote the operation and maintenance personnel to deeply grasp the equipment status, improve the professional technical level and equipment management level, and fully guarantee the overall inspection. Under the premise of scope and effect, the number of manual inspections and inspection work is reduced. In the case that the converter station is under guarded by a small number of people, it is more conducive to concentrate the limited personnel's energy on the equipment inspection, and improve the effectiveness and pertinence of the equipment inspection.

5. Analysis of actual operation effect of patrol system of converter station
Through the use of the system, the company implemented a smart station patrol system for the converter station. The back-end management system is arranged in the information control center, and the internal network connection method enables the whole company to visually and accurately see the operation of the converter station and the inspection of the converter station personnel. By comparison, after using the system, the inspection time is reduced by 5%~10%, the personnel cost is reduced by 5%~10%, and the personnel arrival rate is obviously guaranteed. The responsible person of the power supply company saw the defect of the converter station equipment more intuitively, and timely responded to eliminate hidden dangers in various aspects. The patrol personnel's on-time inspections are in place, which can eliminate the hidden defects of large defects in the bud, which greatly guarantees the normal operation of the equipment. The initial estimation in the entire maintenance and repair work can reduce the cost by about 8% to 10%, which brings great economic benefits.

After using the intelligent patrol system for the patrol station, the manual operation of the patrol personnel was reduced, the business process of the management was standardized, the occupancy rate of the patrol personnel was well ensured, and the standardization of work and the modern management level were improved. Improving the inspection work of the entire converter station to a higher height, which can ensure that the inspection work can be effectively implemented, and ensure that the equipment management, equipment maintenance and other work have reliable data, so that the equipment may be hidden. The system realizes the standardization, standardization and scientification of the operation and management of the converter station, which effectively guarantees the safety of power production and achieves the expected results.

6. Conclusion
The application of the intelligent inspection robot in the converter station provides powerful technical support for the safe and stable operation of the electrical equipment, and meets the daily needs of the converter station for equipment inspection. However, the complexity of the converter station and its speciality in the power system make the intelligent inspection robot have some shortcomings in the application and need to be solved in a targeted manner. From the point of view of the inspection work of the converter station, the intelligent inspection robot is a new type of technology detection method, which is in line with the development trend of equipment inspection and has broad application prospects. Therefore, it should make full use of its multiple technical advantages in combination with application environment and working characteristics.
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