Application of Automatic Inspection Technology in Closed Facility Scenarios

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Abstract: This article investigates and analyses the feasibility of the application of automatic inspection technology in closed facilities such as cabinets and trenches, the investigation and analysis of the on-site environment, inspection content and inspection methods of the existing closed inspection facilities such as cabinets and trenches, this article analyses the currently applied inspection robot technology and its implementation methods, and compares the advantages and disadvantages, it also carried out a key investigation on the automatic inspection technology and its principles that may be applied to this project, providing a basis for the automatic inspection of closed facilities such as cabinets and trenches

1. Introduction

With the development trend of less and unmanned patrol inspection in substation and the overall requirements of comprehensive information management, the comprehensive patrol inspection and state monitoring means of substation equipment are gradually transforming from traditional manual patrol inspection to automatic and intelligent patrol inspection [1].

At present, the inspection method in the closed facility scenario of the substation is mainly manual inspection, and the manual inspection of the substation needs to be conducted by opening the cable trench and the box door. It cannot be used to check the actual operation of the equipment in the closed state [2]. Automatic and real-time detection; traditional manual inspection methods cannot effectively supervise the inspection staff, and often there are situations in which the inspections are not in place and the inspections are not timely, which leads to untimely handling of hidden dangers in the equipment and leads to electrical accidents. The running status of the machine cannot be used for trend prediction and timely alarm.

Through the investigation of the operating environment and the existing inspection technology, research on automatic inspection techniques for closed facilities such as cabinets and cable trenches, and use of automatic inspection robot technology to develop closed facilities such as various trenches in substations and closed equipment such as cabinets “No entry, no cover, no opening of the cabinet door” automatic inspection, reducing manual inspections, improving operation and maintenance quality and efficiency [3].

2. Feasibility Analysis of Applying Automatic Inspection in Confined Facilities

2.1 Common Inspection Requirements and Methods of Closed Facility Scenarios

The current inspection method for cable trenches is mainly manual inspection. Operation and maintenance personnel regularly open the cable trench cover and enter the interior of the cable trench to check the cable body, cable heating, cable trench water, foreign objects, cable supports, and fire blocking [4]. Due to the narrow space inside the cable trench, the lighting and ventilation conditions are limited, making inspections inefficient and affecting the health of inspectors. During the on-site inspection, inspectors are required to manually record the inspection results to determine whether there are abnormalities. After returning to the work unit, the inspection results are entered

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into the computer data system. By reviewing and comparing the previous inspection results, a comprehensive judgment is made as to whether there are any abnormalities. For the daily inspection of outdoor boxes and cabinets, the current inspection method is to open the box manually, the current cable trench inspection scenarios and inspection methods are shown in Figure 1.

Fig.1 Common Inspection Requirements and Methods of Closed Facility Scenarios

2.2 Automatic Inspection Technology

2.2.1 Intelligent Inspection Robot System for Substation

With the continuous development of substation intelligent inspection technology, and the state grid company's vigorous promotion of substation intelligent inspection robot technology and inspection system construction in recent years, an intelligent inspection substation intelligent inspection robot system has been initially formed [5]. The system has data flow, data transmission, intelligent analysis, background centralized management, real-time monitoring, reporting system, system parameter setting and other full-process management functions based on data flow. Figure 2 shows the structure of a conventional substation inspection robot system.

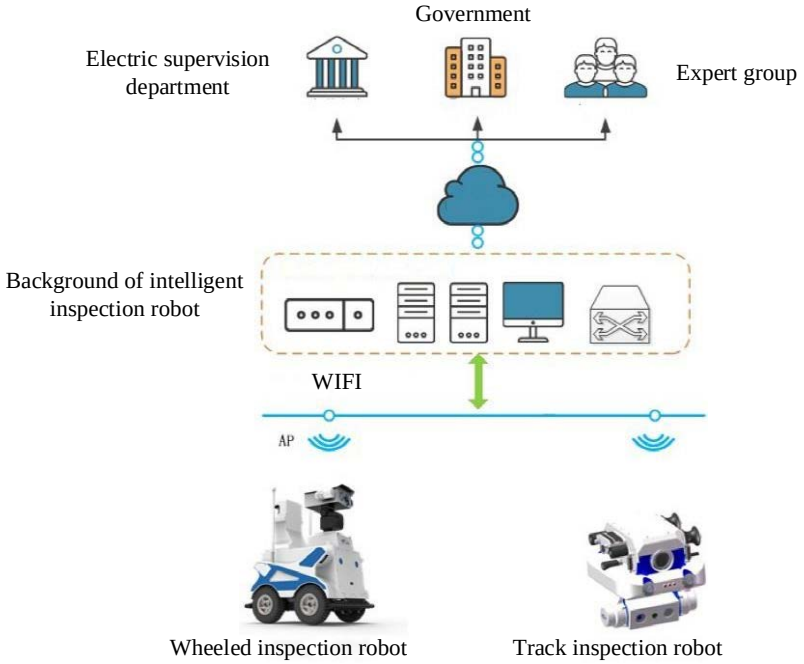

Fig.2 The Structure of a Conventional Substation Inspection Robot System.

2.2.2 Auxiliary Detection Device

The use of auxiliary inspection devices such as fixed inspection devices and portable devices can be used as an effective expansion method for inspections in enclosed spaces. The data acquisition front-end module based on the wireless image transmission module can be directly connected to the communication module of the inspection system wirelessly to realize the data transmission; or the robot can forward the data to the system background. The auxiliary device expansion diagram is shown in Figure 3.

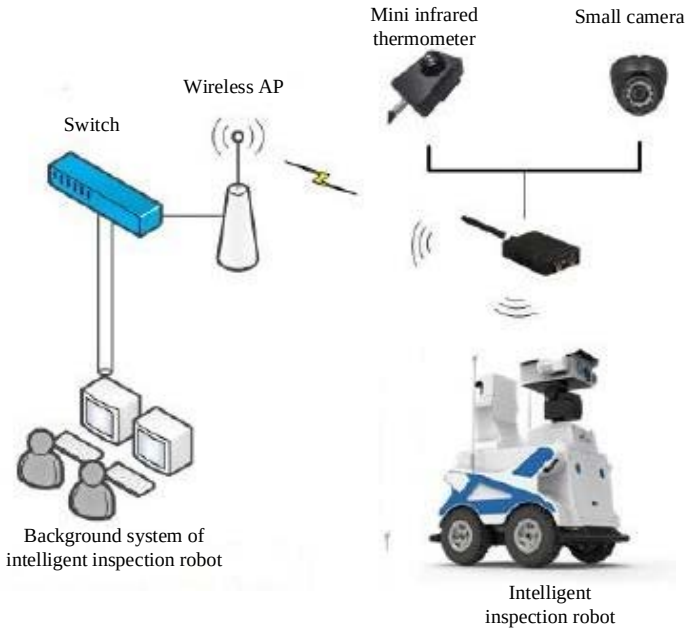

Fig.3 The Auxiliary Device Expansion Diagram

2.2.3 System Docking Technology

The purpose of system docking is to realize data sharing between the substation intelligent inspection system and other monitoring systems such as video monitoring systems and various online monitoring systems, to achieve the rational use of resources and reduce the cost of system construction [6]. According to the overall security protection framework of the national power secondary system and the security measures that must be adopted for data transmission between the various districts, in order to strengthen the isolation between the security zones, different types of network security equipment are used to make the business systems in each security zone obtain Effective protection, that is, cross-region secure data transmission technology.

3. The Realization of Automatic Inspection Technology in the Scene of Airtight Facilities

3.1 Site Modification and Installation

According to the different types of inspection data collection and environmental characteristics, the composition of the data acquisition device and the environmental adaptation characteristics are designed, and the field device integration design and installation are combined with the substation inspection robot system data acquisition method. Front equipment such as visible light cameras, infrared thermometers, temperature and humidity sensors, contact switches, and water level sensors are integrated to unify inspection data and network with robots for data transmission. At the same time, the substation equipment management method is reasonably used to achieve the correspondence between the subordinate equipment and the collected information, reduce the background data processing workload of the inspection system and improve the system operation efficiency.

3.2 Data Acquisition and Transmission

Using the front-end equipment such as visible light camera, infrared thermometer, temperature and humidity sensor, contact switch, water level sensor, etc., the environmental status in the closed space is monitored. Combined with the wireless transmission mode, the communication between the wireless transmission device and the robot system is compatible, and the robot or Wi Fi network is used as the medium to realize the background docking with the intelligent inspection robot system of the substation. The software platform docking, data fusion, and data analysis functions for the inspection environment are developed through system docking technology and power data cross-region transmission specifications. The basic design framework for closed space inspection is

shown in Figure 4.

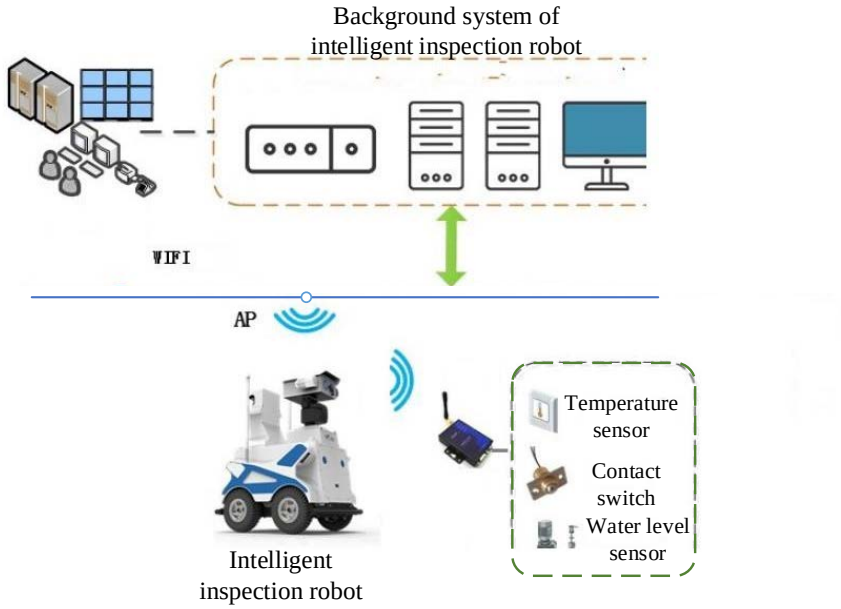

Fig.4 The Basic Design Framework for Closed Space Inspection

3.3 The Realization of Automatic Inspection Technology in Closed Facility Scene

3.3.1 Data Transmission Method

The wireless transmission device and the intelligent inspection robot realize wireless data transmission. The robot is transferred to the system management background to realize centralized analysis and management of data in the background. In specific implementation, in order to ensure the validity of data transmission, the wireless data transmission device needs to be designed and installed in accordance with the overall performance and functional requirements of the robot system. Robot-based information transmission method. The front-end inspection equipment receives data from the robot and sends data to the robot. After the robot obtains the data, it converts the data through its own network system and outputs it as a data transmission that conforms to the network transmission go to the robot background for processing. The data transmission model of the miniature acquisition equipment is shown in Figure 5.

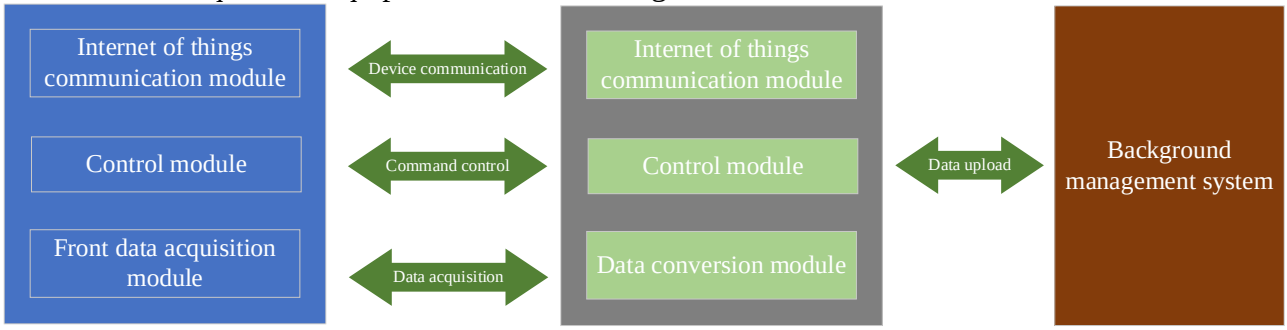

Fig.5 The Data Transmission Model of the Miniature Acquisition Equipment

3.3.2 Patrol Data Collection Process and Data Identification

The inspection equipment is installed at the appropriate position of the object to be inspected, and the corresponding points and inspection tasks are set through the back-end system. The robot inspects the cabinet according to the assigned task. When the robot reaches the inspected equipment area, it wirelessly transmits Send data collection instructions, the inspection equipment collects the data and then wirelessly forwards it to the system background through the robot. The inspection device adopts passive power supply and intermittent working mode. When there is no acquisition task, it is in standby state to reduce energy consumption. During work, it is activated remotely by the robot to collect data and resume the standby state after completing data transmission.

3.3.3 Data Comprehensive Analysis

The data collected by the inspection device is transmitted back to the background through the robot system for integration and unified management. An inspection model of a closed inspection space such as a closed cabinet is formed, and an inspection model database is established. Combining historical inspection data, using big data analysis, analysing trend changes of inspection data, combining manual operation and maintenance experience and advanced knowledge, comprehensive data processing technology to achieve inspection and status judgment of closed cabinets.

4. Conclusion

Based on the investigation of enclosed spaces such as cable trenches and closed cabinets, and fully understood the role of such enclosed equipment and facilities in the entire substation system, and clarified that through the intelligent and unmanned trend of substations, through automation and intelligence the significance of the inspection mode to achieve centralized management of operating status.

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