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Application Analysis of Electrical Automation Based on Artificial Intelligence Technology

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Abstract: *The business goals of power companies are low operating costs, high asset efficiency, and low transmission and distribution losses, making the intelligent development of distribution networks an inevitable trend to improve overall operating efficiency in the future. Distribution network automation and intelligence help to optimize the operation mode of the distribution network by monitoring the operation status of the distribution network during the normal operation of the distribution network, which can improve the reliability of the distribution network equipment and reduce the labor intensity and maintenance costs of the operators. This article uses artificial intelligence technology to design an electrical automation system, and applies the system to the intelligent inspection of substation equipment failures. By comparing the common electrical automation system and the electrical automation system under artificial intelligence technology, the fault recognition rate of the substation equipment is found. The intelligent automation system has a higher recognition rate of equipment failures, reduces the workload of maintenance personnel to repair the failures, and maintains the continuous power supply of the grid.*

Keywords: *Artificial Intelligence Technology, Electrical Automation, Equipment Failure, Intelligent Distribution Network*

1. Introduction

With the rapid growth of power demand, the long-term low reliability of power supply is not conducive to my country's economic development. On the other hand, due to the development of science and technology, high-tech enterprises and residential household appliances have continuously improved power quality requirements. In order to realize the automation and intelligence of power supply, it is necessary to improve the power supply quality of equipment through smart technology. The electrical automation system based on artificial intelligence technology can automatically identify substation equipment failures, allowing maintenance personnel to perform troubleshooting in time to ensure power supply stability.

Many scholars at home and abroad have conducted research and analysis on electrical automation applications based on artificial intelligence technology, and have achieved good results. For example, a scholar took the operation of a substation as the research object. The electrical central control room of the substation has a rigid manual monitoring panel, which is full of control switches, status indicators, meters, flashing signals, etc., and there are many secondary electrical separation components. The cable is complicated, which makes the maintenance workload heavy. Once the electricity is connected to the DCS, the rigid I/O circuit is accepted, and the conventional equipment is still used in the field. However, DCS focuses on the automatic control of the steam turbine and boiler process, and less control of the electrical part. It has a limited sampling frequency I/O to control the level of collection point collection information [1]. A power plant began to introduce artificial intelligence management technology, using intelligent I/O for AC sampling, reducing the configuration of field equipment, simplifying the wiring of the secondary circuit, and fully considering the characteristics of electrical control, making the operation of the system structure more logical. As a result, electrical monitoring has achieved rapid growth not only in design concepts, but also in electrical intelligent control equipment [2]. Although the application field of electrical automation based on artificial intelligence technology is wide, the operating technology of electrical engineering automation equipment is not

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mature enough, and it is necessary to strengthen the skill training of operators.

This article introduces the role of artificial intelligence technology in the application of information fusion technology to fault diagnosis. According to the three configuration modes of the electrical automation system, an automation monitoring system based on artificial intelligence technology is constructed, and the system is used to monitor the overall operation process of the substation. Find equipment failures and implement automatic maintenance.

2. Artificial Intelligence Technology and Electrical Automation System Construction

2.1 Artificial Intelligence Technology

Artificial intelligence technology has been widely used in various fields, mainly because the technology has a strong learning ability, based on human experience to simulate the process of people dealing with problems, and help people overcome difficulties beyond human resources [3]. For example, data mining, neural network, information fusion, etc. are all common artificial intelligence technologies, and this article mainly uses information fusion technology. In terms of equipment failure inspection, it is difficult for a single technology to deal with equipment failures, but the use of different levels of information fusion technology can systematically improve the fault diagnosis ability [4].

2.2 Configuration Mode and Construction of Electrical Automation System

(1) Centralized monitoring method

The characteristics of this monitoring method are convenient for operation, good equipment maintenance performance, low protection level, and easy system installation. However, this method mainly transfers the various functions of the system to a processor for centralized processing, which results in a large workload of the processor and reduces the processing speed and efficiency. Since all electrical equipment is included in the monitoring system, a large increase in monitoring facilities will gradually reduce redundant servers. Longer cable interference will also reduce system reliability, and when the number of cables in the control room increases, the number of cables will increase. Risk of fire due to interaction. At the same time, when the isolation knife start lock and switch are connected to the hard wire, the auxiliary knife holder contacts are often misaligned, causing equipment operation errors. However, the secondary cables are complicated and inconvenient to check the lines, which significantly increases the service load. Sometimes it is easy to confuse the cable line during the line test [5-6].

(2) Remote monitoring method

The remote monitoring method can save the number of cables, installation cost and control space, and has the characteristics of high safety and flexible configuration [7]. Because the communication speed of different field buses is not very high, and the connection amount of the electrical part of the power station is relatively large, in recent years, this monitoring method has been widely used in the power generation system of small units, but it is not suitable for the electrical automation system of the whole plant construction.

(3) Fieldbus monitoring mode

At present, artificial intelligence technology is widely used in the integrated automation system of substations and has rich business experience. Smart electrical equipment is also developing rapidly, and they are all grid control systems used for power generation. This scheme makes the design of the system more relevant, setting control spaces for different functions in different sections. The use of on-site monitoring can also reduce the number of isolation devices, terminals, I/O cards, analog cards, etc., and install smart electrical equipment to communicate with the monitoring system, saving a lot of installation and maintenance costs, thereby reducing overall costs [8]. In addition, the functions of each device are independent, and the devices are connected through a flexible Ethernet configuration, which significantly improves the reliability of the entire system. Any equipment failure will only affect related components. Therefore, on-site monitoring methods are the development direction of future power plant automation monitoring systems. As shown in Figure 1, it is an electrical automation monitoring system based on artificial intelligence technology. The DCS interface machine, console and network bridge are all connected to the wiring port through Ethernet. When the equipment sends a fault signal, the system will feed back the source of the fault to the operation.

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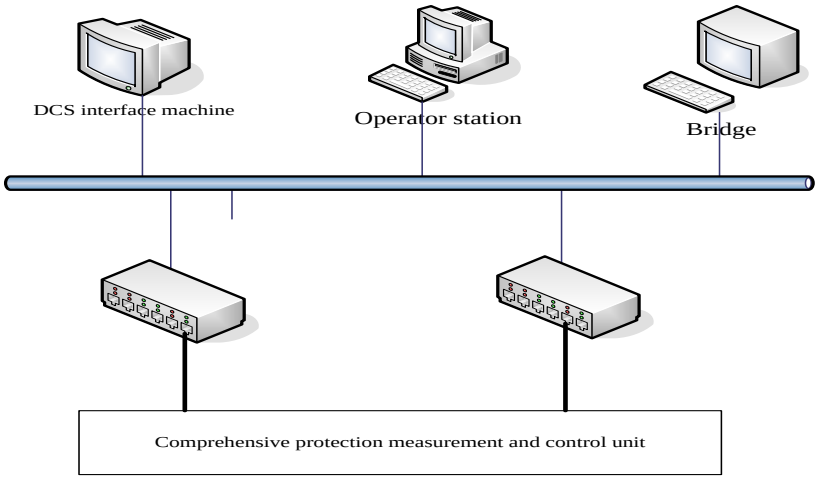

Figure 1: Construction of electrical automation monitoring system based on artificial intelligence technology

2.3 Application Effect of Electrical Automation

(1) Improve power grid security

The application of electrical automation system monitors the real-time working conditions of the power distribution equipment in operation, promptly disposes of equipment defects, integrates the management of the defects of the power distribution equipment and archives, and reduces the probability of failure. Compared with the traditional switching operation mode of power distribution, the application of electrical automation system can realize the remote operation of the equipment, improve the safety level, provide a unified grid drawing data for each production department of the power grid enterprise, and realize "one map of the whole network"[9-10].

(2) Improve the economic benefits of power supply enterprises

The electrical automation system monitors the operation data of the distribution network, monitors the distribution network system's load in different areas, and conducts intelligent analysis of abnormal loads, which can reduce line losses; read the network reconstruction of the distribution network to achieve Optimal grid operation mode, at the same time, through the calculation and analysis of power flow and the level of reactive power compensation of the system, the layout of reactive power equipment and the operation of switching on and off are carried out scientifically and rationally, so as to realize the remote operation of power distribution switchgear, improve work efficiency, and save operating costs. The system fault self-healing function shortens the power outage time of the line, and the power sales of power grid companies can be greatly increased [11].

(3) Improve the work efficiency of power grid enterprises

The electrical automation system performs rapid statistical analysis of the distribution network operation data, and realizes the integrated maintenance of multiple diagrams of the distribution network line drawings. While ensuring that the line topology and switching modes are consistent under individual application requirements, it improves the efficiency of drawing maintenance. It also provides managers with accurate operation reports to improve the efficiency of operation analysis. The intelligent analysis function of the automation system provides quick power flow calculation and theoretical analysis tools, while the intelligent prediction function of the system provides quick load forecasting tools, which provides a theoretical basis for distribution network planning [12].

(4) Improve the quality of power supply.

The electrical automation system comprehensively performs intelligent analysis on the voltage quality monitoring and qualification rate statistics of the distribution network through the implementation of the statistical analysis of power supply reliability based on each user, and realizes the automatic adjustment of voltage and reactive power, which improves the reliability of power supply.

(5) Improve customer service level

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The implementation of intelligent analysis on the distribution network provides accurate grid operation data for grid planners and market dealers, and provides a data foundation for accelerating business expansion and application on user-side demand. Accurately generate the planned maintenance and power outage scope and information of the distribution network, and notify users in time, realizing user interaction.

2.4 Mathematical Model of Load Power Supply Path of Distribution Network

In view of the problems that need to be considered during the search process of the load power supply path and the optimal restoration plan, the following two objective functions are established

(1) When the power loss load is the smallest

$$\min L_1 = \sum_x \mu_i b_i \tag{1}$$

Among them, u_i is the specific gravity coefficient of the load, and b_i and x are the load and the number of buses carried by the bus that has not restored the power supply.

(2) When the number of switch operations is the least

$$\min L_2 = \sum_{i=1}^{m} b_i (1 - C_i) + \sum_{j=1}^{n} b_j h_j \tag{2}$$

Among them, m is the number of section switches, n is the number of line tie switches, is the closed change state of the section switch, and represents the closed change state of the tie switch.

3. Research on Electrical Automation Based on Artificial Intelligence Technology

3.1 Research Significance

Effectively reduce power grid losses, improve the power supply capacity of the network, and reduce the probability of user power outages; overload control and automatic meter reading and billing can also be used to achieve the purpose of improving the economic benefits and operating efficiency of the enterprise.

3.2 Research Content

After establishing an electrical automation system based on artificial intelligence technology, compare the recognition rate of ordinary systems and artificial intelligence systems to check substation equipment failures, so as to prove that the introduction of artificial intelligence technology can strengthen the fault detection function of electrical automation systems. After analyzing the application of the system monitoring function, real-time monitoring of the operation status of the substation equipment is carried out through the monitoring and early warning of equipment failure and the function of automatically executing the failure processing after the failure occurs.

4. Application of Electrical Automation System in Substation

4.1 Fault Detection

Table 1: Detection results of fault recognition rate

	Ordinary electrical automation system	Artificial Intelligence Electric Automation System
Voltage instability	83%	97%
Parts ageing	76%	95%
Trip fault	85%	98%
Load short circuit	80%	96%

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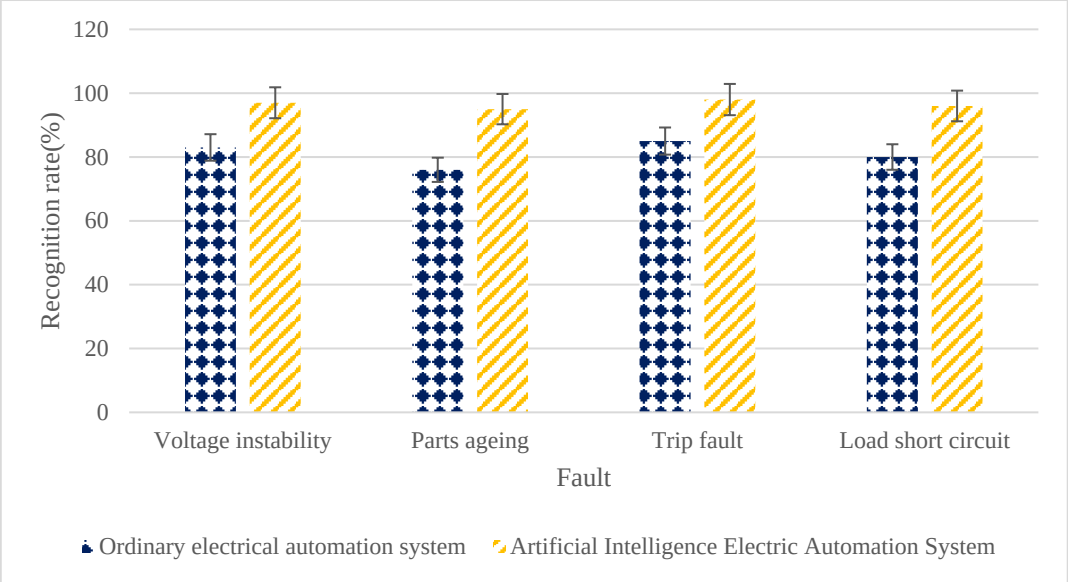

Figure 2: Comparison of fault recognition rate of two electrical automation systems

The electrical automation system based on artificial intelligence technology can detect faults that occur during the operation of the substation. As shown in Table 1 and Figure 2, it is a comparison of the recognition rate of substation operation faults between ordinary electrical automation systems without artificial intelligence technology and improved electrical automation systems with artificial intelligence technology. For voltage instability faults, the fault recognition rate of ordinary electrical automation systems is 83%, while the fault recognition rate of artificial intelligence technology automation systems is 97%; for substation equipment components aging faults, the fault recognition rates of the two systems are respectively 76% and 95%; for tripping faults, the fault recognition rates are 85% and 98% respectively; for load short-circuit faults, the fault detection rate of ordinary electrical automation systems reaches 80%, but the detection rate of artificial intelligence technology automation systems The normal system is 16% higher. Therefore, it can be seen that the artificial self-energy technology strengthens the fault identification function of the electrical automation system, which is conducive to reducing unnecessary economic losses and maintaining the normal power supply even if a fault is found in the substation operation.

4.2 Application of System Monitoring Function

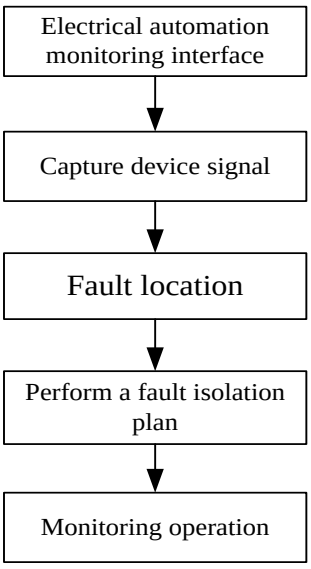

Figure 3: Electrical automation system monitoring process

As shown in Figure 3, it is the automatic operation process of the electrical automation system to

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monitor the substation equipment. First, the system opens the monitoring interface and captures the working status signal of the substation equipment. If it finds that the equipment has a fault problem, it can locate the fault location, and then execute the fault isolation plan to automatically perform monitoring operations on the equipment.

5. Conclusion

This article applies information fusion artificial intelligence technology to the construction of electrical automation systems. The purpose is to use the system to automatically monitor substation equipment to diagnose the faults that may occur during the power generation operation of the equipment, and to prevent grid technicians from failing to find faults in time and causing power supply Instability can also reduce the workload of staff and improve electricity safety. After comparing the identification and detection rate of equipment faults between electrical automation systems based on artificial intelligence technology and ordinary systems, it is also proved that artificial intelligence technology does improve the recognition rate of system faults and play a role in monitoring the normal operation of power grid equipment.

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