Research on the Application of Intelligent Technology in Low Voltage Electric Automation Control System

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Abstract. Based on the background of intelligent technology, the paper describes in detail the architecture and main functions of the electrical automation control system, including data collection, information transmission, electrical control, etc., based on the principles of stability and scalability in the design of low-voltage electrical automation control systems. Design and implementation of the thesis is to explore the performance of the designed system and select the application examples of the electrical automation control system for analysis. The research results show that the electrical automation control system we designed meets the requirements of artificial intelligence regulation and can effectively improve the safety of the system.

Keywords: Intelligent technology, electrical automation control system, function design, data acquisition.

1. Introduction
Some of the judgment ability, reaction ability, collection ability and identification ability possessed by artificial intelligence technology can effectively replace human beings, greatly reduce human labour intensity in industrial production, and effectively promote industrial production efficiency. Through long-term development and practical application, artificial intelligence technology has obvious advantages in the field of electrical automation in my country. Specifically, it is mainly reflected in the following aspects: (1) Because the traditional electronic control model has many uncertain factors, when carrying out the controller design work, the designer only needs to apply artificial intelligence technology reasonably. It is not necessary to deeply understand and master the non-linear changes and parameter changes of the control object model. (2) The artificial intelligence controller itself has the characteristic of remarkable operation consistency. Therefore, even if the designer inputs unknown new data in the process of result prediction, satisfactory prediction results will be achieved. (3) The artificial intelligence controller can realize the adjustment and control of the electrical automation system by using the corresponding data. Reasonable use of corresponding data information and language information will not only help designers modify and improve the design of artificial intelligence controllers at any time, but also the anti-interference ability of the controller itself has been significantly improved. (4) When using artificial intelligence technology to design functional performance, designers only need to use the corresponding time and fall time [1]. Realize real-time adjustment of the parameters of the automation controller, which promotes the improvement of the corresponding efficiency of the automation controller logic.
2. Function description of electrical automation control system

2.1. Information collection
The information collection function is the basic function in the electrical automation control system. The electrical automation control system must have related terminals to accurately grasp the operating time, operating status, failure phenomenon and equipment temperature and other related information, so that the staff can grasp the operating status of the system in a timely and comprehensive manner, and quickly when a failure occurs, provide scientific diagnosis accurately and efficiently and troubleshoot in time.

2.2. Information transmission
After collecting useful data information, the terminal equipment of the electrical automation control system transmits the information to the processing centre. The data information is analysed in the processing centre. Finally, the processed instruction information is retransmitted to the terminal, and the terminal performs the equipment operation according to the instruction information [2]. The information transmission process is the key to achieving effective control functions. During the information transmission process, the correctness of the encoding must be ensured, the data transmission is efficient and timely, and the transmission of garbled codes and other problems must be avoided.

2.3. Information analysis
In the process of information monitoring and control of the electrical automation control system, the information transmitted from the terminal equipment must be analysed and processed accordingly, and the feedback information must be transmitted to the terminal equipment in time after processing. For some information that cannot be processed by the system, relevant staff are required to process it manually. Information analysis is the process of realizing system control and monitoring. The focus is on processing and analysing the information collected by terminal equipment and software, and then sending the information in the database. If the system is unable to process independently, the staff is required to use the system to coordinate various tasks. In addition, the system should store the collected information, including equipment and other data, to facilitate the analysis and processing of the staff. The information transmission process is shown in Figure 1.

![Figure 1. Information transfer realization process](image-url)
3. Electric automation control based on artificial intelligence technology

3.1. Design of electrical automation equipment
In fact, electrical automation systems are more complex, including multiple disciplines and fields. For example, in the operation of electrical automation equipment, operators are required to have good comprehensive qualities and perfect professional knowledge. In addition, the complexity of electrical automation focuses on operational effectiveness, which can reduce downtime or other accidents caused by operating errors or improper operations [3]. Therefore, artificial intelligence technology plays an important role when facing this practical problem. Programming with computer theory as a basis can realize computer-based intelligent control. Intelligent operation of electrical equipment can replace the problem of human brain labour shortage. Not only the work efficiency is improved, but also the cost input can be reduced. In addition, the use of artificial intelligence technology can improve the scientific operation of electrical automation equipment and optimize the actual environment of equipment operation. Figure 2 shows the electrical automation control system based on artificial intelligence technology.

![Figure 2. Electric automation control system based on artificial intelligence technology](image)

3.2. Electrical control process design
In the electrical automation control system, the electrical control process is the main content. The use of artificial intelligence technology in the electrical control process can promote the improvement of electrical automation control capabilities and effectively improve the efficiency of work and operation. In the design of electronic control process, the main technologies used are expert system, neural network and fuzzy control [4]. Among them, fuzzy control is mainly based on fuzzy linguistic variables and reasoning. From the analysis of basic ideas, fuzzy control is based on the fuzzy model of the controlled object and uses a fuzzy controller to control the system. The structure of fuzzy control is shown in Figure 3. In the actual control process, based on fuzzy logic inference rules, a computer control system is used to establish a corresponding feedback channel digital control system.
Take the fuzzy C mean value in fuzzy control for example. Fuzzy C-means introduces membership weights to achieve soft separation of all sample points in the data set, so that samples of the same category are clustered around the cluster center, and have a higher tolerance for ambiguity samples in sample points [5]. After the cluster centers are initialized according to the sample data, the cluster centers and the membership weight of each sample are updated iteratively by minimizing the objective function. When the cluster center position gradually stabilizes in the process of multiple iterations, and the change difference is within the set range, the algorithm update is stopped. The objective function formula of FCM is shown in formula 1:

$$J_m = \sum_{i=1}^{N} \sum_{j=1}^{C} u_{ij}^m \|x_i - c_j\|^2 \quad 1 \leq m < \infty$$

(1)

Among them, m represents the fuzzy weight parameter, $U_{ij}$ represents the membership degree of sample $x_i$ to category $j$, $C_j$ represents the cluster center of category $j$, and $\|\cdot\|$ is a measure of distance. The calculation formula for the iterative update of membership degree $U_{ij}$ and cluster center $C_j$ is expressed as:

$$u_{ij} = \frac{1}{\sum_{k=1}^{C} \left[ \frac{\| x_i - c_j \|}{\| x_i - c_k \|} \right]^{m-1}}$$

(2)

$$C_j = \frac{\sum_{i=1}^{N} u_{ij}^m \cdot x_i}{\sum_{i=1}^{N} u_{ij}^m}$$

(3)
The termination conditions for iterative update are:

\[ \max_y \left\{ \left| u_{ij}^{(k+1)} - u_{ij}^{(k)} \right| \right\} < \delta \]  

(4)

Since FCM is an unsupervised algorithm, there is a problem of validity testing. Therefore, it is necessary to evaluate the performance of the algorithm through some clustering evaluation indicators. Commonly used clustering evaluation indicators include entropy, Pearson correlation coefficient, mutual information, and Davies-Bouldin index etc [6].

3.3. Communication design

Communication is the main part of the electrical automation control system. The electrical automation communication system can ensure the accuracy and speed of the information resource transmission process. In fact, there are more terminal nodes in the electrical automation control system. Therefore, in order to improve the quality and efficiency of communication, the modern communication method often used in the power part is to communicate with wireless and wired transmission methods. In the communication method selection process, it is necessary to comprehensively consider the actual situation of electricity users, so as to choose the best communication method reasonably and effectively. Telephone lines and dedicated lines are relatively common forms of wired communication methods [7]. Among them, the cost of telephone line communication is relatively low, and its communication security and reliability are relatively low. Although the telephone line connection process is more convenient, it has more advantages. Low timeliness. This also shows that the telephone line communication method is usually used for power distribution terminals that have relatively low real-time requirements. Compared with telephone lines, the security, reliability and timeliness of dedicated line communication methods are relatively high. It is used in power distribution terminals that have higher requirements for timeliness, but its cost is also relatively high.

The wireless communication method is mainly combined with ordinary radio communication and high-speed intelligent transmission. Ordinary radio communication is generally used in the process of electrical load control and management. It has low cost, lacks good reliability, and cannot be used in high-reliability power distribution terminals. In contrast, the high-speed intelligent transmission communication method has a relatively high transmission rate and good accuracy. It can realize the free choice of routing functions, and it can also realize the automatic reporting of grid operation. It is safe and reliable. Higher requirements are used in power distribution terminals, but the cost is higher. When the system is in the running state, the necessary serial port initialization operations are carried out through the main thread, and the communication thread is used to complete the serial port monitoring. Once the corresponding communication event occurs, the communication thread will inform the main thread with a custom message, and the main thread can carry out the serial port in real time Line port read and write processing. The main thread and the communication thread use the message method to establish a connection [8]. If the main thread no longer needs to receive related messages, the serial port monitoring thread needs to be cancelled in time. The serial communication process is shown in Figure 4. In the actual communication stage, the main battle polls each slave station. When the command or data sent by the main battle is received, the data is returned to the slave main battle according to the command. In this way, a distributed computer monitoring system is formed.
3.4. Design of fault diagnosis
For electrical equipment, when a failure occurs, there will be certain signs, that is, different signs indicate that the equipment has different failures, and signs are non-linear and uncertain. Therefore, before the equipment fails, it is necessary to effectively predict the signs, judge the type of equipment failure, and realize the fault location and maintenance, which is particularly important for the operation of the equipment. The use of artificial intelligence technology can accurately locate, repair and isolate electrical equipment faults, so that electrical equipment can operate effectively and stably. At present, neural networks and fuzzy logic in artificial intelligence technology are widely used in fault diagnosis of electrical equipment. For example, transformers are a particularly important part of the power system, so transformer fault analysis and diagnosis are the focus of research. If artificial intelligence technology is used, it can analyse transformer oil and gas, and use the analysis results to grasp the degree and type of transformer failure.

4. Conclusion
As a brand-new science and technology, artificial intelligence technology can be used in various fields to significantly improve work efficiency. Giving full play to the advantages and functions of artificial intelligence technology in the electrical automation control system can effectively improve the efficiency and level of electrical automation control, control the cost of the enterprise within a reasonable range, and effectively improve the economic and social benefits of the enterprise. Therefore, exploration and innovation should be increased, and the potential of artificial intelligence technology should be tapped to the greatest extent to contribute to the creation of an intelligent society.

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