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Research on Electrical Automation Control Design Based on PLC Technology

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Abstract: As science and technology continue to progress forward, electrical automation engineering is also developing, of which programmable logic controller (PLC) technology is widely being used. Through the integration of PLC technology and traditional electrical automation technology, good development of modern science and technology is promoted while traditional automation is preserved. The development of electrical engineering can greatly improve the strength of science, technology, and economy in our country. Based on PLC technology, this paper analyzes the design of electrical automation control.

Keywords: PLC technology; Electrical automation control; Design

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1. Introduction

Programmable logic controller (PLC) refers to a programmable memory that is applied to the internal storage program, the real timing, logic operations, and counting activities. In the field of electrical automation control, leveraging PLC technology can effectively showcase the advanced scientific and technological capabilities in overseas furniture. In the recent developing era, the application of electrical engineering automation technology is becoming more and more extensive. Among them, PLC technology has become the mainstream technology in electrical automation control.

2. PLC technology concept

PLC technology begins from engineering requirements, develops the corresponding control strategy, and better achieves sequence control and logic operations. This technology combines computers with traditional control technology, which is different from other control technologies such as single-chip microcomputers. It can effectively carry out logical control with the help of software, and it is relatively simple in the process of configuration and parameter change, which can meet the development needs of electrical engineering. PLC technology originated in the United States. After years of development, it is used worldwide. It has a very

significant impact on electrical automation control technology as it progresses further. The application of PLC technology helps to carry out electrical automation control, thus greatly reducing the input of manpower and material resources, and lowering the cost of construction. PLC control technology includes two types: module and box type. The module type consists of the power module, input/output (I/O) module, and memory. The box type includes the power supply, display board, and memory. The selection of an appropriate central processing unit (CPU) is based on the system performance requirements to meet the demands of electrical engineering. The two system structures each have distinct advantages, but both utilize the open bus structure. The primary feature of the modular structure is its ability to facilitate system expansion based on practical engineering needs [1].

In the application process of modern engineering, PLC technology has many advantages. Firstly, PLC technology has strong anti-interference ability, which can cope with the system control needs in different situations and meet all kinds of working conditions. Secondly, PLC technology has a very wide range of applications. It has been widely used in the medical, electrical, and aviation fields. Thirdly, PLC technology is compact in size. It can effectively save space, thus promoting the miniaturization development of automation control systems. Finally, PLC technology offers significant advantages in maintenance. It excels in data processing, logic control, and other functions to effectively meet the automation control needs of electrical engineering [2,3].

3. Design principles of electrical automation control

3.1. Design principle

In the design process of an electrical automation control system, the following principles need to be observed to ensure the reliability and effectiveness of the system. Firstly, follow the principle of integration. Individual components such as sensors, controllers, etc., can be seamlessly integrated to form a coordinated system. Secondly, follow the principle of modularity. The system needs to have good scalability and flexibility, to facilitate subsequent upgrades and maintenance. Thirdly, follow the principle of user-friendliness. In the design activities, it is necessary to pay attention to the optimization of the system interface, so that it is more intuitive, understandable, and convenient for the operator to carry out management and control. Finally, implement the principle of maximization of economy and benefit. This principle pays attention to cost control and resource optimization to provide a guarantee for the achievement of economic benefits. By following the above principles, you can design a more efficient, stable, and easy-to-maintain automated control system. These principles guide the system design framework, ensuring it can adapt to evolving technological and market needs [4-6].

3.2. The importance of system characteristics

Reliability, safety, and efficiency are the important characteristics of the electrical automation control system.

In the electrical automation control system, reliability is the first factor to be considered. Through a reliable system, stable operation can be guaranteed, the time consumed by failure and downtime can be greatly reduced, and the continuity of the production process and product quality can be guaranteed so that it has consistency. Therefore, the system needs to have self-diagnosis and fault tolerance, to better cope with possible software and hardware problems [7,8].

Safety is an important aspect in need of high attention. The system must ensure the safety of operators and devices to prevent accidents. These include safety features such as emergency stop mechanisms and electrical isolation [9].

Efficiency directly impacts the system's performance and resource utilization. The construction of an efficient electrical automation control system can significantly enhance production efficiency and effectively

reduce energy and material waste. This promotes improved economic efficiency of enterprises while also supporting environmental conservation efforts.

4. Electrical automation control design based on PLC technology

4.1. Design sequence control for electrical engineering

In electrical engineering, sequence control is crucial, facilitated by the application of PLC technology, enabling effective control activities essential for modern societal development. PLC technology can be utilized specifically as a sequence controller. For example, in thermal energy power plants, PLC technology enables technicians to clean residue and dust from power generator furnaces. By replacing traditional sequence controllers, PLC technology significantly improves work and production efficiency during residue cleaning in thermal power generators. Enhanced efficiency plays a crucial role in power plant operations, where PLC technology ensures increased power generation efficiency. In the final stages of applying PLC technology, staff can focus on residue cleaning with enhanced management center and field data management capabilities. Adopting PLC technology in power plants substantially reduces production costs and labor demands. Technicians can monitor and control operations efficiently using control procedures, thereby boosting overall production efficiency. The sequence control flow of electrical engineering is shown in **Figure 1** [10].

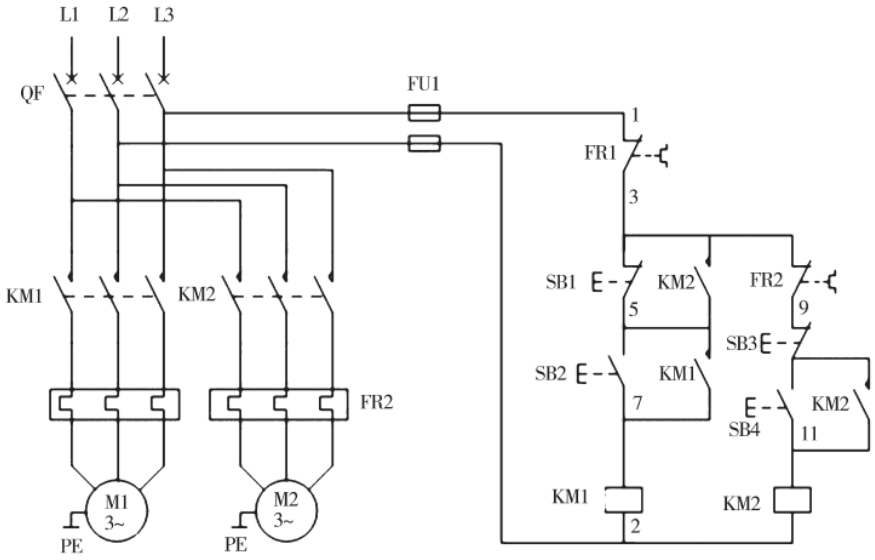

Figure 1. Sequence control flow of electrical engineering

4.2. Design switching quantities for electrical engineering

In the application of PLC technology, switching control plays a pivotal role. PLC technology demonstrates significant advantages in achieving effective switching control. Its primary objective is to leverage programmable memory for enhanced relay application, thereby effectively replacing traditional mechanical relays. When using virtual relays, improving reaction speed is crucial. The negligible reaction time of virtual relays allows for more precise control over switching quantities. PLC technology effectively addresses the issue of slow response times in traditional relay-based electrical control operations. It facilitates automatic switching, ensuring reliable relay connections, safeguards electrical systems, and migrates risks such as short circuits. In short, PLC technology resolves issues inherent in traditional control methods within electrical automation. By effectively addressing these challenges, it ensures improvements in the level of electrical automation control [11-13].

4.3. Program control design

In program control design, attention must be given to the configuration of various modules, including the organization and control modules. The organization module acts as the interface between the operating system and the user program, facilitating system calls, and managing loops and driver modules. Cyclic program processing is a key aspect of PLC technology, involving the execution of the main program and its organization block. The user program within the organization block achieves cyclic execution, meeting the programming requirements through function modules. This dynamic display subroutines ensures effective implementation.

Additionally, during loop execution, the display bit increments with each cycle. When the display bit exceeds 8, it resets to 0, facilitating dynamic visualization of the loop call and showcasing data dynamics.

5. PLC technology under the electrical automation control project case

5.1. Case overview

This case study focuses on a state-owned manufacturing enterprise that initiated a workshop renovation project to promote production efficiency and quality. The core of the project is the integration of PLC technology in the automation control system to improve workshop management and ensure smooth production processes [14].

5.2. System implementation

In the electrical automation control system, PLC and automation technology are primarily used to enable the automatic transportation of raw materials and precise machine control to ensure the automatic sorting of finished products. By connecting sensors and monitoring equipment in the workshop, production data can be collected in real-time, allowing for continuous supervision and control during the production process. As shown in **Table 1**, the application of PLC technology in this case study has increased production efficiency by 50%, mainly due to the reduction of time, automatic processes, and prevention of errors from manual operation. Additionally, the failure rate has been reduced to 2%, attributed to the great precision and optimized failure management capabilities of PLC technology. Therefore, the reduction in energy consumption highlights the importance of automated control systems in improving production efficiency. Following implementation, employee satisfaction improved due to reduced work intensity, creating a safer and more comfortable working environment. These achievements highlight the significant impact of PLC technology.

Table 1. Production changes of intelligent manufacturing workshop

Index	Before modification	After transformation	Improvement ratio
Production efficiency	100 units/hour	150 units/hour	+ 50%
Failure rate	5%	2%	- 60%
Energy consumption	100 units/production unit	80 units/production units	- 20%
Employee satisfaction	70%	85%	+ 15%

6. The advantages of PLC technology in electrical automation control

6.1. Improve anti-interference capability

With continuous economic development, PLC technology has been widely adopted in the electrical engineering industry to enhance its anti-interference capabilities. Technical personnel, responding to the needs of the modern era, have set higher standards for PLC technology. The integration of isolation transformers and radio

wave signal filtering equipment in electrical automation control systems optimizes the use of PLC technology. Consequently, the level and efficiency of electrical automation control will affect social development and internal competitiveness. The anti-interference ability of PLC technology is crucial for improving an enterprise's competitiveness [15].

6.2. Development of network digitization

In the current era, although economic technological improvements have faced challenges, PLC technology has advanced significantly, driving electrical automation control toward greater intelligence. As the knowledge economy accelerates, PLC technology is increasingly applied in electrical automation, fostering network digitization. Technical staff can focus on societal needs by adjusting network digital systems and digital programming, thereby showcasing the advantages of PLC technology, and promoting the development of electrical automation management.

6.3. Enable advanced perception and decision-making

The introduction of visual neural network extends PLC capabilities beyond the traditional logic control. With visual neural networks, PLCs can perform real-time recognition and analysis of visual images. For example, on a production line, PLCs integrated with visual neural networks can accurately detect the quality, shape, or position of a product, enabling automated quality control and positioning. They can also handle complex visual tasks such as pattern recognition and object classification. This enhances the PLC's ability to adapt to different production needs and environments, thus improving production efficiency and product quality.

7. Closing remarks

In summary, PLC technology demonstrates its universality and efficiency in the field of electrical automation control, promoting industrial automation and intelligent manufacturing. With continuous technological and market development ongoing research and innovation are essential. PLC technology must continue to evolve, aligning with industry trends to optimize processes, enhance competitiveness, and support the healthy development of the industry.

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