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Design of Elevator Control System Based on PLC

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Abstract: With the acceleration of urbanization, the utilization rate of elevators in buildings has gradually increased. In order to meet people's increasing demand for elevators, it is necessary to strengthen the optimization design of elevator control system. The application of PLC technology in the design of elevator control system can not only realize the basic functions of elevator control system by using its characteristics of programmability, extensibility and high reliability, but also realize cloud data interaction with the intervention of Internet of Things technology, enhance the data analysis ability of the control system, and meet the intelligent needs of elevator control design at this stage. This paper will take PLC as the research object, analyze its application and design in elevator control system.

1. Introduction

Elevator control system is the core part of elevator, and its performance directly determines the safety, stability and efficiency of elevator operation. The traditional elevator control system has many problems such as slow information transmission speed, low system reliability, and insufficient interpersonal interaction, and the application of PLC technology can make the elevator control system form intelligent interactive performance, greatly improve the stability of the control system, to meet the needs of modern buildings for elevators, and provide users with better experience.

2. PLC technology

2.1 PLC technology introduction

PLC is an electronic device specially used to control industrial automation systems, which can be programmed to achieve automatic control and monitoring of machines or production lines. In the work mainly based on the microprocessor, the collection of computer technology, automatic control technology and communication technology, has the characteristics of simple operation and strong reliability. The working principle of PLC is: The controller can process input signals according to predefined programs and logic, among which the relevant programs are mostly written in graphical programming languages similar to ladder diagrams. In the signal input, the signals are first transmitted to the CPU, and the CPU judges and calculates according to the logic conditions of the program, and transmits the settlement results through the output module to achieve the operation of

external devices. At present, with its more powerful industrial special control function, and advanced and mature computer control system, it is widely used in social production and service, and can be programmed according to its programmable characteristics and stable performance characteristics, to achieve more diversified functional development[1].

2.2 Composition Structure

After analyzing the PLC structure, it can be found that it can be divided into different separate modules, mainly CPU module, power module, I/O module, etc. The specific structure distribution is shown in Figure 1.The CPU module is mainly responsible for executing the program written by the user and controlling the entire operation process of the PLC. The power module is used to ensure the normal and stable operation of the AC power supply and control the AC voltage within the available voltage range without taking other protective measures. The I/O module is the center of input and output, which can be used to receive signal input from external devices, such as key input, sensor recognition, etc., and can also control external devices and convert input signals into operations, such as motor operation or light induction[2].

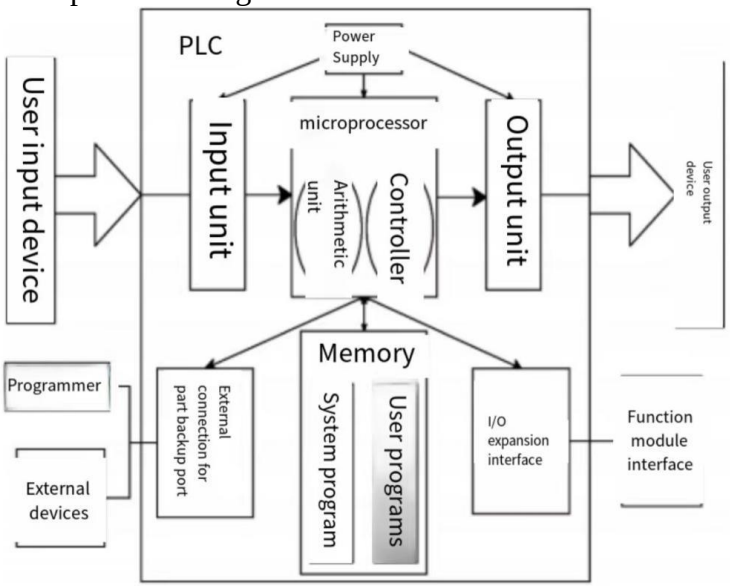

Figure 1: A Schematic diagram of the PLC structure

2.3 Technical Features

The application of this technology can show the following characteristics: (1) operation reliability characteristics. PLC mainly uses microelectronics technology, which can reduce the vulnerability of equipment in actual operation, thus improving the overall operating efficiency of the system, and can perform automatic diagnosis and identification of operating faults to enhance system stability.(2) Anti-interference characteristics. This feature is mainly reflected in the system's ability to resist the impact of impulsive or instantaneous interference on the system during operation. Because the technology needs to be responded by multiple scans of the system in use, instantaneous interference cannot affect the stability of the system. Due to this feature, it can effectively prevent and reduce the wrong operation commands caused by system misactions in practical applications.(3) Programmable features. In application, the technology mainly relies on ladder diagram and command language to control, which has certain plasticity and flexibility, and can effectively reduce the difficulty of system programming.(4) Configuration flexibility characteristics. Compared with the traditional control system, the innovation of this technology lies in the use of the building

block structure, this application can not only reduce the difficulty of system design, but also enhance the easy development of the program, which can be applied to the elevator control system, can effectively meet the needs of various uses, convenient for technical personnel to combine and adjust, optimize the functional structure of the control system. Avoid the function loss of elevator control system, can effectively solve the problem of elevator idle.(5) Easy installation features. In practical applications, only the I/O interface end of the PLC structure is connected to complete the installation of the main functional area, and after the system receives the fault signal, the specific fault point location can be locked according to the signal situation to provide error correction assistance for maintenance personnel[3].

3. Application of PLC technology in elevator control system

3.1 Integration of PLC in elevator control system

The PLC is applied to the elevator control system, and its specific PLC control circuit is shown in Figure 2. The information of the elevator up and down operation needs to be transmitted to the PLC controller through the button panel. The identification of the elevator floor number is carried out by multiple sensors, and the controller is used to adjust the display of the floor number. In addition, the car switch and related electrical switch in the elevator are also controlled by the PLC controller for unified operation. The signal output of the controller can be realized by the elevator's light-emitting diode memory lighting circuit to indicate the number of layers and direction of operation. The PLC access to the elevator control system can realize the overall monitoring and management of the entire elevator workflow, which can be applied to linear planning and structural planning, according to the design concept and function of the elevator planning and selection[4].

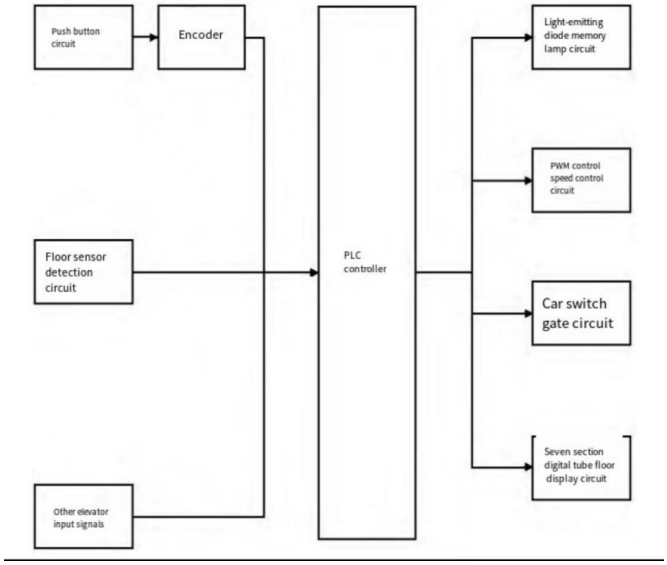

Figure 2: The PLC elevator control circuit

3.2 PLC control system workflow

The working flow of PLC in the elevator control system is as follows: (1) When the PLC is connected to the elevator control system, the elevator is located on the first floor of the building, and can receive the information of each call button in the control system to facilitate the corresponding response.(2) When the elevator stops at any floor, the upper and lower call buttons of the floor can send the door opening information to the control system to control the movement of

the elevator and the opening of the door, which will form a certain delay operation to effectively ensure the safety of the elevator. In addition, the elevator control system can receive another operation at the same time when performing one operation, that is, the above instructions will be repeatedly executed according to the system structure programming during operation.(3) The key in the elevator control system, as the information input device of the control system, will light up the corresponding call light after receiving the instruction, and form the execution command feedback to turn off the light after completing the corresponding operation.(4) A travel controller will be provided in the shaft of each floor of the elevator. When the car reaches the floor, it will touch the switch of the travel controller, and then let the system perceive that it has reached the command specified area, and form the corresponding output operation.(5) In addition to the automatic control according to the button call instruction command, the switch function of the elevator is also provided with a manual operation button to ensure the safety of the elevator operation, and the self-locking function cannot be opened or closed during the elevator operation.(6) During the operation of the elevator, each floor to which the car travels will display the corresponding floor indication number in the prompt area to achieve information feedback on the operation process.(7) In order to ensure the safety of the elevator in operation, the car is equipped with an emergency call button. The button has a communication function, which can be used to contact the elevator control system center or the property when the elevator operation is abnormal, and conduct real-time investigation of the elevator fault[5].

4. Design of elevator control system based on PLC

Based on PLC technology to design the elevator control system, the relevant personnel need to combine the elevator use needs and the specific situation of building use, formulate a reasonable design plan, mainly follow the design principles as far as possible to meet the actual control needs of users, give full play to the advantages of PLC technology, with low energy consumption and anti-interference advantages, etc. We need to improve the reliability of the elevator control system.

4.1 Overall design steps

The application of PLC technology to design elevator control system, the overall design steps are as follows: (1) determine the control range. In order to meet the design and development needs and make full use of the use function of PLC, designers should collect the relevant information of the building, investigate the use and frequency of the elevator during the concentrated travel period of the building population, and establish the control indicators.(2) The experimenter should make technical plan, design the control system based on the information mastered, formulate technical plan scientifically, and ensure rationality, that is, the control mode and operation mode of the system are reasonable, and can realize the free switching between automatic and manual. The reasonableness of the use of various electrical components in the system requires the use of high-quality sensors, limit switches, electric valves and indicators. The rationality of system programming, to set the programming logic module and the number reasonably, to ensure that the effect of efficient control of input and output can be achieved.(3) The hardware and software design of the elevator control system should be scientific and reasonable. On the basis of ensuring the reliability and stability of the control system, it is necessary to increase the economic suitability of the equipment, ensure that the configuration of various electrical components in the control system is reasonable, and achieve the transportation effect of the elevator.(4) The design of the elevator control system should do a good job of debugging and running. The experiment is to ensure that the design of the elevator PLC control system can achieve the expected design effect, and ensure that the operation effect under different working conditions meets the expected requirements. In the

design and debugging, the designer should check the data and optimize the design procedure to ensure the safety and reliability of the elevator control.

4.2 Hardware Design

4.2.1 PLC Selection

In the process of selecting PLC, the elevator control system is determined according to the actual use needs of the elevator, and is divided from the perspective of structure, control function, communication network status, etc. Among them, the selection of PLC can be selected according to the overall score and actual needs. For example, the I/O points used for input and output should be selected according to the actual control requirements of the building and the number of cars, and to ensure the stable continuity of the elevator input signal, the digital expansion unit module should be selected to strengthen the design of the input circuit. From the perspective of physical structure, although the integral PLC control has the advantages of simple structure and low price, it will reduce the expansion ability and flexibility of the control system in use. If the PLC control system has a wide range of expansion, the failure module can be directly replaced for the failure to achieve recovery, but the procurement cost of this type of selection will be relatively high.3.2.2 Traction motor circuit design

The design is mainly to set the speed control of the elevator, in order to facilitate the use of elderly users, to set a low-speed elevator, which can be designed for 4m/s to carry. In the process of calculating the power of the traction motor, the bearing weight and the speed of the elevator should be fully considered. The following is the schematic diagram of the main circuit of the traction motor, and it can be found that the inductance and resistance can be part of the stator circuit of the motor, the external voltage is 380v, the voltage frequency is 50Hz, L1, L2, L3 are respectively the AC power supply access line, and QB1 is the main power switch, which is used for the overall power protection of the elevator. Among them, QA1 and QA2 are responsible for the positive and negative control of the traction motor respectively, while QA3 and QA4 are high and low speed operation controllers to ensure the smooth operation of the traction motor. During the acceleration and deceleration process, independent closing and short circuit control is used to adjust the operation brake of the elevator. Under the action of the power delay device, the QA6-QA8 switch will form a sequential closing and disconnecting operation, forming different levels of elevator braking, and achieving a smooth driving and stopping process. As shown in Figure 3.

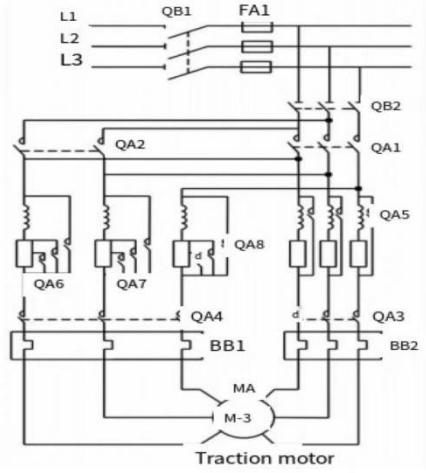

Figure 3: Main circuit of the traction lead motor

For the design of the control loop of the traction motor (FIG. 4), TC is the control transformer,

which is used to convert the live line voltage into AC voltage, and BB1 and BB2 are auxiliary normally closed contacts of the thermal relay. When the system is overloaded for a long time, the switch will be disconnected, resulting in a loop control failure.

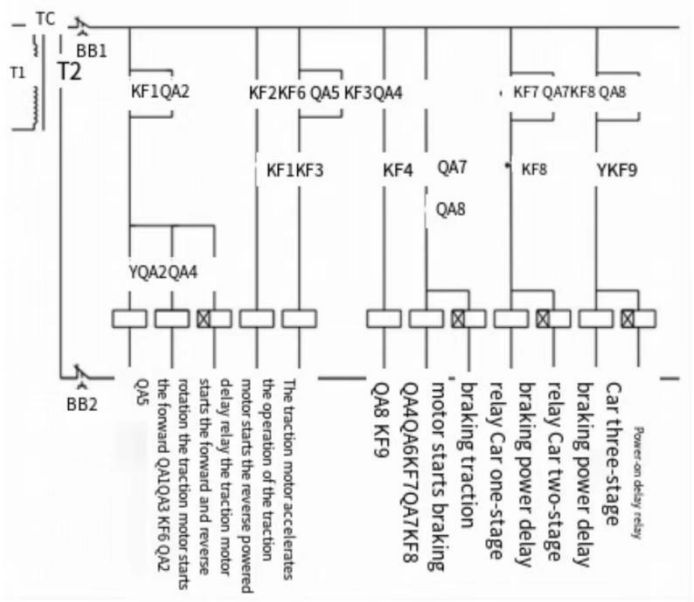

Figure 4: Control loop of the traction motor

4.2.2 Car controller and I/O module design

The selection of elevator car controller and I/O module is mainly used to complete the floor selection input, and form the corresponding feedback with the change of car floor operation. In this design, inverter is used to control the AC motor, to realize the accurate positioning of the elevator car, and to form a complete operating closed-loop system. Among them, the intelligent controller with PLC as the core can realize the detection and adjustment of the motor speed to achieve the effect of smooth operation. Table 1 shows the memory integer variables.

Table 1: Memory-integer variable

variable name	Variable description	Type of variable
Open and close manually	0: Default finish 1: Open the door 2: Close the door	Memory type
Elevator operation direction	0: Default finish 1: Up 2: Down memory consolidation Door switch control 78: off 0: open	Memory type
On the call	0: No call 1: A call	Memory type
Under the call	0: No call 1: A call	Memory type
Inside the call	0: No call 1: A call	Memory type

4.2.3 Intelligent Gateway Design

The intelligent gateway design of the elevator control system is mainly based on the access of Internet of Things devices to achieve control and management, in which different Internet of Things devices can be connected to the Internet to achieve the interconnection of the Internet of Things. At present, the elevator control system in China supports a variety of Internet of Things link methods, and the PLC controller with relatively simple configuration is used to achieve the effect of easy

programming Settings. The main functions of the intelligent gateway are as follows: (1) Remote data monitoring, which can be used to view and regulate the operating parameters of the elevator at any time.(2) The function of receiving alarm information at any time can understand the fault status and fault cause of the equipment at the first time.(3) Remote upload, download and debug PLC program, can effectively solve the relevant debugging problems.(4) Save and view historical data to facilitate the tracking of the historical operating status of the device.

4.3 Software Design

4.3.1 Car door control program design

The program design mainly includes the control of the inside and outside door of the car, the control of the switch limit switch and the detection sensor of the family. The limit switch control is mainly the automatic control of the elevator door, when the command is executed after the operation is finished, the automatic closing control can ensure that the limit switch contact is normally closed, and closed when there is no signal, and disconnected when there is a signal. The door opening control program design is mainly through the top of the car to touch the floor to the level of the limit switch, at this time the door signal can be transmitted to the PLC controller, and by the PLC to execute the command, this process needs to use programming to determine the switching conditions, and then according to the different conditions into different development links. The design of the closing procedure is to use the timer inside the PLC, when the sensor detects that no one enters the elevator or the button is unable to operate, it can automatically close the door operation, and hover in the area, when the user triggers any door button, it will start the door opening procedure and execute the corresponding operating instructions.

4.3.2 Call command control program design

The program design mainly includes internal selection command program and external selection command program, among which the internal selection command is mainly triggered by the input command inside the car, forming the prompt operation of the indicator light. Then the PLC can get the input signal and make calculation and judgment, control the traction motor to operate, so that the car reaches the designated floor, then the limit switch will be triggered, forming the operation of the indicator light, and respond to the door opening. The outgoing command design is mainly used for the outgoing call request of the elevator system. The outgoing call command will be stored for the elevator running in the opposite direction of the car, and the outgoing call command will be executed after the above command operation is completed. In addition, it should be noted that the storage method of outbound instructions is the linear design of the number of times, and the instruction will be eliminated after the completion of the outbound instructions. For the control program of call instructions, designers need to optimize the programming to ensure that it can quickly identify instructions, and provide optimal upstream and downstream arrangements to ensure that all customer needs can be met, and intelligent operation processing can be carried out when passing through the floor of outbound instruction operation, which is convenient to reduce unnecessary runs.

5. Conclusion

In order to realize the efficient integration of PLC and elevator control system, it is necessary to strengthen the technical application of PLC, and fully grasp the type of elevator controller, and realize the overall control role of elevator with the help of PLC programming. Elevator company designers need to fully understand the functions of PLC and related use efficiency, choose to use

linear programming or structural programming, and then use PLC technology to improve the level of modern elevator control technology. In the application of PLC technology, the research and development of this technology should also be gradually strengthened, so that it can efficiently solve various practical venetto, and is widely used in other related fields.

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