Simulation Design of a Single Six Story Elevator

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Abstract: This design is aimed at using Siemens S7-1500 series PLC as the control system, and using a single six story elevator simulation model as the controlled object. After consulting literature on PLC controlled elevator systems and studying the control technology schemes used in the literature, the control design for a single elevator was completed. A group control algorithm based on scheduling principles was adopted to minimize waiting time and receive call signals from each elevator. By calculating the time required for each elevator, the shortest elevator was selected for transportation. Compared to other group control algorithms, the implementation of this group control algorithm is simple, has a short development cycle, and has good control effects. It can well meet the design requirements of passenger capacity, average waiting time, average passenger travel time, and overall system energy consumption.

Keywords: Siemens PLC; Control System; Simulation Design; Single Elevator

1. Requirements for project technical indicators

(1) Display the position of elevator floors. In PLC, we use limit switches to simulate sensors to display the position of the floor.

(2) Realize automatic and manual door opening and closing. After reaching the floor and meeting the corresponding conditions, the door can automatically open and close at a fixed time. You can also set buttons to manually open and close the door.

(3) Carrying passengers with a load capacity of 1050KG. Initialization requirements: The running direction should be upward, and after initialization, it should stop on the 5th floor.

(4) Signal selection and elimination in the lift car. In the car, passengers can select the destination floor for elevator operation through the floor selection button on the control panel inside the car, which is called the internal selection signal. When the floor button for that purpose is pressed, the signal is memorized. Represented by a coil in PLC, it can be cleared once the conditions are met.

(5) Automatically move the elevator up or down. After determining the direction of the elevator and when it is in the closed state, the elevator automatically goes up and down. And represented by a coil, it will automatically eliminate after reaching the destination floor.

2. System scheme design

2.1 Analysis of Controlled Object Characteristics

The control algorithm is the most important part of the PLC elevator control system design, and it is necessary to fully consider the operating status of the elevator when designing the control algorithm. For example, going up and down, opening and closing doors, calling both inside and outside to ensure the safety and complete functionality of the elevator after it is put into use. Taking the call signal as an example, the call signal includes an internal selection signal and an external call signal. When a passenger selects a floor in the elevator, the internal selection signal indicator light on that floor is lit, and the internal selection signal is stored. The passenger arrives at the corresponding floor and executes the door opening program, indicating that the car has arrived at the floor and executed the door opening program to wait for the passenger to leave. At

this time, the internal selection signal should be cleared. In addition, when designing the elevator control system, it is necessary to consider the self-locking and interlocking relationships of the elevator control. Therefore, random logic control is used in the elevator control design.

The analysis of the characteristics of elevator controlled objects mainly includes 3 aspects: elevator model, design parameters and relative address lists, and the selection of communication methods:

Elevator model

The elevator objects mainly include: the overall structure of the elevator (including the car, motor, limit switch, etc.), buttons on each floor (up and down call buttons and indicator lights, etc.), internal equipment of the elevator (car door opening and closing buttons, car floor selection buttons and indicator lights, etc.), and other structures. The elevator model adopts a single step six story structure, and its appearance and schematic diagram are as follows:

Design parameters:

NAME	Design parameters	NAME	Design parameters
Number of passenger elevators	1	Number of passenger elevator floors	6th floor
Single part load	Passenger/freight elevator 1050kg	Single department staffing	15 people

2.2 Analysis of System Safety Indicators

The hazards that may occur in elevators generally include: personnel being squeezed, impacted, and falling or shearing; Personnel were electrocuted, and the lift car exceeded the limit travel and collided; Car overspeed or falling due to broken rope; Structural damage caused by material failure, loss of strength, etc. The safety of elevators not only fully considers the rationality and reliability of the structure, electrical control, and traction, but also sets up specialized safety devices for various possible hazards.

1. Protection against overtravel
2. Protection against elevator overspeed and rope breakage
3. Protection against personnel shearing and falling
4. Stop switch and maintenance operation device
5. Fire protection function

2.2.1 Control algorithm design

Algorithm design ideas

When the elevator starts to start, determine whether it is initialized. If the initialization is successful, directly enter the

operating mode. When there is a door opening or closing signal indication, execute the up or down control. After initialization, determine whether it is overloaded. If it is overloaded, the elevator will not move. If it is not overloaded, the elevator will run. Based on the number of floors that the operation indicator light and the car floor selection button indicator light/hall call button indicator light are on, determine whether the elevator is up or down. After reaching the destination, The elevator opens and closes, and the operation ends.

3. Implementation of control system

3.1 Basic Control Logic

3.1.1 Door opening and closing control logic

Opening and closing control: When reaching a certain level and responding to the signal requirements of that level, the door will be delayed and closed when the door is opened in place. The door closing indicator light will flash, and when the door is opened and pressed for a long time, it will open and wait (the car door will automatically open), or when encountering an infrared light screen signal that is not responding or an overweight sensor action, the door will open and wait. In the automatic state, while maintaining the door opening state, the door closing button can be pressed to immediately respond to the door closing action. When the elevator stops in the door area, you can press the door open button in the car to reopen the closed or unclosed doors of the elevator. If the call button on this floor is pressed, the elevator door will open several seconds after the door waiting signal is turned off and the door has not started, and the door is already closed or in the process of closing. If the button is held down, the door remains open.

3.1.2 Initialize Control Logic

After resetting the elevator to zero, regardless of which floor the car is currently on, reset the elevator to the first floor for standby and return the initialization completion signal to confirm the completion of initialization. After receiving the ready signal, the elevator model will issue an automatic operation signal before proceeding with other operational controls.

3.1.3 Elevator operation control logic

After completing the initialization operation, the elevator waits for an external call signal on the floor, receives an internal call signal after receiving a person, and confirms whether this floor is the same as the target floor. At different times, the elevator will choose the direction of operation and start running, judging whether it has reached the target floor every time it reaches a floor. After reaching the target floor, the elevator opens the door to pick up and disembark passengers. After receiving a person in the elevator, determine whether the elevator is overweight. If it is overweight, the elevator will not operate and the fault light will flash; On the contrary, after a brief delay, the elevator closes the door and continues to operate, completing the operation control of a single elevator.

3.2 Cluster control algorithm

3.2.1 Algorithm Description

Elevator group control is based on a single elevator control system, so when designing elevator group control priority scheduling, it must be based on the control logic of a single elevator. Therefore, priority scheduling for group control cannot conflict with the operation of a single elevator. Based on the elevator operation logic, we have designed the following operating rules for the group control elevator system:

(1) Following the principle of proximity

(2) When a fault occurs, a single unit operates independently

(3) In fully automatic mode, the door automatically opens and closes upon arrival at the station

(4) Open the door button to open the door.

3.2.2 Algorithm design

Before the elevator runs, the car may be on any floor, and elevator initialization is necessary at this time. After initialization, run according to the call signal. From the perspective of reducing energy consumption and improving efficiency, the cluster control of elevators should follow the priority response of standby elevators to calls, if there is no

standby elevator. The principle of selecting an appropriate elevator to respond to calls should be followed. Similar to the principle of a single elevator, the cluster control program should prioritize scanning for call signals at the beginning of each scanning cycle. If there is no call signal, the logical program scanning of the elevator part ends; If there is a call signal, the program starts performing a distance comparison algorithm for each elevator and selects the closest elevator to process this signal. If all elevators are not suitable for handling this call, keep this call and proceed to the next cycle of scanning to cycle through.

4. Control system selection and system connection

4.1 Control system selection

We have chosen Siemens S7-1200 series PLC as the control system for this design. Modular SIMATIC S7-1200 controller enables simple yet highly accurate automation tasks. The SIMATIC S7-1200 controller achieves a modular and compact design, which is powerful, investment safe, and fully suitable for various applications. The design with strong scalability and high flexibility can achieve the highest standard communication interface for industrial communication, as well as a complete set of powerful integrated technical functions, making this controller an important component of a complete and comprehensive automation solution.

The performance of the SIMATIC HMI basic panel has been optimized to be perfectly compatible with this new controller and powerful integrated engineering configuration, ensuring simplified development, fast startup, precise monitoring, and the highest level of availability. The SIMATIC S7-1200 has an integrated PROFINET interface, powerful integration technology functions, and a design with strong scalability and high flexibility. It achieves a simple and effective technical task solution for communication, and fully meets the application requirements of a series of independent automation systems.

4.2 Communication connections between systems

1. Establishment of communication environment

(1) Open the 'Network and Sharing Center' and click 'Change Adapter Settings' to change the wired network card to automatically obtain an IP address.

(2) Change the Ethernet IP address of the virtual network card to be in the same network segment as the wired network card.

2. Use S7-PLCSIM Advanced to establish a simulation PLC

3. Test the communication between EET and simulated PLC

(1) Enter the IP address of the simulated PLC in the PLC IP address configuration field.

(2) Click the connect test button to establish a connection between the EET and the simulated PLC.

4. Install the single step six story elevator project in the Botu into PLCSIM Advanced

(1) Set the IP address and select 'Allow PUTGET communication access from remote objects' in the PLC attribute connection mechanism.

(2) Compile and download this project.

5. Test Control Procedure

(1) Modify the input/output DB block of the communication settings in the elevator simulation software to be consistent with the program

(2) Place the software in PLC control mode to start the experiment.

5. Design of green energy-saving system

This design uses a PLC (programmable controller) to control the operation of the elevator. Compared to traditional relay control methods, PLC has the characteristics of high reliability, small size, strong anti-interference ability, simple programming, convenient maintenance, low power consumption, complete control functions, and strong universality. When using PLC control method for control, various special control requirements can be achieved, and the program only needs to

be changed to be applicable to various production processes. During maintenance, faults can be quickly eliminated by replacing various modules, and the PLC also has self-diagnosis and fault alarm functions. The various indications on the panel are convenient for operators to inspect and debug, greatly reducing the workload. The various indications on the panel are also convenient for operators to inspect and debug, greatly reducing the workload of the staff. The cost and funds have been greatly reduced in terms of initial investment in construction and later maintenance, resulting in a significant increase in economic benefits and better compliance with green environmental protection requirements.

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