Programming and Debugging of Multi-layer Elevator with Teaching Function

Lina Mao, Zhenguo Yuan

Guangdong Industry Polytechnic University, Guangzhou, Guangdong, China

Abstract: With the development of modern economy and urban life, elevator has indispensable become an means of transportation in people's daily life. The traditional relay elevator control system greatly reduces the reliability and safety of the elevator system due to the large mechanical and electromagnetic inertia of the relay itself. In order to ensure that the elevator operation is efficient, energy-saving, safe and reliable, the elevator control mode must be improved. Programmable logic controller (PLC), developed according to the needs of sequential logic control, is an electronic device for digital operation designed for industrial specially environment application. PLC has fast processing speed and high reliability, which can ensure the normal, safe and reliable operation of the elevator. The elevator controlled by touch screen is convenient and operable, which has become the choice of more and more high-end elevators. Traditional elevator control methods often rely on physical buttons, which are prone to wear and failure after a long time of use, affecting the normal operation of the elevator. The touching screen control mode is more durable, and the operation is more intuitive and easy. Passengers can quickly select their destination floor with just a touch of the screen, greatly enhancing the elevator experience.

Keywords: Elevator; PLC; Touch Screen; Electrical Control

1. Introduction

The electrical control part of the elevator mainly has two control methods: relay control and computer control. The failure rate of elevator using relay control system is high, which greatly reduces the operation reliability and safety of elevator. So it's basically eliminated. Because there are many kinds of computers, according to the composition method and operation mode of computer control system, computer control can be divided into PLC control and microcomputer control two ways. Among them, PLC has been widely used for its advantages of small size, strong function, low failure rate, long life, low noise. low energy consumption, easv maintenance, flexible modification logic, easy programming, easy to link into the control network and so on.[1,2] Through this research, we hope to provide

useful reference for the innovation and development of elevator industry and teaching. We believe that with the continuous progress of touch screen technology and the continuous expansion of application fields, touch screen elevators will play a more important role in the future, providing more convenient and efficient services for people's travel.[3-5]

2. Overview of Relevant Principles and Technologies

The elevator control system is mainly composed of the main circuit of variable frequency speed regulation, input and output unit and PLC unit. As shown in Figure 1, PLC is used to manage and control the start, acceleration and deceleration, stop, running direction, floor display, landing call, operation in the car, safety protection and other command signals of the elevator traction motor and door switch. Figure 1 shows the simplified model of the elevator on the fifth floor and the schematic diagram of the control cabinet.[6,7]

3. Function Analysis and Research of Control System

3.1 Elevator Internal and External Functions

Inside the elevator, there should be 5 floor (1 to 5 floors) buttons, opening and closing buttons and floor displays. Up and down

display. When passengers enter the elevator, the elevator should be able to allow passengers to press the floor button representing the destination they want to go to, called the internal call button. When the elevator stops, it should have the function of opening and closing the door, that is, the elevator door can be automatically opened, and after a certain delay, it can be automatically closed. In addition, there should also be a button to control the opening and closing of the elevator inside the elevator, so that passengers can control the opening and closing of the elevator at any time when the elevator stops. The elevator should also be equipped with a display screen, used to show the elevator is now in the state, that is, the elevator is rising or falling and the elevator is in the floor of the floor, so that passengers can clearly know their position, far from their own to the floor, the elevator is rising or falling.



Figure 1. Schematic Diagram of Elevator Control

The exterior of the elevator is divided into 5 floors, and each floor should have a call button, a call indicator, a rise and fall indicator, and a floor display. The call button is a tool used by passengers to make a call, and the call indicator light should be kept bright before completing the corresponding call request. It is used to show the status of the elevator, like the rise indicator light, the fall indicator light and the floor display. Of the five floors, the first floor has an up call button, the fifth floor has a down call button, and the remaining three floors have an up call button and a down call button. The rise and fall indicators and floor

displays, the 5 floors of the elevator should be the same.[8-10]

3.2 Analysis of Elevator Operation Status

The running state of the elevator can be divided into initial state, running state and running state.

3.2.1 The initial state of the elevator

At this time, the elevator is on standby on the 1st floor, the elevator lighting is on, each display screen is initialized, and the elevator is in the following state:

Call lights on all floors are off;

Each display inside and outside the elevator is "1";

All elevator doors inside and outside the elevator are closed.

3.2.2 The elevator is in the process of operation

The elevator is in the following states:

After pressing the call button on a floor (Floors 1-5), the call light on the floor is on, and the elevator responds to the call on the floor.

When the elevator is going up, if the calling level is below the target running level above the current operation of the elevator, the elevator will first go up to this level before completing the previous command, and then complete other call actions from near to far after completing the call on this level. If the calling level is below the current level of the elevator, the elevator does not respond to the previous command until the elevator is back on standby.

When an elevator is going up, if there are multiple downlink calls, all of which are above the current floor, the elevator reaches the highest downlink call floor, and then responds to other downlink call floors from highest to lowest.

When the elevator is going down, if the call level is above the target running level under the current operation of the elevator, the elevator will first go down to this level before the completion of the previous command, and then complete other call actions from near to far after the completion of the change of the floor. If the calling level is above the current level of the elevator, the elevator does not respond to the command until the previous command is completed and until the elevator is back on standby.

When the elevator is going down, if there are

multiple ascending calls, all of which are below the current floor, the elevator reaches the lowest descending call level and then responds to other ascending call levels from lowest to highest.

The display of each floor changes with the movement of the elevator, and the indicator light on each floor also changes.

The elevator door is always closed during operation, and the door will not open until the specified floor is reached.

Support other calls during the elevator operation.

3.2.3 The state of the elevator after operation.

After arriving at the designated floor, the elevator will remain on standby until a new command is given. After the elevator reaches the designated floor, the elevator door will automatically open and automatically close after a period of delay. In this process, manual opening or closing is supported; The value displayed on each floor is the location of the floor, and the upstream and downstream indicators are off.

Elevator control requirements: accept the call command of each button (including internal and external calls), and respond accordingly; When the elevator stops at a certain floor (such as the 4th floor), press the call button (up or down call) of the floor (4th floor) at this time, it is equivalent to issuing the command to open the elevator door and open the door. If the elevator car is not on the floor at this time (in the other 4 floors), wait until the elevator is closed, and control the elevator to run up or down according to the principle of not reversing; The non-reversing principle of elevator operation means that the call that does not change the current direction of elevator operation is preferentially responded to, and the call that makes the elevator run in reverse is not responded to until all these commands are responded to. For example, if the elevator is ascending between the 2nd floor and the 3rd floor and there is a call on the 2nd floor, a call on the 3rd floor and a call on the 4th floor, the elevator first responds to the call on the 4th floor, and then responds to the call on the 3rd floor and the call on the 2nd floor. The elevator is equipped with upper and lower level induction on each floor (the first floor only has the lower level, the fifth floor only has the upper level). When the level point is reached and the floor has a call signal, the

elevator starts to slow down and stop on the level, otherwise it will continue to pass through the floor at high speed; When a call button is pressed, the response indication is lit and maintained until the elevator completes the call; When the elevator stops on a certain floor, press the door opening button inside the elevator to open the elevator door, and press the door closing button inside the elevator to close the elevator door. But the doors cannot be opened while the elevator is moving; When the elevator runs to a certain floor, the corresponding indicator lights up, until the elevator runs to the front floor when the floor indicator changes.

4. Program Implementation

Hall call and outgoing call button memory program as shown in Figure 2. Call and internal call memory in the car box are shown in Figure 3. T2 means that the elevator automatically returns to the base station (1st floor) when it is not used for a period of time.

4	M301	нын ут	(14101	,
	M101			
	M302	H502	(11102	,
-	M102	H120		
14	M303	M502		2
-	M103	енн Ц —		
20	M304	H503	(1104	,
	M104	M120		
26	H305	H500	(1105	,
╞	M105			
32	M306	H514	(1106	,
-	M106	H120		
38	H307	H514	(11107	,
-	11107			
44	M308	HSHS 	(11108	2
1	M101			

Figure 2. Outgoing Call Button Memory



Figure 3. Internal Call Memory Program

The comprehensive judgment of whether the floor is open is shown in Figure 4.



Figure 4. Open the Door Comprehensive Judgment Procedure

Touch screen running interface:

When the elevator does not call on the first floor in Figure 5.



Figure 5. Initial Interface of Elevator When the elevator is on the third floor, the external call on the third floor goes up, and the external call on the second floor goes down, the touch screen runs the interface, as shown in Figure 6.



Figure 6. Elevator in Operation

5. Conclusion

This paper uses PLC to design the elevator control system, including ladder diagram program and touch screen software design, to realize the basic functions of the 5-storey elevator; FX2N programmable controller is used to set up the elevator control system to complete the elevator command inside the car, outside the hall call command, floor position indication, door opening control and other control tasks.

In order to promote the sustainable development of touch screen elevators, we can increase R&D investment in key technology fields such as the Internet of Things, big data, and artificial intelligence, and continuously improve the intelligent level and personalized service capabilities of elevators.

And strengthen cooperation and exchanges within the industry, jointly develop technical standards and industry norms for touch screen elevators, and promote the healthy development of the entire industry.

Acknowledgement

This work was supported by the 2020 China University Industry-University-Research "New Innovation Fund Generation Information Technology Innovation Project" (2020ITA05040); Guangdong Provincial Department of Education's 2021 Young Innovative Talents Project in Colleges and Universities (2021 kQNCX 161); Guangdong Provincial Department of Education's 2021 Innovation Team Project for Colleges and Universities (Nature) (2021kct083); Special Project in Key Fields of Colleges and Universities in Guangdong Province (High-end Equipment Manufacturing) 2022ZDZX3008; 2016 Guangdong Science Plan and Technology Project (2016B090927002).

References

- [1] Liao Changchu (Ed.) FX Series PLC Programming and Application. China Machine Press, 2015.4
- [2] Junxiu Li, Ed. Application Technology of Programmable Controller. Chemical Industry Press, 2018.7
- [3] Ouyang Huaming. New Thinking of Elevator Control System Based on PLC Technology. Journal of Xiangtan Teachers College, 2018.6
- [4] Wang Yadong. Application of FX2N series PLC in Elevator control system. Engineering Technology, 2017.6
- [5] Zheng Xuewei. Design of elevator control system based on PLC. Tianjin: Master Thesis of Tianjin University,2016.6:14-45

- [6] Liu Chunyu et al. Research on Improving the Reliability of PLC Control System. China New Technology and New Products, 2020.7
- [7] Han Xiangxiang. PLC and touch screen, frequency converter, configuration software application all. Chemical Industry Press,2018.11
- [8] Wang Jian. Practical technology of touch

screen. China Machine Press, 2021.12.

- [9] Zhang Lei, Shan Qibing, Li Chunhong, Sheng Haijun, YU Maoquan. Touch screen configuration control technology. Tsinghua University Press,2024.01.
- [10] Duan Chendong, Zhang Yanning. Elevator Control Technology. Tsinghua University Press,2020.09.