ISSN: 2472-3703 DOI: 10.6911/WSRJ.202012_6(12).0059

PLC Control and Real-time Monitoring of a Sightseeing Lift

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Abstract

This paper presents the PLC control of a sightseeing lift for an eight-floor building. It controls the lift operation and the inverter. In addition, a remote monitoring system for the lift is also developed based on the Kingview.

Keywords

PLC control technology; Kingview software; real-time monitoring.

1. INTRODUCTION

With the continuous development of urban construction, supermarkets, business buildings, hotels, resorts are constantly increasing, they create a comfortable space with the central open style modeling. The sightseeing elevator plays a great role in the atmosphere of elegant decoration.

According to the external call signal and its own control logic operates the elevator, while the call is random. The elevator is actually a man-machine interactive control system. The elevator system covers the motor driving technology, frequency conversion technology, PLC technology, electrical and electronic control technology, assembly technology, communication technology, industrial control configuration monitoring technology. It can also be used as a practical teaching platform for PLC, inverter, industrial control configuration technology related courses of electrical and building automation. Therefore, the elevator model has become a common learning course in Colleges and universities, which can provide rich practical projects and learning tasks to meet the learning needs of different levels of students.

The configuration elevator control system adopts random logic mode. When the frequency converter receives the elevator calling direction signal sent by PLC, the frequency converter starts the motor according to the set speed and acceleration value. After reaching the maximum speed, it runs at a constant speed. When reaching the deceleration point of the target layer, the controller sends out the high speed cut-off signal, and the frequency converter reduces the maximum speed to the crawling speed with the set deceleration.

The industrial control configuration software is used to realize the communication between PLC and the core ECU, real-time remote control and monitoring of the elevator operation. In the monitoring interface, the inner layer call, door opening and closing control can be realized; the current status of the elevator, floor display, up and down action screen tracking display, and the actual call registration of each floor are checked. In addition, after certain modification, the monitoring program can be designed as a teaching simulation elevator system to test the feasibility of PLC program. In the teaching of PLC, configuration software application and elevator control, it has outstanding advantages and good use value.

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2. ELEVATOR PLC SYSTEM

The elevator system is composed of body and controller. The main body includes base, column, internal and external selective control panel; the controller includes PLC, frequency converter and switching power supply.

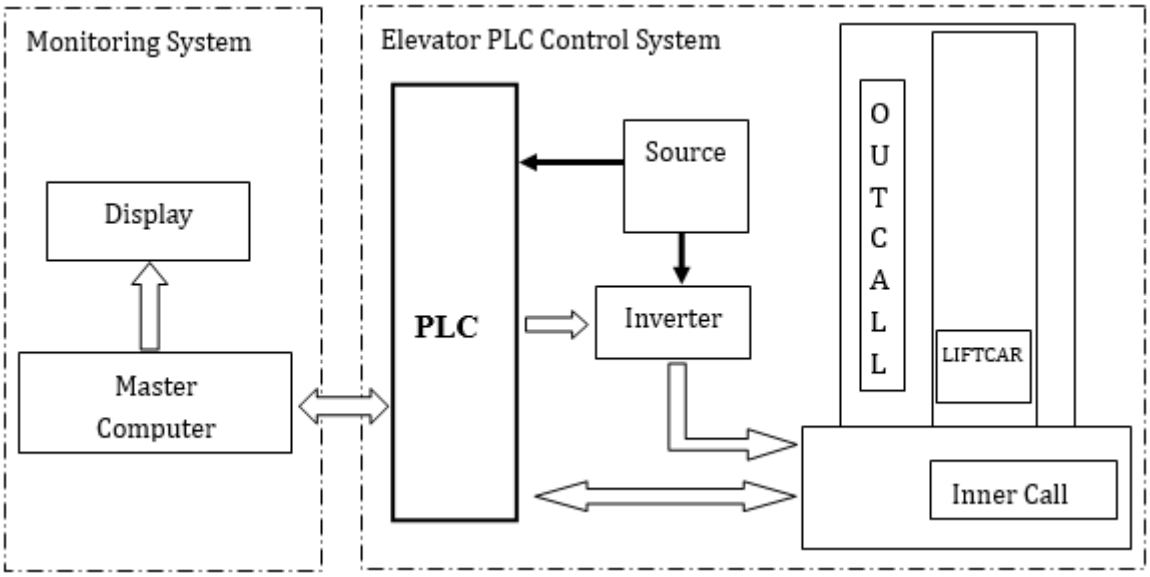

Fig 1. Block diagram of Elevator system

The elevator is divided into eight floors, each floor has digital display of the floor number of the lift car, outbound call button and outbound call registration indication. The inner call panel of the lift car includes 1 ~ 8 floor internal call buttons, opening and closing buttons, internal call registration display, elevator up and down operation indication.

The elevator has hardware and electrical limit protection, which will not rush out of the operation range of 1 ~ 8 floors due to programming error.

The back of the main control board is equipped with power socket and safety tube base, and the specification of safety tube is 250V10A. The power supply voltage of the device is AC 220V50Hz. Three core single phase socket with protective grounding system shall be used.

2.1. Elevator Input Signal and Significance

(1) Position signal. The position signal is generated by eight sensors XK1~XK8 installed at the elevator parking position. It is “off” at ordinary times and “on” when the elevator runs to this position.

(2) Command signal (internal call). There are 8 command signals, which are generated by 8 command buttons of "1-8" (K11~K18). Press a button to indicate that the passengers in the elevator want to go to the corresponding floor.

(3) Call signal. There are 14 call signals, which are generated by K21~K34 call buttons respectively. Press the call button to indicate that the passengers outside the elevator want to take the elevator. For example, pressing K23 means passengers on the second floor want to go up, and pressing K24 means passengers on the third floor want to go down.

(4) There are 2 opening and closing control signals, and 2 opening and closing in place signals.

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2.2. Elevator Output Signal and Significance

(1) Running direction signal. There are two running direction signals, which are composed of two arrow indicator lights to show the elevator running direction.

(2) Command registration signal (internal call). There are 8 command registration signals, which are composed of L11~L18 indicator lights respectively, indicating that the corresponding command signals have been accepted (registered). After the instruction is executed, the signal disappears. For example, if the elevator is on the second floor, pressing "three" means that passengers in the elevator want to go to the third floor, then L13 light indicates that the requirement has been accepted. When the elevator runs up to the third floor L13 goes out.

(3) Call registration signal. There are 14 call registration signals, which are composed of L21~L34 indicator lights, and their meanings are similar to the above-mentioned command registration signals.

(4) Floor digital display signal. BCD code is output by four points and sent to seven segments of digital display after decoding by CD4511, indicating the current floor position of the elevator. LEDa~LEDg represent seven segments of digital display of each stroke.

(5) 2 action signals of opening and closing the door. Elevator up and down action signals, high-speed, medium speed control signals, sent to the inverter.

2.3. Elevator Operation Principle

(1) At the beginning, the elevator is on any floor.

(2) Receive and register all command signals and call signals of elevator outside the floor, register and output registration signals.

(3) According to the earliest registered signal, it can automatically judge whether the elevator is up or down. This logical judgment is called elevator orientation. Elevator orientation can be divided into two types according to the nature of the first registration signal. One is command orientation, which compares the destination pointed out by the command with the current elevator position to get the conclusion of "up" or "down". For example, if the elevator is on the second floor, if the instruction is on the first floor, it will go down; if the instruction is on the fourth floor, it will go up. The second type is the elevator call orientation, which is to draw the conclusion of "up" or "down" according to the comparison between the source location of the call signal and the current elevator position. For example, if the elevator is on the second floor and the passenger on the third floor wants to go down, press K3. At this time, the operation of the elevator should be upward to meet the passenger on the third floor, so the elevator should be upward.

(4) When the elevator receives multiple signals, the first signal is used for orientation, the same direction signal is executed first, and then the direction is reversed after all tasks in one direction are completed. For example, if the elevator is on the third floor, the second floor command signal, the fourth floor command signal and the first floor command signal are input in turn. If the signal queuing mode is used, the elevator will go down to the second floor→up to the fourth floor→down to the first floor. In the same direction first execution mode, the elevator goes down to the second floor→down to the first floor→up to the fourth floor. Obviously, the second way is efficient because of its short round-trip distance.

(5) It has the function of intercepting vehicles in the same direction. For example, if the elevator is on the first floor and the instruction is on the fourth floor, it will go up, and there will be a call signal on the third floor. If the call signal is call up (K25), the elevator will stop at the third floor and carry passengers along the way; if the call signal is call down (K24), it can not stop, but go to the fourth floor first and then return to the third floor.

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(6) When the task of one direction is completed, the direction change principle of the farthest station shall be followed. For example, if the elevator is on the first floor, it will go up according to the command of the second floor. At this time, there are call down signals on the third floor and the fourth floor respectively. The elevator stops on the second floor and continues to go up after getting off. If you stop at the third floor to change direction, the requirements of the fourth floor can not be taken into account. If you stop at the fourth floor to change direction, you can stop the train in the direction of the third floor.

(7) When there is an external call signal, the lift car will sound the call signal. When it reaches the floor, the lift car will stop running and the car door will open, and it will close automatically after 3S delay. When there is a command signal (internal call), the lift car will ring the call signal. When it reaches the floor, the lift car will stop running, the car door will open, and the door will close automatically after 3S delay.

(8) When the elevator is not leveled or running, the door opening and closing buttons do not work. After leveling and the elevator car stops running, press the open button to open the lift car door, and press the close button to close the lift car door.

(9) When the elevator responds to the space between two floors or more, the elevator operates at variable frequency and runs at high speed in the middle, and reduces to low speed when approaching the response floor. If there is a new call to respond in the middle of high-speed operation, and there are less than two floors between the buildings, the variable speed response is low-speed response.

2.4. PLC Programming

There are many input / output points and complex situation in the PLC programming of eight floor elevator, which is a great test for the logical thinking ability of programmers. It can be divided into call registration, uplink and downlink decision-making, lift car parking, door opening and closing control, floor digital display, high-speed operation logic, etc. In order to facilitate kingview to achieve better monitoring, the auxiliary program is added.

3. KINGVIEW MONITORING OF ELEVATOR SYSTEM

Kingview is an industrial monitoring software which integrates human-machine interface (HMI) system and monitoring management system developed by Beijing Yakong Technology Development Co., Ltd. It can communicate with PLC, intelligent module, board intelligent instrument, remote data acquisition device (RTV) and other external devices. The field information can be transmitted to the control room in real time to ensure that the field operators and plant managers can see all kinds of data. Managers can obtain real-time and historical data without going deep into the production site, optimize the control of field operations, and improve productivity and product quality. Kingview has a wealth of toolbox, library and operation guide, easy to learn, widely used in industrial control. In the process of system operation, Kingview completes real-time data exchange with I/O devices depending on embedded device management program. The combination of PLC and kingview software can form a more popular monitoring system.

The success of the program debugging is the premise of the normal operation of the whole monitoring system. The design of monitoring system should be combined with PLC program, and the variable setting should correspond to the I/O distribution of PLC respectively. With kingview6.53 software of Beijing Yakong company, the elevator monitoring system is designed, including equipment configuration, graphic monitoring interface, variable database construction, animation connection, operation debugging and so on.

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3.1. Equipment Configuration

Equipment configuration is to link the communication between PLC and kingview, the PLC manufacturer, equipment name and communication mode can be direct filled in the corresponding dialog box.

3.2. Design Graphic Monitoring Interface

The graphical monitoring interface is used to simulate the actual industrial field and industrial control equipment. The task of this system is to draw the elevator simulation picture. As shown in the figure 2, the elevator simulation screen is composed of elevator shaft, lift car, hall of each floor, external call display, current floor display, internal call button, manual door opening and closing button, etc.

Fig 2. Kingview monitoring interface

3.3. Set Variables and Construct Database

Data is used to describe various properties of industrial control objects. Various variables defined by kingview constitute the database. Variables that do not need to exchange data with other applications are called memory variables, while variables that exchange data with other applications are called I/O variables. The data collected from the lower computer and the instructions sent to the lower computer, such as "internal and external call buttons" and other variables, are all included in the database It needs to be set to "I/O variable". In the running process of kingview system, whenever the value of I/O variable changes, the value will be automatically written to the remote application program; whenever the value in the remote application program changes, the value of I/O variable in kingview system will also be automatically updated. Because the system uses PLC to control the elevator, the I/O address of PLC plus a small amount of memory variables can be used to set the required variables of graphical interface. The system uses 59 variables, including 10 memory integer variables, 48 I/O discrete variables, and 1 memory real variable.

3.4. Animation Connection

Animation connection refers to the establishment of a relationship between the graphic objects on the interface and the data variables in the database. When the value of the variables changes, the animation effect of the graphic objects will be displayed on the screen; or the

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software users can change the values of the data variables through the graphic objects to realize the bidirectional control between the graphical interface and the objects. The animation connection of the system includes car, floor display, internal call button, door switch demonstration, etc.

In order to smooth the movement of the elevator car without jumping change; the opening and closing of the door also have good effect, the command language of picture attribute is followed:

```
//lift car movement
if (m150==1)
{
k3=k3+4.5;
}
if (m151==1)
{
k3=k3+7.5;
}
if (m152==1)
{
k3=k3-7.5;
}
if (m153==1)
{
k3=k3-4.5;
}
//M150 Low speed up running auxiliary relay.
//M151 High speed up running auxiliary relay.
//M152 High speed down running auxiliary relay.
//M153 Low speed down running auxiliary relay.

//Lift door open
if ((i00==1)&&(O11==1))
{
m11=m11+7;
}
if ((i01==1)&&(O11==1))
{
m12=m12+7;
}
if ((i02==1)&&(O11==1))
{
m13=m13+7;
}
if ((i03==1)&&(O11==1))
{
m14=m14+7;
}
if ((i04==1)&&(O11==1))
{
m15=m15+7;
```

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```
}
if ((i05==1)&&(O11==1))
{
m16=m16+7;
}
if ((i06==1)&&(O11==1))
{
m17=m17+7;
}
if ((i07==1)&&(O11==1))
{
m18=m18+7;
}
//Lift door closed
if ((i00==1)&&(O10==1))
{
m11=m11-7;
}
if ((i01==1)&&(O10==1))
{
m12=m12-7;
}
if ((i02==1)&&(O10==1))
{
m13=m13-7;
}
if ((i03==1)&&(O10==1))
{
m14=m14-7;
}
if ((i04==1)&&(O10==1))
{
m15=m15-7;
}
if ((i05==1)&&(O10==1))
{
m16=m16-7;
}
if ((i06==1)&&(O10==1))
{
m17=m17-7;
}
if ((i07==1)&&(O10==1))
{
m18=m18-7;
}
```

3.5. Operation and Debugging

Check the bidirectional control function of the elevator monitoring interface and the elevator hall, and observe the opening and closing, up and down and display of the elevator in the main

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screen of the elevator by pressing the actual buttons on the elevator; on the contrary, observe the opening and closing, up and down and display of the actual elevator by pressing each button on the elevator monitoring interface. With debugging, real-time monitoring can be good realized.

Fig 3. Actual rendering

4. CONCLUSION

The system uses the "kingview" made in China to realize the data collection and monitoring of elevator. The monitoring interface is clear, with strong and good bidirectional control function. The main body of elevator has open interface, which can accept the control of other types of controllers (such as ARM, MCU or PC), or use touch screen. The multi body can realize group control and fuzzy control of elevator. The concrete is rich and powerful redevelopment, which can be used as the graduation design and research of graduate students.

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