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Design of Automatic Control System of Intelligent Garage Door Based on PLC

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Abstract

This article studies the use of PLC ladder diagram programming to control the switch of the smart garage door. The system uses Mitsubishi FX series FX2N-16MR PLC, and at the same time chooses Aosheng/ AU-RK02-12 wireless remote control switch as the remote control. The owner can conveniently switch the garage door in the car. The power supply is MEAN WELL S -60-24 Single output switching power supply is used as the power supply of the garage door, equipped with buzzer, and the inside and outside of the garage are used as indicators, and finally a complete intelligent garage door control system is designed.

Keywords

Intelligent Garage Door; PLC Control System; Safety; Stability.

1. Introduction

We are currently in an era of rapid technological development. Since China has become the second largest economy in the world, the living standards of our people have been greatly improved. Private cars have changed from a luxury item to a home for every household. Affordable means of transportation have also contributed greatly to people adapting to the fast-paced life of modern society. However, the safety issue of private car parking has gradually become an annoyance in people's hearts. Traditional garage doors have many defects, such as low stability and safety, cumbersome operation, slow movements, poor sealing, short service life, and difficult maintenance[1]. In this environment, smart garage doors are gradually being known and used. With the gradual maturity of PLC technology, my country is now gradually introducing PLC technology, which has been widely used in some intelligent control fields, such as smart garage doors. Because programmable controllers have the characteristics of safety and stability, many manufacturers use programmable controllers as the control elements of smart garage doors. In today's life, with more and more private cars, the requirements for garages are getting higher and higher, and smart garage doors are becoming more and more extensive[2].

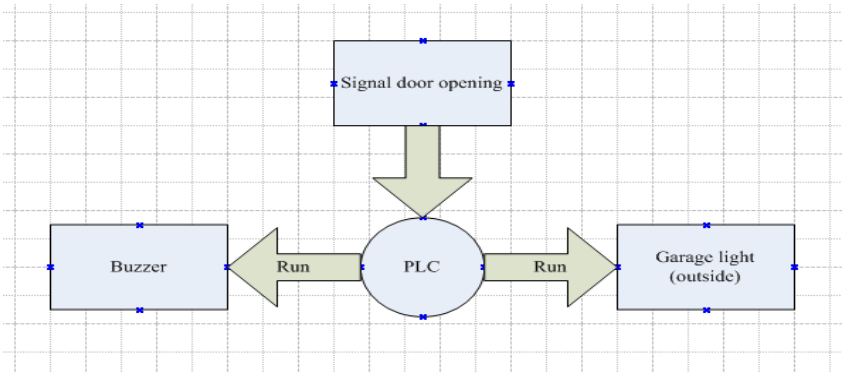

Figure 1. Flowchart of car entry and exit

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2. Design of Flowchart for Cars in and Out of Depot

When the car enters the garage, when the car travels to a certain distance from the garage, the owner presses the door open button on the wireless remote switch remote control, the receiver will send the door open signal to the PLC, and then the PLC controls the garage door to open. In order to comply with the green energy-saving development concept, the lights in the garage will be turned on after the smart garage door is fully opened, and at the same time, the lights outside the garage will be turned off [3]. The flowchart is shown in Figure 1.

3. Selection of components

3.1 Selection of remote control switch

The requirements for the selection of wireless remote control switches: the distance between the wireless remote control switches is long, and at the same time it must have high stability, strong anti-interference ability, and can be used in strong electromagnetic interference environments[4]. The control is stable, the transmitter and receiver can only be used one to one. To sum up, it is determined to choose the Aosheng/ AU-RK02-12 wireless remote control switch of Shenzhen Aosheng Technology Development Co., Ltd., as shown in Figure 2.

Figure 2. Aosheng/AU-RK02-12 wireless remote control switch

3.2 Motor selection

The motor of the smart garage door provides power to the opening and closing of the garage door, and the contactors KM1 and KM2 controlled by PLC control the forward and reverse rotation. It is very convenient to control the opening and closing of the garage door through the forward and reverse rotation of the motor. The main considerations when selecting the motor of the smart garage door are: the area and weight of the smart garage door, the local weather and climate, and the service life of the smart garage door. Brushless DC motors have greater power density (high core utilization rate), higher efficiency and better control performance[5]. If energy saving and other factors are taken into account, the user's cost will be greatly reduced. Therefore, the brushless DC motor selected in this design is the brushless DC motor of TT MOTOR. As shown in Figure 3.

Figure 3. TT MOTOR brushless DC motor

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3.3 Power supply selection

Provide power source for energy-consuming equipment, input 220V AC and output 24V DC, 24V DC power supply is the kinetic energy source of the entire smart garage door, so the output of the power supply must be stable and must have overload and overvoltage protection. International universal full range AC input, with short circuit, overload, over voltage protection, natural air cooling, 100% full load aging test, switching operating frequency 77KHZ[6]. Therefore, MEAN WELL S-60-24 single output switching power supply was selected. As shown in Figure 4.

Figure 4. Meanwell S-60-24 single output switching power supply

3.4 Selection of PLC

It can be classified from the perspective of PLC structure, which can be divided into integral type and modular type. PLC can be divided into control room-based installation and field installation in terms of usage and environment. Generally speaking, the manufacturer should choose a PLC with an appropriate word length. Due to the difference in the number of I/O points of the PLC, the functional characteristics of the PLC are also different, so if the number of I/O points remains the same, then there will be fewer options[7]. Many of them can only be used in small control systems. If they are suitable for large and medium-sized control systems, the number of I/O points needs to be selected reasonably.

When determining the PLC, the input/output ratio of the PLC must be considered, and the selected I/O points will directly affect the price of the PLC. In addition, the operating difficulty factor of the PLC system should also be considered, and finally its cost performance should be considered. After fully comparing the characteristics of each PLC, choose the PLC that is most suitable for the control system of the smart garage door. After comparing the various solutions, finally choose the overall Type PLC. To sum up, this design chooses Mitsubishi FX series FX2N-16MR, even if the I/O points are not enough, the expansion unit can be used. There are many convenient places to use Mitsubishi FX2N-16MR: flexible use, convenient control, powerful communication function, It is suitable for the use of various functions of various large-scale blocks[8]. Its execution speed is very fast and cost-effective, as shown in Figure 5.

Figure 5. FX2N-16MR of Mitsubishi FX series

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4. I/O port allocation

First, follow the circuit diagram to wire the control box and assign the I/O ports, and then turn on the power switch of the control box. In the PLC interface, set the switch to the RUN position. After setting, you can see that the current PLC is already working. Then carry out specific debugging.

This debugging process is just a simple simulation debugging. In order to detect whether the PLC system program is stable, some program fine-tuning may occur during debugging. To determine whether the final program is stable, further debugging is required to make the program more complete and stable. Record the following table. After completing the following basic debugging, the debugging of the entire system is basically completed, and the final job is the analysis of the debugging results, as shown in Table 1.

Table 1. I/O port allocation

Types	PLC elements	Function
Inputs	X0	emergency stop
	X1	Hand/Automatic transfer switch
	X2	Sensor switch (inside)
	X3	Sensor switch (outside)
	X4	Anti-pinch grating (normally closed)
	X5	Lower limit
	X6	Open limit
	X7	Opening/closing medium speed
	X10	Door closing low speed / door opening high speed
	X11	Open the door manually
	X12	Manual closing
	X13	Door closing high speed / door opening low speed
	X14	Abnormal reset
Outputs	Y1	Open the door manually
	Y2	Manual closing
	Y3	Open/close door at medium speed
	Y4	Open/close door low speed
	Y5	Open/close door high speed
	Y6	Automatic door opening light flashes
	Y7	Auto close light flashes
	Y10	Door open/close reminder
	Y11	Fault warning light
	Y12	Automatic door opening
	Y13	Automatic closing
	Y14	Abnormal stop

5. System design debugging

5.1 Network transmission settings

The program must be downloaded to the PLC before setting up the network transmission. The specific process is: first connect the PLC and the computer's serial port, and then click "Transfer Settings" under the "Online" option, and then the "Transfer Settings" page will appear. Set the PLC parameters in the setting interface. Can realize the communication between PLC and computer, and then set up other network sites, and further carry out communication test[9].

5.2 Program debugging record

First carry out the wiring of the control box and the distribution of I/O ports, and then turn on the power switch of the control box. In the PLC interface, set the switch to the RUN position. After setting, you can see that the current PLC is already working. Then carry out specific debugging.

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Table 2. Action result

PLC elements	Action record	Action result
X0	OFF	Automatic door stops working
X1	ON	The program jumps to automatic, the automatic door starts automatically
X2, X3	ON	Y12 automatic door opening, Y6 automatic door opening light flashing action
X4	OFF	Y13 automatically closes and stops, Y12 automatically opens the door
X5	ON	Y13 automatic door closing stops, Y7 door closing light stops flashing
X6	ON	Y12 automatic door closing stops, Y6 door closing light stops flashing
X7	ON	Y3 Automatic door opening/closing operation at medium speed
X10	ON	When closing door, Y4 automatic door closes at low speed; when opening door, Y5 automatic door opens at high speed
X11	ON	When X1 is OFF, Y1 manually opens door
X12	ON	When X1 is OFF, Y2 manually closes the door
X13	ON	When opening the door, Y4 automatic door opens at low speed; when closing, Y5 automatic door closes at high speed
X14	ON	Exception elimination

6. Summary

In the debugging process, the pre-designed functions and actions can be realized normally, with high reliability and convenient maintenance. The security of the smart garage door is strengthened in the process of writing the program, and the garage door is also strengthened in the program. Safety and fault prompt function of garage door. Therefore, this subject solves the extremely high stability required by the smart garage door of the garage, and the cost cannot be too high. It is an economical product that is more suitable for such occasions.

References

[1] Wang Shuang. Automatic garage control system based on PLC control[J]. Internal Combustion Engine and Accessories. 2018(17)

[2] Thabit Sultan Mohammed, Waleed K. Al-Khairi, Aamer T. Al-Jubouri, Omar S. Shamas. Development and Implementation of an Automated Car Parking System[J]. Applied Mechanics and Materials.2015 (789)

[3] Yi Ying Yu, Qing Yang, Zhang Wei Han, Li Li, Dong Liang. Planning Design of Stereo Parking Lot Based on Bionics Principle[J]. Key Engineering Materials. 2014 (621)

[4] Wang Lihong. Design of automatic garage door system[J]. Occupational Technology. 2017(02)

[5] Zhou Biying. Design of classroom intelligent energy-saving lighting system based on 89C52[J]. Electronic Design Engineering, 2015, 23(18): 83-86.

[6] Bai Xinzhuang. Discussion on PLC selection [J]. Petrochemical Industry Automation, 2005(05): 25-27.

[7] Sun Shujian. Research on parallel component extraction and parallel display method of ladder diagram [D]. Hangzhou Dianzi University, 2015.

[8] Li Min, Xia Yuewu, Qiao Bin. Design of intelligent garage door control system based on STM8 and nRF24L01[J]. Journal of Chongqing Technology and Business University (Natural Science Edition), 2014, 31(07): 81-84.

[9] Xu Hang, Li Qixiang. Design of multifunctional wireless remote control switch[J]. Electronic production. 2014 (08)

[10] Wang Jing. Design of automatic gate circuit based on PLC [J]. Digital Technology and Application, 2011 (07): 122+125.