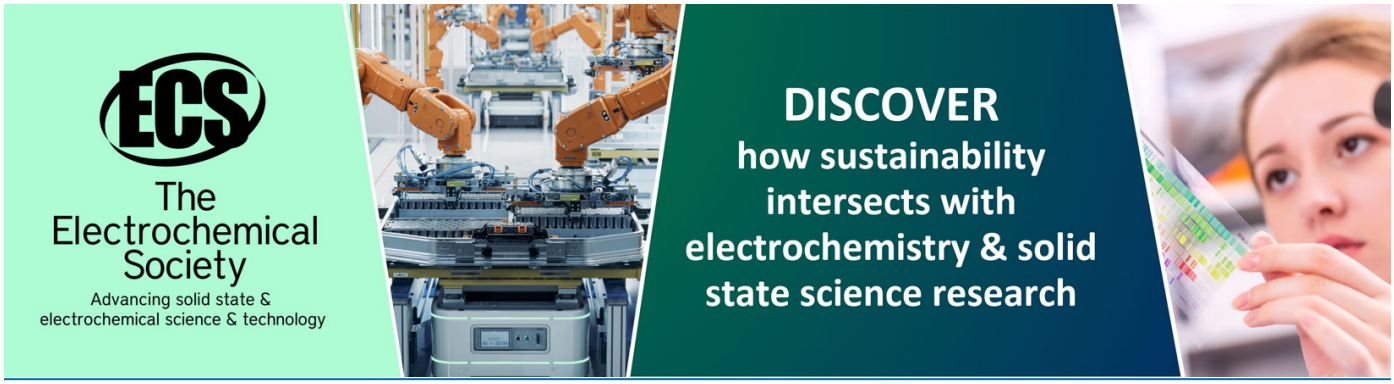
Design of Car Washing Control System Based on PLC



Design of Car Washing Control System Based on PLC

Yanan Meng, Xiaoyan Hu*, Feng Qi and Zhimin Chen

Jilin Institute of Chemical Technology, Jilin, China

*Corresponding author e-mail: 779078328@qq.com

Abstract. In order to improve the efficiency of car wash and reduce the labor intensity of car washers. According to the process flow of automatic car washing and its characteristics of simple operation, high efficiency, convenience and stable operation, an automatic car washing control system based on PLC is designed, and WinCC configuration software is selected as the upper computer as the man-machine interface design. The simulation results show that the system has strong stability, improves the automation of car washing and meets the actual needs.

1. Introduction

With the rapid development of science and technology in today's society and the improvement of human living standards, the number of private cars and buses is increasing day by day. At the same time, car washing services also emerge. Due to the large number of cars, there may be some uncertainties such as waste of water, time-consuming, inefficient and so on in manual car washing, so the automatic car washing industry is becoming more and more popular and has gained a firm foothold in the fierce competition in the market tide. The development of automatic car washing control system can meet the needs of more people and improve the competitive advantage of our country in the automatic car washing industry. In many car wash control systems, the mainstream control methods are PLC and single-chip computer. PLC has the advantages of flexibility, versatility, strong anti-interference ability and convenient maintenance[1]. At the same time, the current automatic car wash control system mainly includes door-frame Reciprocating Car wash and brushless car wash. The choice of this time is gantry car wash.

2. Overall Scheme of Car Washing Control System

The automatic car washing control system is mainly composed of upper computer, PLC and field I/O equipment. The structure sketch of the control system is shown in Figure 1. After starting the horizontal drum to reach the position to be washed, the photoelectric detection switch on the top of the car is connected and ready to be pre-washed with clean water. After the pre-wash starts, the portal frame begins to move from the front to the rear, and the water pump starts to spray clean until the portal frame reaches the rear of the car and then moves to the front to complete the pre-wash, so as to achieve the effect of descaling. After that, foam cleaning is started with the same way as the pre washing method, and then rinse and dry again. Because the water stains on the car body can easily absorb dust, it is necessary to use a dryer to dry the water after washing to ensure the long-term cleaning of the car body.

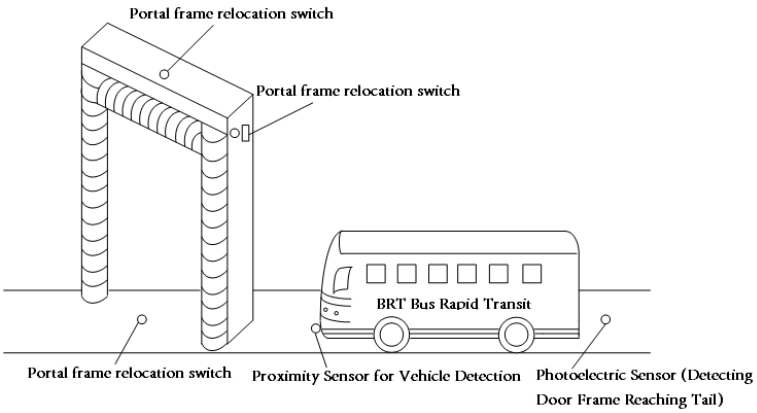


Figure 1. Structure diagram of automatic car washing control system.

The whole control system is controlled by PLC. It uses automatic control and manual control to wash the car. In the manual control state, it can choose which control process to carry out. In the automatic state, the system will control the next process automatically according to the corresponding time of each control process, and the end of time will control the next process automatically.

The automatic car wash control system should select the working mode according to the actual situation when using, the working process of the two modes is as follows:

The type of car washing is optional, but the car washing process contains 3 processes: foam cleaning, rinsing and drying. If the switch is placed in the manual mode, press the start button to perform the foam cleaning. According to the flushing button, clean water is carried out; the air dry button is used for air drying; the end button is used to finish the car washing operation. If the mode switch is placed in the automatic mode, press the start button to perform the car wash process (foam cleaning 20s→clean water 30s→air dry 15s→ end→return to wait for cleaning). At the end of the car washing process, the bell should be ringing. If the stop button is pressed at any time, the car washing operation will be stopped immediately. The process flow chart of the automatic car washing control system is shown in Figure. 2.

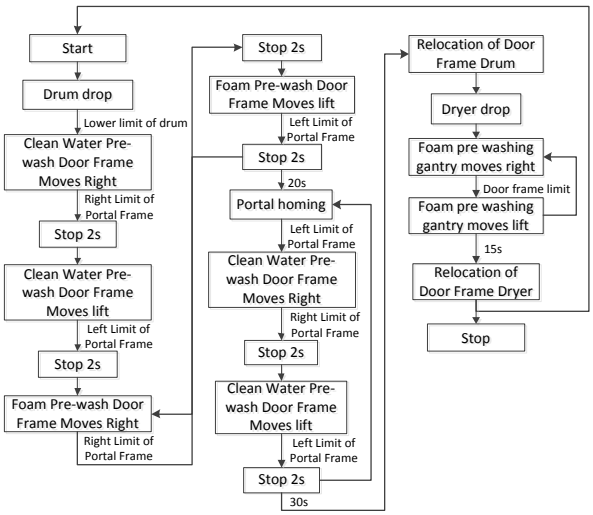


Figure 2. Process flow of automatic car washing control system.

The two working modes of the automatic car washing control system can meet all kinds of requirements of the car washing site. For some vehicles with more dirt and grease stains, the automatic control mode can not be completely cleaned, so the manual control mode can be chosen. In this way, the cleaning time can be reasonably controlled according to the requirements of vehicle cleaning, so as to achieve the effect of complete cleaning.

3. Model Selection of Control System

3.1 I/O Address Allocation

According to the functions and requirements of the car washing control system, part of the I/O address distribution of the control PLC is obtained as shown in Table 1.

Table 1. I/O Address.

Input		Output	
Name	Address	Name	Address
Start button	I0.0	Door frame shift right	Q4.0
Stop button	I0.1	Door frame shift left	Q4.1
Portal frame right limit switch	I0.2	Drum drop	Q4.2
Portal frame left limit switch	I0.3	Drum rising	Q4.3
Roller upper limit switch	I0.4	Drum rotation	Q4.4
Drum lower limit switch	I0.5	Drum reversal	Q4.5
Upper limit switch of dryer	I0.6	Dryer Rise	Q4.6
Lower Limit Switch of Dryer	I0.7	Dryer drop	Q4.7
Automatic Selection Switch	I1.0	Foam jet pump	Q5.0
		Clean water pump	Q5.1
		Dryer	Q5.2

3.2 Selection of PLC

The selection of PLC should be analyzed comprehensively from the aspects of PLC capacity, power supply, machine type, communication networking ability, I/O module and special function module. The basic principle of PLC selection is to ensure that the control function and maintenance convenience are satisfied, and to strive for the highest cost performance. When selecting the type, we should mainly consider such factors as meeting the corresponding functional requirements, reasonable structure, suitable installation mode, meeting the requirements of response speed and ensuring reliability, and achieving the unity of the model[2].

Through the analysis of the structure and function requirements of the automatic car wash control system and the allocation of I/O addresses, the CPU selected is Siemens S7-300 series CPU315-2DP. Besides centralized I/O structure, it can also be widely used in distributed automation structure. It has the most MPI channel multi-point interfaces, as well as data backup function and password protection function. The input module and output module adopt SM321 and SM322 respectively, which can fully meet the requirements of the automatic car washing control system.

4. Software Design of Control System

4.1 Lower Computer Program

The logic control program of automatic car washing control mainly includes the following modules: water pre washing procedures, foam cleaning procedures, rinsing procedures and drying procedures. The control flow chart of the drying program is given here. Initially, the system should be initialized. When the vehicle moves to a fixed position, the photoelectric monitoring switch identifies it. When the drum drops to the designated position, the portal frame moves to the rear while the horizontal drum and the vertical drum rotate at the same time. When the portal frame reaches the rear part of the vehicle, the horizontal drum and the vertical drum rotate back. When the vehicle moves to a fixed position, the photoelectric monitoring switch identifies. When the drum begins to descend to the designated position, the portal frame moves to the rear along with the horizontal drum and the vertical drum will rotate forward at the same time. When the portal frame reaches the rear of the vehicle, it will return, while the horizontal drum and the vertical drum are reversed. During this period, the dryer runs synchronously with it, dries the moisture on the body of the vehicle, and when the portal frame returns. When the portal frame is returned, the dryer also returns to the upper limit[3,4]. The control

process of pre washing, foam cleaning and flushing is as continuous as this process. The flow chart of automatic drying is shown in Figure 3.

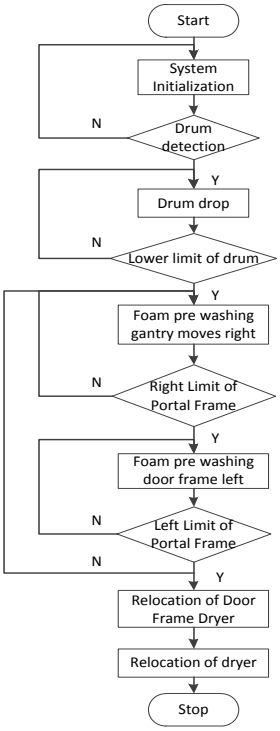


Figure 3. Auto-drying flow chart.

At the same time, for the convenience of programming and later debugging, the control system adopts modular programming structure, and the ladder diagram of manual automatic program in drying process is shown in Figure 4.

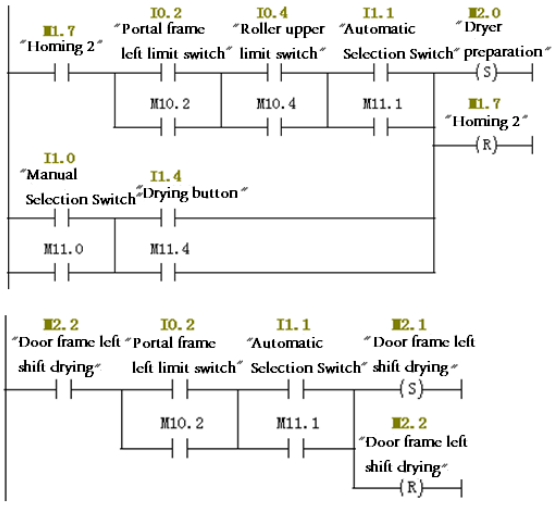


Figure 4. Hand-operated trapezoidal diagram of drying process.

4.2 Realization of Supervisory Control Function of Upper Computer

The upper computer program of the system focuses on real-time monitoring and alarming the parameters of the lower computer, and facilitates the operator to detect and control the whole process by means of visual interface. WinCC configuration software is used in system monitoring, which has the advantages of simplicity, high efficiency and powerful function. Firstly, the communication between upper and lower computer is realized by MPI communication cable. Then the control parameters in the monitoring interface are corresponded with the variables in Step7 project. The monitoring interface developed according to the functional requirements is shown in Figure. 5. The

interface shows the working status of the portal frame moving, the functions of a certain process in cleaning, start/stop, manual/automatic, start and stop of the pump and ringing prompt, which can be displayed on the touch screen.

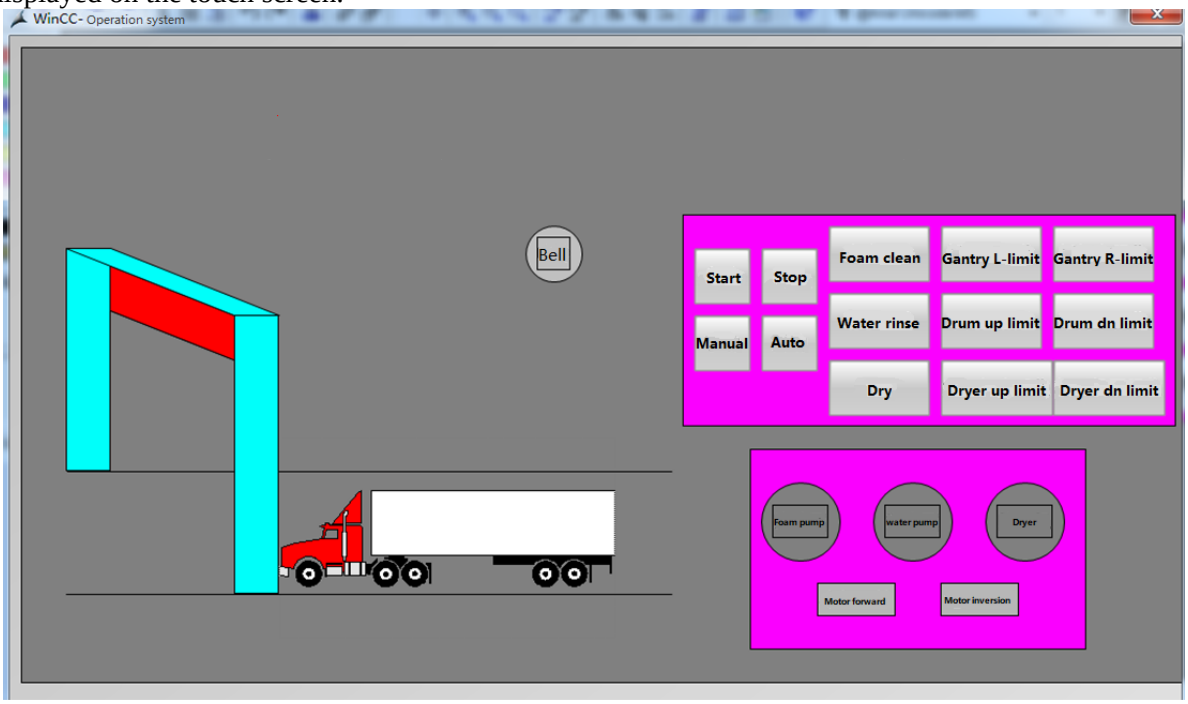


Figure 5. System monitoring interface.

5. Debugging of System Operation

System operation debugging is to test whether the functions of PLC program and configuration monitoring system meet the control requirements. It is divided into debugging of PLC program part and debugging of configuration monitoring function. In the process of debugging the PLC program, the problems found in the debugging process need to be investigated one by one, and constantly revised and improved until the debugging is successful. In debugging, it is mainly about whether the control buttons in the configuration interface act, whether the color displayed by the buttons is consistent with the running state, and whether the buttons act in accordance with the control tasks. After debugging, it shows that the system has strong timeliness and is easy to operate, but in the actual debugging process, the phenomenon of photoelectric switch induction delay may occur.

6. Conclusion

This design is based on PLC automatic car wash control system, which has high efficiency, strong stability, low cost, greatly improves the car wash efficiency and automation, and can realize the switch between manual and automatic modes. The PLC controller is stable, reliable, easy to maintain and compatible. It can work in various environments. At the same time, the visual mode of WinCC is easy to monitor and operate. The automatic car washing control system not only cleans all aspects of the vehicle, but also adapts to many types of vehicles, and has practical application value.

References

[1] X.D.Wang, Design of Integrated Automation Control System, Electrical Age. 6(2011) 118-120.
[2] S.P.Ji, Siemens PLC and Industrial Network Technology, Xi'an: Machinery Industry Press, 2008.
[3] G.X.Zhu, Control system of train automatic cleaning machine based on PLC and configuration software, Electrical technology, 2010(6), pp.30-31.
[4] T.Y.Zhang, S.Ma, Z.Liu, Design of Automatic Car Washing Control System Based on PLC, Mechanical Engineering and Automation, 2018(4), pp.177-179.