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Design of Automatic Distribution System for Storage Logistics Trolley

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Abstract

In order to improve the automation of warehousing and logistics distribution, the design and development of warehousing and logistics trolley automatic distribution system is realized with the cost-effective PLC control module as the core. Through the simulation test, the logistics trolley distribution system based on PLC as the control core and supplemented by human-computer interaction, signal acquisition, safety protection, vehicle drive and other modules has high efficiency, good real-time performance and strong portability, and has a wide application prospect.

Keywords

Logistics; Automatic Distribution.

1. Introduction

The project research involved in this paper originates from the actual demand of the general project of the 2021 innovation and entrepreneurship training plan for college students in Jiangsu Province - "Automated medical logistics warehousing system based on robot intelligent sorting" platform. The platform integrates the PLC control core module, sensor module, logistics trolley, safety assurance module, human-machine switching module, etc., which can complete the automatic distribution task between the stations under the internal environment of logistics warehousing, while giving consideration to the human-machine seamless switching under different working conditions, emergency stop state locking and overrun safety assurance.

2. Requirements of Automatic Distribution System

2.1. Description of Automatic Distribution System

Table 1. System Control Requirements

Control demand	Function description
1. Power on automatic reset	The trolley can automatically return to the original point at any position (running state) and wait for the start signal.
2. Manual/automatic switching	Set start/stop control (automatic state) and forward/backward selection (manual state).
3. Automatic cycle	After the system is started under automatic status, the delivery vehicle starts from the origin, arrives at each station in turn, returns to the origin in reverse order, and waits for a new start signal. The dwell time of each station is initially set by the system.
4. Automatic cycle automatic reset	When the system receives the stop signal, if the trolley is at the station, it will continue to stop and wait; If the trolley is on the way, stop it after arriving at the station; Continue the original process after the start signal is detected again.
5. Emergency stop protection	When the system detects the emergency stop protection signal, it will stop immediately. After the emergency stop signal is reset, it needs to recover to the current state and continue to operate.
6. Manual intervention	After the system is switched to the manual state, the distribution trolley can be manually controlled to move forward or backward.
7. Limit protection	When the system is running, the trolley realizes position protection by starting and ending limit.

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The automatic logistics distribution system is composed of rails, distribution vehicles, sensors and protection modules. Set the starting point, set N distribution stations on the way (3 stations are simulated in this paper), and install limit protection modules at the end. The distribution trolley is controlled by the drive module, and operates reciprocally between the starting point and the destination, which can realize automatic distribution at each station.

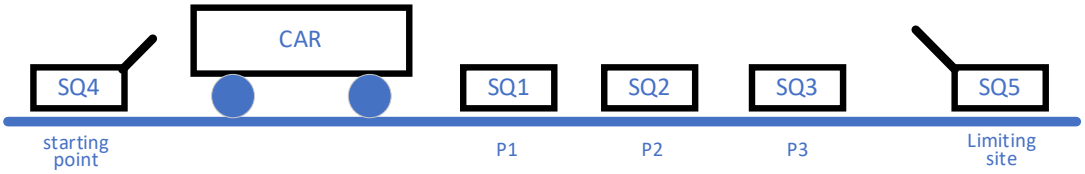

Figure 1. Schematic Diagram of Automatic Distribution System

2.2. Automatic Distribution System Control Demand

The trolley running along the track is used as the distribution carrier to realize the logistics transportation of each distribution station between the starting point and the terminal. The specific control requirements are shown in Table 1.

3. Research on Control Strategy

Table 2. I/O allocation of automatic distribution system

I/O allocation of automatic distribution system					
Input				**Internal register**	
X0	QS0	Emergency stop	M1	Forward conditions	
X1	SQ1	P1	M2	Fallback condition	
X2	SQ2	P2	M10	Stop condition	
X3	SQ3	P3	M11	Emergency stop conditions	
X4	SQ4	Starting point			
X5	SQ5	Right limit	**Timer**		
X6	SB3	Manual forward	T1	Forward P1 Time	
X7	SB4	Manual Backward	T2	Forward P2 Time	
X10	SA1	Manual/Automatic	T3	Forward P3 Time	
		X10 Manual	T4	Backward P2 Time	
		~X10 Automatic	T5	Backward P1 Time	
X11	SB1	Start-up			
X12	SB2	Stop			
Output			I/O allocation table		
Y1	KM1	Forward			
Y2	KM2	Backward			
Y10	LED0	Origin indicator			
Y11	LED1	P1 indicator			
Y12	LED2	P2 indicator			
Y13	LED3	P3 indicator			

According to the functional requirements of the system, PLC is selected as the main control module; The distribution trolley traveling along the track realizes two-way traveling through the drive module; Take the travel switch as the position protection; Station signal acquisition is completed through photoelectric sensor; Set human-computer interaction module (including

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change-over switch, control button, emergency stop button, etc.) to assist in system function control. The specific system control function block diagram is shown in Figure 2 below.

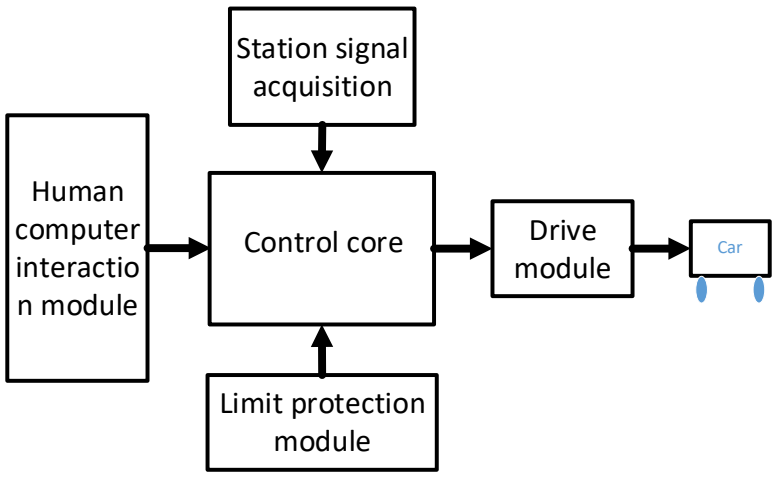

Figure 2. System Control

4. Hardware Resource Configuration

Hardware resource configuration selects Mitsubishi FX series PLC as the control core according to the functional requirements, and flexibly configures the baud rate of communication between PLC and computer, the proportion of timer and counter in PLC, input filter delay, PLC power down holding storage area and other parameters according to the site conditions[1].

4.1. System I/O Allocation Table

It can be seen from Table 2 that the I/O resources of the selected PLC shall not be less than 16 points, and the internal configuration is equipped with power down latch registers and timers.

4.2. Hardware Resource Wiring Diagram

The system wiring diagram is shown in Figure 3. The actual wiring on site shall comply with the safety operation regulations of electricians; The device layout shall be reasonable, and the installation shall be correct and tight; The wiring is beautiful and tight; Switch value and input/output address shall be clearly marked on the wiring point [2].

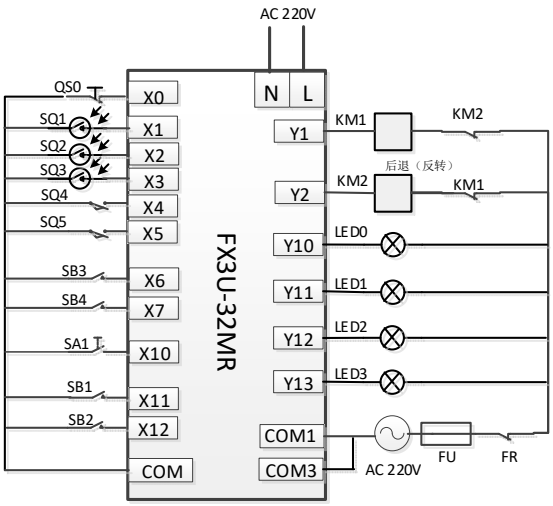

Figure 3. System wiring diagram

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5. Program Module Design

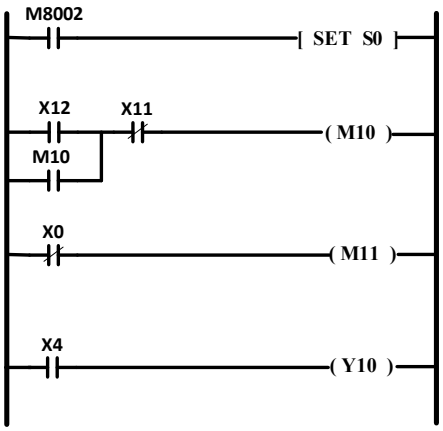

Figure 4. Ladder statement module

In this paper, GX Works2 supporting Mitsubishi is selected to complete the development of the source program design, and GT Designer 3 is used for simulation verification. Such program development combination gets rid of the shackles of the hardware environment, with flexible configuration and accurate operation results[3]. The specific programming adopts SFC+ladder diagram bilingual sentence module.

5.1. Ladder Module

This module is mainly used for system power on initialization and locking system stop signal and emergency stop protection signal. The ladder module program language is shown in Figure 4, and the I/O resource configuration of PLC is shown in Table 2.

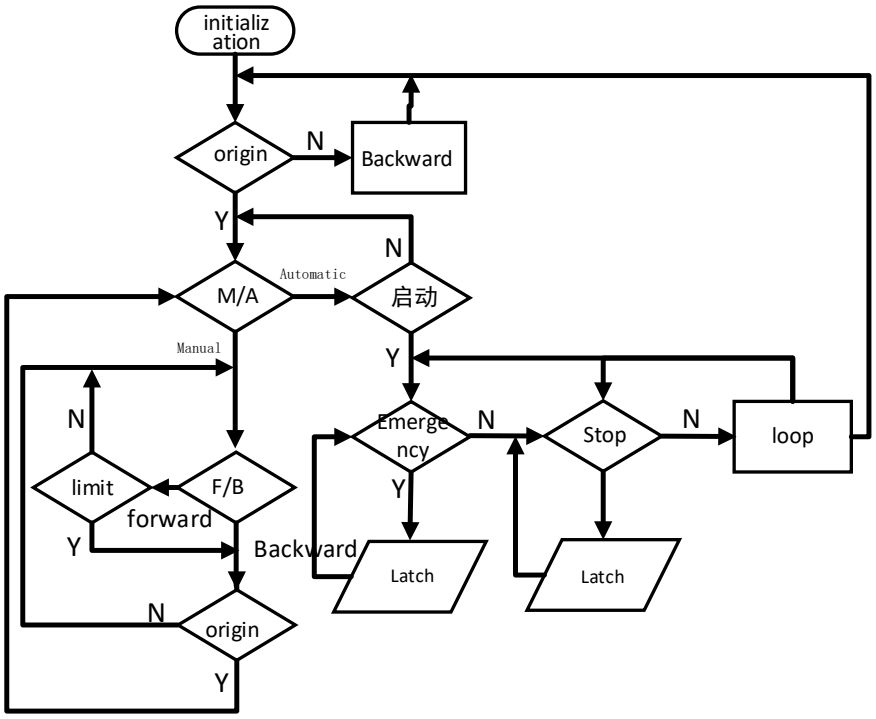

Figure 5. SFC Process

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5.2. SFC Module

SFC process is shown in Figure 5, and operates autonomously according to the cycle flow of "starting point → entering station 1 → delayed waiting at station 1 → entering station 2 → delayed waiting at station 2 → entering station 3 → delayed waiting at station 3 → exiting station 2 → delayed waiting at station 2 → exiting station 1 → delayed waiting at station 1 → starting point". During this period, emergency stop protection, stop latch, limit protection and other breakpoint monitoring and return shall be set, and the on-site protection and recovery mode under abnormal state shall be realized in combination with PLC internal state latch memory. The waiting time at the station calls the internal timing/counter of PLC, and realizes the independent adjustment of the dwell time through the initialization and setting parameters of the program to meet the needs of different logistics distribution occasions.

6. Concluding Remarks

After the completion of the system design, it successfully passed the loading verification test of the warehousing logistics platform, which proved that the "automatic distribution system of warehousing logistics trolley" completed in this design has the advantages of intelligence, high efficiency and good real-time; At the same time, the modular design ensures the portability of the system and has a broad application prospect.

Acknowledgments

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