外 文 翻 译

毕业设计题目：基于 PLC 的机械手控制

原 文 1 ： The research of automatic mold manipulator control system on PLC

译文 1：研究模具机械手控制系统自动控制

原文 2：PLC Controlling System of Transportation Manipulator and Simulation Debugging

译文 2：PLC 控制系统的运输机械手和仿真调试

The Research of Automatic Mold Manipulator Control System on PLC

Abstract—Automatic mold manipulator control system uses Mitsubishi FX2N series PLC as the control core, KINCO servo system as the main control object, and MCGS touch screen as the terminals. By the use of the external sensors to detect the trigger signal and drive the actuator, and then the manipulator can auto-complete the four process flow operation: feeding Drawing - Anti-pulling – Punching in each position, which is capable to avoid the risk of manual operation and the shortcomings of low productivity, achieve automation and intelligent of the production, and improve the product quality.

Keywords—PLC, Servo-system, Automatic mold manipulator

I. INTRODUCTION

As the essential tool for cold machining, the punching is widely used in nowadays. The tradition punching is controlled by manual, which is low effective and high dangerous. In this paper, the electrical control system for the manipulator is designed, which makes it possible to cooperate punching and manipulator to achieve the automachining of the mold. It is of great use to steady and improve production quality, raise product efficiency, improve the working conditions. It mainly includes three way of controlling in the robot, which is based on relay, PLC, or computer. While relay control system is prone to malfunction and poor at flexibility, computer control system lacks the ability of anti-interference and is complex to design, but the PLC control system is reliable at operation, easy to maintenance, strong at antiinterference, and energy saving, which makes it the most widely used control plan in the punching control system.

II. THE OVEROLL SCHEME OF THE CONTROL SYSTEM

It mainly includes three parts in the automatic mold manipulator control system: automatic loading system,robot system, and display system. Depending on the function demand of the manipulator, in this study, embedded computer touch screen is used as the upper machine, Mitsubishi FX2N Series PLC is used as the lower machine, servo system and the solenoid valve are used as the main actuator, and the magnetic switches and photoelectric sensors are used as detection element. The overall scheme of the control system is shown as Fig2.1

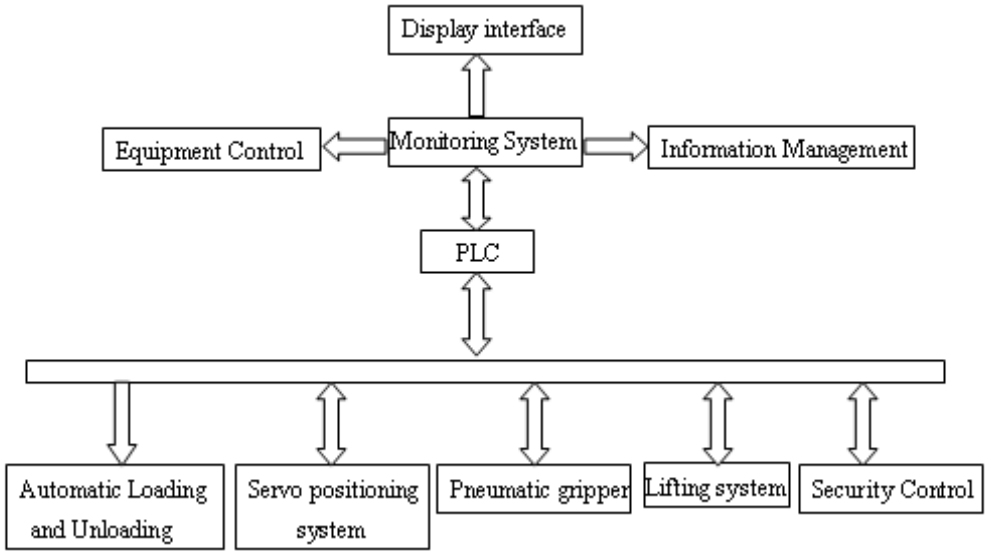

Fig2.1 Schematic of the manipulator control system

As the system's upper machine, that is monitoring system, embedded computer touch-screen is mainly responsible for device status animation display, debugging control, alarm information, production records, etc.; the monitoring system communicates with PLC via serial port, sending information and accepting control commands of the system communicates with PLC via serial port, sending information and accepting control commands of the equipment send by PLC through this interface. PLC control system, as the upper machine of the control system, is the core of the whole control system. Its function is to achieve signal acquisition, automatic load-unload control, servo positioning control, pneumatic gripper control, upwarddownward control and security systems control, etc. It mainly includes magnetic switch and photoelectric sensor signal acquisition in signal acquisition, these signals are send to PLC, which is of great importance to the reliable and safe operation of the control system; automatic loadunloading control is actualized by the control of vibrating loading and robot rotation by the PLC; servo positioning control is the critical and core issues of the whole control system, which is mainly achieved by program for the PLC and servo drive; pneumatic gripper control and upwarddownward control are achieved by control the solenoid valve; to realize security control, it is needed to coconsiderate each factor and program for the PLC.

III. ALLOCATION OF THE HARDWARE CONTROLSYSTEM

A. Hardware requirement of Control System Main functions of Control System are to achieve precise control of automatic mechanical movement, which basically include the overall rotation manipulator position servo control, to shift the workpiece manipulator clamp / open motion

control, motion control solenoid lessons of raw materials, machinery and hand movements control, punch press stamping control. Control system hardware design must meet the following requirements:

(1)To achieve the rotation system's high precision position servo system, the angle error should less than ±0.2%;

(2)When pneumatic manipulator moves the semi-finished workpiece, it must be accurate clamping every time, make sure it is stable and reliable in the rotation process;

(3)If the process of moving the workpiece is unusual, such as the items were falling or in incorrect position, it must stop stamping automatically and alarm immediately.

(4)Good security and maneuverability. The hardware block diagram of Auto Mold Manipulator Control System has been shown in Figure 3.1, various switch-type sensor passes the device status to PLC (such as the state of mechanical hands, the workpiece location) for processing, then the CPU will do all sorts of computing processing, in order to achieve real-time controlling on executing agencies. Fig 3.1Block diagram of control

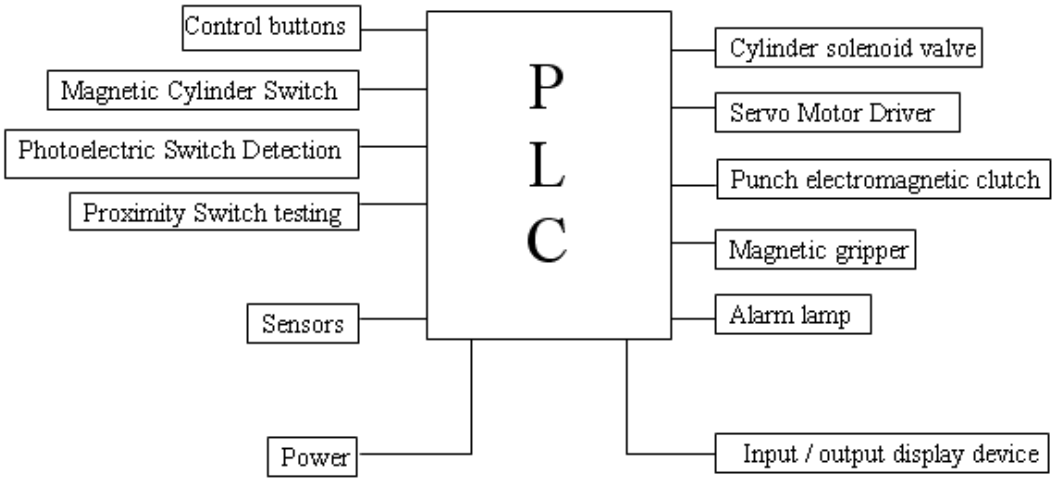

Fig 3.1Block diagram of control system hardware

B. Allocation of Main Hardware

(1)Using FX2N Series PLC as the core controller, it can achieve the device automatically controlling, and output the information after real-time processing of a variety of state. The input signal received by the sensor equipment shows the working conditions of the devices, through real-time processing to achieve a variety of pneumatic valves motion, servo motor action and electromagnet movement.

(2)Servo systems are generally closed-loop control; its control block diagram has been shown in 3.2. First, usingoptical encoder detects the servo motor's positionθ0, and then sending the data to control processing, so that it can compose a negative feedback closed-loop control system with a given position θi of the servo motor. The working process of closed-loop control system shows as follows: first of all, set a given objectiveθias servo motor's position, so controllers sent pulse commands to servo motor and make it turn to the target location, that is, sending out a certain number of pulses, we can read the actual location of the servo motor with the help of photoelectrical encoder's counting pulses. Due to load disturbance or other non-linear factors, if the actual location of the servo motor has a deviation with the given location, and this deviation (△θ=θi－θ0) is not equal to 0, the motor pulse number can be adjusted through setting the algorithm controller, so that the actual location outputθ0 of the system can be subject to a given target location.

According to previous analysis, the result can be drawn: This servo control system is a position changing system, it uses the photoelectric encoder to detect the physical location of the system in real-time, through the controller to adjust the location of the system, to reduce the deviation between the actual position and target location, and make sure the control system with simple structure.

The controlling of position servo system is the most critical part of the system; its control can affect that: whether the equipment could run smoothly and successfully. In this research, KINCO ED series of servo system will be choose to achieve automatic mold manipulator rotating position and angle control, the internal of this drive integrates drive, control, bus, I / O functions and so on, and it can store 256 programs internally, each program also can be stored a kind of movement curve, including acceleration, deceleration, maximum speed, target location and other important parameters of the movement curve, through the eight I / O ports, it can achieve a maximum of 128 movements curve's direct transfer, while with the communication function which is supported by ED, external controller can also call 256 internal storage procedures in ED, and changes the parameters inside drive system

(3)In order to ensure the detection of equipment's working conditions is reliable, the sensors must be selected and installed reasonably, and ensure that the correct sensor signal can be sent to PLC. The system will chose themagnetic switch sensors based on the detection of cylinder, it can be

easily installed on the cylinder surface; for the detection of workpiece position, the inductive proximity switches sensors will be selected to prevent interference with the signal and ensure reliable data; for electromagnetic detection of the arm, it will use photoelectric sensors.

IV. SOFTWARE DESIGN OF CONTROL SYSTEM

The important objective of the Control System is to achieving the continuous operation on Automatic Mold Manipulator System, meanwhile it must consider the functions of the program pursued is with high integrity and reliability, using modular design of the PLC control program, and make sure the system's mechanical movement running sequentially and reliably. In the hardware system with limited resources, it can achieve all the completed functions and guarantee the system going safely and reliably.

A. Fundamental principle of PLC Program's Implementation

After PLC is power-on, CPU will do internal process first under the supervision of the system program, it includes hardware initialization, I / O module configuration checks, keeping the scope of power outages and other initialization setting processing. Before implementing the user program, the check of communication services and self-diagnosis will be completed. In the communications services stage, PLC should be completed communication with a number of intelligent modules and other peripherals, and also complete the data receive and send tasks, respond to programmer typed command, update the contents of the program's displays, update the contents of the clock and special registers, etc. The work principle shows in Figure 4.1 as below:

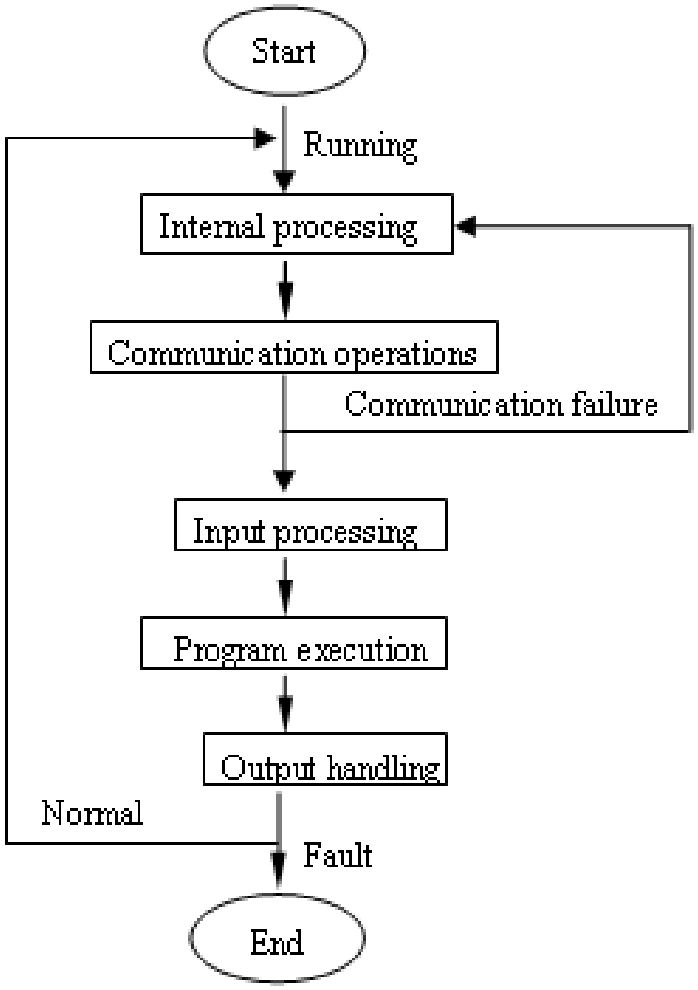

Fig4.1 Working process of PLC

B. Achievement of PLC Program

PLC programming is commonly used in modular programming to achieve the overall function; this method has the following advantages:

(1)Clear structure, similar to the function in C language, readable, easy to modify in debugging;

(2)The program can be standardized; especially some features can be compiled into a standard procedure;

(3)Various modules of the program can be written and participated by many people, reduce program development time; For Mitsubishi Series PLC, its program is modular; the fundamental way is to use subroutines, the control system can call the program modules of subroutines in an appropriate time, the control system program mainly constituted by some modules shown as Figure 4.2:

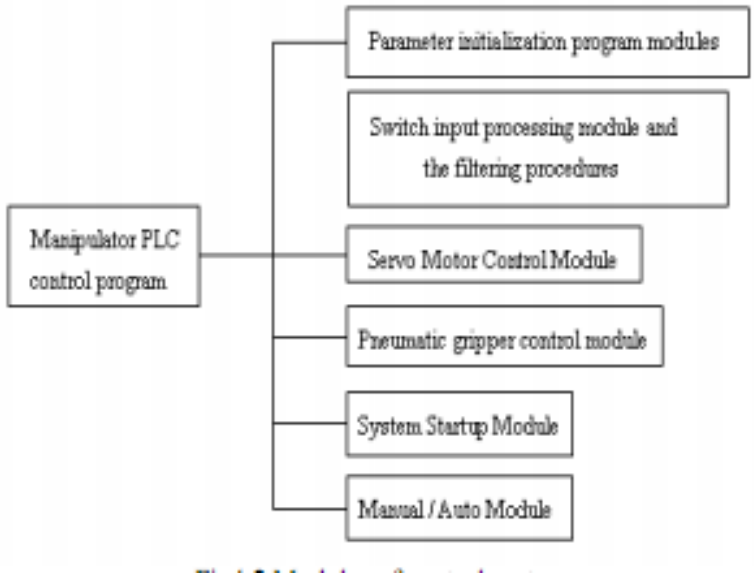

Fig4.2 Modules of control system

V. PROBLEMS AND SOLUTION DRINGDEBUGGING STAGE

On-site commissioning is one of the most important aspects in PLC control system design; it must be with rational planning and strict requirements. Debugging process is very cumbersome and complex, all kinds of unexpected issues often arise, such as the problems on debugging inductive load. In the Control System, it often uses inductive load such as intermediate relay and electromagnet, due to inductive load can produce back-EMF voltage at the moment when the power is turned on or off, this voltage peak may be damaged or generate additional magnetic coils, thus affecting the normal debugging, therefore, during the stage of designing and debugging this type of load, certain measures must be made in order to prevent the back-EMF voltage affect the Control System and cause adverse effects. When electromagnet is powerdown, the magnetic power cannot be eliminated rapidly, which might lead to the materials cannot be put in exact location in time, and affect the normal operation of ControlSystem. In debugging stage, the diodes, which are satisfying the requirement of the equipment, can be opposite and paralleled connection with electromagnet, the previous problem will be solved perfectly.

VI. CONCLUSION

This paper presents the automation on stamping manipulator device, this equipment can instead of manual operation, improve the working environment, however, from the perspective of controlling technology, there is still much work to be done. Currently, the technology based on PLC control has developed on intelligent and network-based direction. The application research of

PLC control technology in intelligent control and large-scale network control will become the future research directions. The problems exists on debugging stage of control system should be studied in-depth and explored. Sum up the order, study new algorithms and approaches, combine the mechanical design and control system genuinely, and that will be able to achieve a better quality of actual control.

ACKNOWLEDGMENT

Thank for the directive in Hebei province in natural science research programme project: zinc-air battery pole tablets stem thickness inlaid into the shaping of the study of on-line detection technology，which support this article.The funding project is 2009317.

Thank for the Natural Science Foundation of Hebei Province , which support this article. The funding project is E2009000096. REFERENCES

[1] Chen Li-ding. Principle and Application of Electrical Control and Programmable Logic Controller [M].Beijing ： china machine press,2005.1

[2] Chen Li-ding,Wu Yu-xiang,Su Kai-cai. Electrical Control and Programmable Logic Controller.Guangzhou: South China University of Technology Press,2001.2

[3] Shi Guo-sheng. Electrical Control and Programmable Logic Controller Technology [M].Beijing: Chemical Industry Press,2004.2.

[4] Ma Hong-qi, Chemical Industry Press. Mechatronics, 2003,(4):36-37

[5] Zhou Wan-zhen,Gao Hong-bin. PLC analysis and design application [M].Beijing: Electronics Industry Press,2004.1.

[6] Liao Chang-chu. FX Series PLC Programming and Applications [M].Beijing: Machinery Industry Press, 2005:141-188

[7] P.Cleaveland.Programmable Controllers Adapt to New Industry Needs[J].Control Solutions,2001,(4):47-50.

[8] Frey G,Litz L.Formal methods in PLC programming[C].IEEE International Conference,2000,(4):2431-2436.

基于 PLC 的自动模具机械臂控制系统的研究

摘要：自动模具机械臂控制系统使用三菱 FX2N 系列 PLC 为控制核心，KINCO 伺服系统的主要控制对象，和 MCGS 的触摸屏端子。通过外部传感器来检测触发信号，驱动执行器，然后操纵可自动完成四个过程流程操作：检测—绘图—抓取—到每一个位置，这是冲切能力，以避免手工操作的风险和生产效率低的缺点，实现自动化智能的生产，提高产品质量。

关键词：PLC，伺服系统，自动模具操盘

一.导言

由于冷加工的必不可少的工具，冲压在时下广泛使用。传统冲压手动控制，这是低效益和高危险的。在本文中，为电气控制系统机械臂的设计，这使得它可以通过机械手冲压，实现自动加工模具。是大幅度的稳定和使用提高生产质量，提高生产效率，改善劳动条件。

它主要包括三个机器人的控制方式，这是基于继电器，PLC 或计算机的。然而继电器控制系统是容易出现故障，计算机控制系统缺乏抗干扰能力并且设计复杂，但 PLC 控制系统可靠的操作，易于维护，抗干扰强，节能，这使得它最广泛应用于冲压控制系统的控制。

二.OVEROLL 计划的控制系统

它主要包括三个部分在自动模具机械臂控制系统：自动装填系统，机器人系统和显示系统。根据机械手的功能需求，在这项研究中，三菱 FX2N 系列 PLC 机作为上层嵌入式电脑触摸屏，伺服系统和电磁阀被用作主要执行机构和磁性开关光电传感器作为检测元件。

图 2.1 所示为控制系统的总体方案

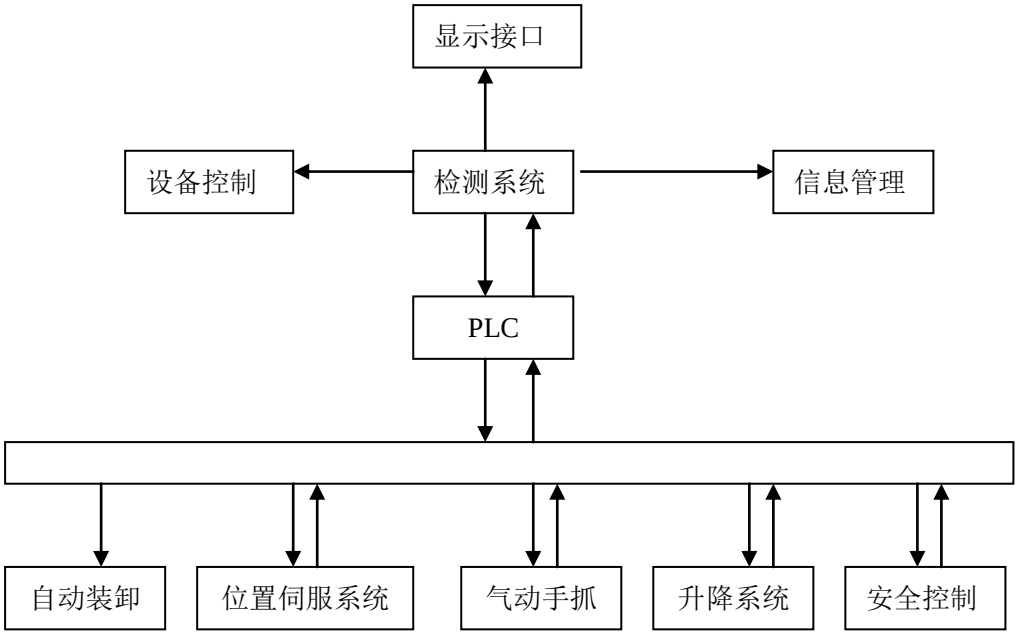

图 2.1 示意图的机械臂控制系统

嵌入式计算机触摸屏是主要负责设备状态动画显示，调试控制，报警信息，生产记录等;监控系统通过串口与 PLC 通信，发送信息并接受系统的控制命令通过串口与 PLC 通信,发送信息和接受设备的控制命令发送 PLC 通过这个接口。PLC 控制系统，作为上位机的控制系统，是核心整个控制系统。它的功能是实现信号采集，自动负载卸载控制，伺服

定位控制，气动夹持器控制，上下控制和安全系统控制等。主要包括磁开关和光电传感器信号采集信号采集，这些信号发送到 PLC，这是非常重要控制系统，保证系统的安全运行;自动控制是由 PLC 实现控制伺服定位加载和机器人旋转,PLC 控制是整个控制的关键和核心问题系统，这方案主要是由 PL 实现和驱动伺服驱动器，气动夹持器控制和上下控制达到控制电磁阀;实现安全控制，需要考虑到每个因素和 PLC 程序。

三．预算分配对硬件的控制系统

A.控制系统的硬件要求

控制系统的主要功能是实现精确控制的全自动机械机芯,基本上包括整体的旋转机械手位置伺服控制，转向工件操纵钳/打开运动控制，运动控制原材料的电磁材料，机械和手部动作控制，打孔按冲压控制。控制系统硬件设计必须满足

以下要求：

（1） 实现轮换制度的高精度位置伺服系统，角度误差应小于±0.2%;

（2）当气动机械手移动的半成品工件，必须每次准确地夹紧，确保它是在旋转过程中稳定可靠;

（3）如果移动工件的过程中是不寻常的的项目，如下降或不正确的位置，必须停止冲压自动和立即报警。

（4）良好的安全性和可操作性。汽车模具机械手的硬件框图控制系统已在图3.1所示，各种

开关型传感器传递到PLC设备的状态（如机械手的状态，工件的位置）处理，然后CPU会做各种计算处理，以实现实时控制执行机构。

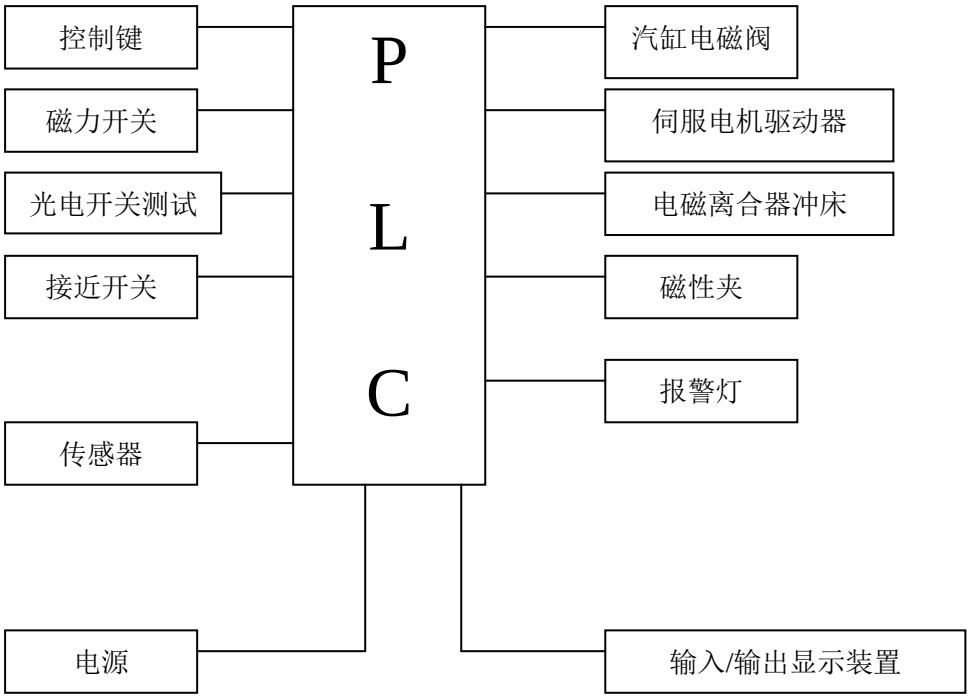

图3.1Block控制系统的硬件框图

B.分配的主要硬件

（1）使用FX2N系列PLC为核心控制器，它可以实现设备的自动控制，并处理输出信息的实时状态。由传感器接收输入信号设备显示设备的工作条件，通过实时处理，以实现多种气动阀门的议案，伺服电机动作电磁铁运动。

（2）伺服系统是一般闭环控制。首先，使用光电编码器检测伺服电机的位置θ0，然后发送数据控制处理，使其能够组成一个负反馈闭环控制系统与伺服电机的位置θi。工作闭环控制系统的过程中显示如下：首先，作为伺服电机的给

定目标θi位置，使控制器发送脉冲指令到伺服电机使它到目标位置，这时，发送一定数量的脉冲，我们可以读取伺服电机的实际位置与光电帮助编码器的计数脉冲。由于负载干扰或其他非线性因素，如果实际伺服电机的位置有一个给定的偏差位置，这种偏差（△θ=θi-θ0）不等于0，电机的脉冲数，可以通过设置调整算法的控制器，从而使实际位置
输出θ0系统可以到一个给定的的目标位置。

根据前面的分析，可以得出结果：这种伺服控制系统是一个位置不断变化的系统，它采用光电编码器检测到的物理位置在实时系统，通过控制器调整系统中的位置，以减少实际位置和目标位置之间的偏差，并确保具有结构简单的控制系统。

位置伺服系统的控制是系统的最重要组成部分，它的控制，可以影响设备是否能顺利和成功运行。在这项研究中，将选择KINCO ED系列伺服系统，以实现自动模具机械臂旋转位和角度的控制，这个驱动器的内部集成驱动器，控制，总线，I/O功能等，并它内部可存储256个程序，每个程序也可以被存储的一种运动曲线，包括加速，减速，最大速度，目标位置和其他重要参数的运动曲线，通过8个I/O端口，最多可以达到128个运动曲线的直接转移，而与这是由教育署，外部的支持的通信功能控制器也可以拨打256内部存储程序
ED和内驱动系统的参数变化。

（3）为了保证设备的检测工作条件是可靠的，必须选择合理的传感器安装，并确保正确的传感器信号可传送到PLC。该系统将在选择磁性开关的基础上，缸检测传感器，可以很容易地安装在气缸表面;检测工件的位置，电感式接近将选择开关传感器，以防止干扰信号，并确保可靠的数据;电磁检测的手臂，它会使用光电传感器。

四.控制系统的软件设计

控制系统的重要目标是实现连续自动模具运行操纵系统，同时必须考虑所追求的程序的功能和高完整性可靠性，采用PLC控制的模块化设计方案，并确保系统的机械机芯按顺序，可靠地运行。在硬件系统用有限的资源，它可以实现所有已完成功能和保证系统的安全和可靠。

A. PLC程序的基本原则实施

在PLC上电后,CPU将首先做内部流程系统程序的监督下,它包括硬件初始化，I / O模块配置检查，保持范围停电和其他初始化设置处理。执行用户程序可完成通信服务和自我诊断检查。在通信服务阶段，PLC应完成了一些沟通智能模块和其他外围设备，并同时完成数据接收和发送任务，响应程序员输入的命令，该方案的内容更新显示，更新时钟的内容和特殊登记册等

工作原理显示在图4.1如下：

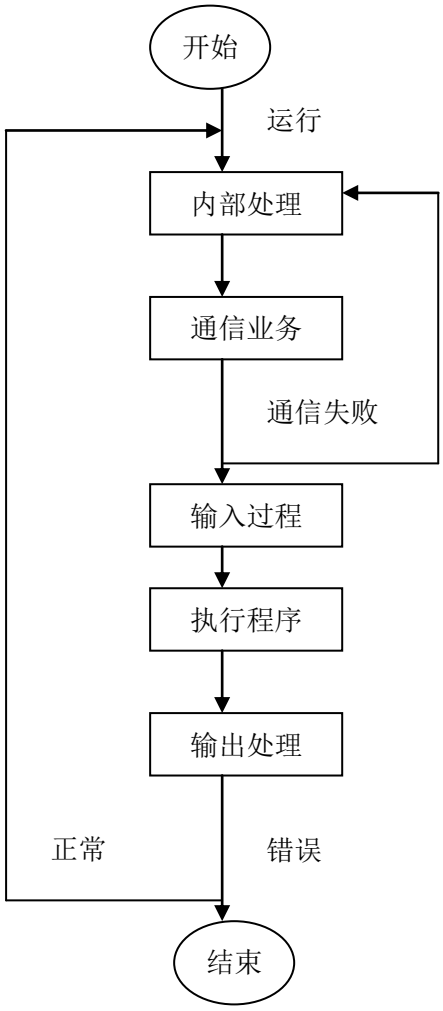

图4.1 PLC的工作过程

B. PLC程序的优点

PLC编程是常用的模块化编程来实现的整体功能;，这种方法具有以下优点：

（1）结构清晰，类似于C语言函数，可读性强，易于修改调试;

（2）该程序可以标准化，特别是一些功能可以被编译成一个标准程序;

（3）可写程序的各个模块很多人参加，减少程序开发时间;三菱系列PLC，其程序是模块化;根本的办法是使用子程序，控制系统可以调用子程序的程

序模块适当的时候，控制系统方案主要

由图4.2所示的一些模块构成：

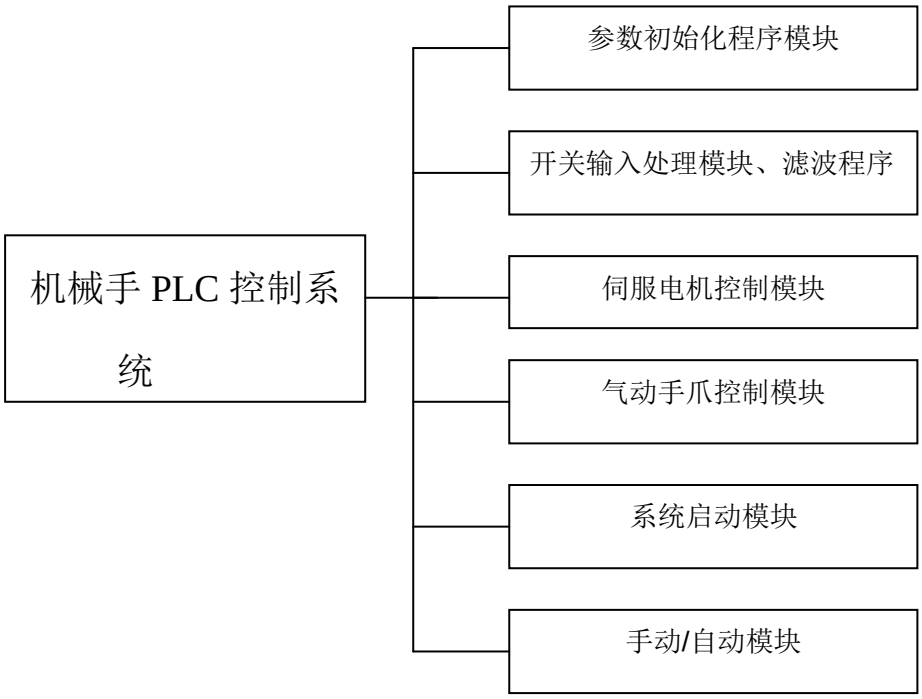

图4.2模块的控制系统

五.问题和解决DRING调试阶段

现场调试是最重要的工作之一在PLC控制系统设计的各个方面，它必须合理规划，有严格的要求。调试过程是非常繁琐复杂，各种意想不到的问题，经常出现，如感性负载调试。在控制系统，它往往很有用，如中间继电器和电感性负载电磁铁，由于感性负载可以产生反电动势的电压开启或关闭电源时，这个电压的峰值可能会损坏或产生额外电磁圈，从而影响正常的调试，因此，在设计和调试这阶段负载类型，一定的措施，必须以防止反电动势电压的影响控制系统造成不良影响。当电磁铁断电，磁性电源不能迅速被断掉，这可能会导致材料不能在确切在时间上的位置，并影响正常运行的控制系统。在调试阶段，二极管，对设备的要求是令人满意的，可相反，与以前的电磁铁相比，并联连接完美的问题将得

到解决。

六．总结

本文介绍了冲压自动化机械臂设备，这种设备可以代替人工操作，改善工作环境，但是，从控制技术的角度来看，仍然存在还有许多工作要做。目前，该技术的基础上 PLC 控制已开发的智能和基于网络的方向。PLC 控制的研究智能控制技术在大型网络控制应用将成为今后的研究方向。问题存在于控制系统的调试阶段，应再深入研究和探讨。总结秩序，研究新的算法和方法，结合机械设计和控制系统，真正能够实现质量更好的实际控制。

致谢

感谢自然河北省指令科研计划项目：锌空气电池极片干厚度镶嵌塑造在线检测技术的研究，它支持资助的项目是 2009317。

感谢河北省自然科学基金省，支持这篇文章。资助的项目是 E2009000096。

参考文献

[1] 陈力丁. 原理和电气控制中的应用可编程逻辑控制器[M]. 北京：中国机出版社，2005.1

[2] 陈力，吴宇翔，苏凯 . CAI电气控制可编程逻辑控制器. 广州：中国南方大学出版社，2001.2

[3] 石锅盛. 电气控制与可编程逻辑控制器技术[M]. 北京：化学工业出版社，2004.2。

[4] 马洪七，化学工业出版社。机电一体化技术，2003，（4）：36-37.

[5] 周湾镇，高虹仓. PLC的分析和设计中的应用[M]北京：电子工业出版社，2004.1。

[6] 廖昌永楚. FX系列PLC编程及应用[M]. 北京：机械工业出版社，2005:141-188

[7] p.cleaveland.programmable控制器适应新的行业需要[J]. 控制解决方案,2001,(4)：47-50。

[8] 弗雷G. 绞合L.形式化方法在PLC编程[C]. IEEE国际会议，2000，（4）：10月

作者：萧炎君，周静，关羽，秦羽霞

国籍：中国

出处：机械工程学院，河北工业大学

PLC Controlling System of TransportationManipulator and Simulation Debugging

Abstract—PLC (programmable logic controller) is one type of general industrial control platforms with high reliability. Based on the PLC of SIMENS SIMATIC S7-200 series, this paper introduces a control scheme of the manipulator transportation control system. The hardware design and PLC programs are given in details. In addition, the configuration simulation of the control system is performed by the application of King view software. This system, with advantages of high reliability, simpleconnection and low power consumption, can be widely used in teaching practice and industrial applications.

Keywords-*PLC; manipulator; simulation; King view*

I. INTRODUCTION

The manipulator is a new type of device in the mechanization and automation of production developing process. It can imitate some functions of the arm, for example,grasping, releasing, handling objects etc. according to a fixed order, and is widely used in industry production and other fields [1]. The application of the manipulator can reduce the workers' repeated operation, and replace humans in dangerous and toxic nvironments, which greatly improve the efficiency and accuracy of work. It also has great significance in the protection of the personal safety, the improvement of the working environment and the reduction of the labor intensity.

Programmable logic controller, or PLC for short, is a type of general industrial control platforms that was first developed in the 1960's. PLC offers several advantages including high reliability, simple programming esy learning onvenient usage and small volume and it has been widely adopted in industrial field [2] [3] □ SIEMENS PLC, production of ermany has been used extensively in China, especially the S7-200 series, due to its compactness, cost-effectiveness, wide range of CPU sizes and easy to programming in a small-scale control system [4].Based on the PLC of SIMENS SIMATIC S7-200 series, this paper introduces a manipulator transportation

control system, which uses the horizontal vertical displacement structure. The manipulator is driven by the cylinder. The corresponding solenoid valves drive the pneumatic actuators to complete the actions, which is controlled by PLC. This control system can be easily used in various industrial production lines to complete parts transportation in a fixed position, thus achieving production automation.

II. ANALYSIS OF CONTROL REQUIREMENTS

The configuration simulation interface of the manipulator transportation control system is shown in Figure 1. This is the initial interface of configuration simulation in King view software [5]. The manipulator can be used to move the workpiece from table A to table B. The system shown is at the initial position.

To meet production requirements, the control system has four working modes of single operation, stepping operation, single-cycle operation and continuous operation. Each working mode can be set with the corresponding switch installed on the operating panel. Single operation is to accomplish the various actions in a manual control. Maintenance of the equipment is often done in this way. The continuous movement process is divided into 8 steps in a cycle, including clining, clamping, rising, extending, declining, releasing, rising and retracting. But the manipulator must be ensured to start from the initial position. The continuous operation is that the manipulator performs each cycle of the action repeatedly. The single-cycle mode is that the manipulator automatically runs from the initial position and stops after a cycle of action. When the stepping

mode is selected, the manipulator then moves one step according to the order.

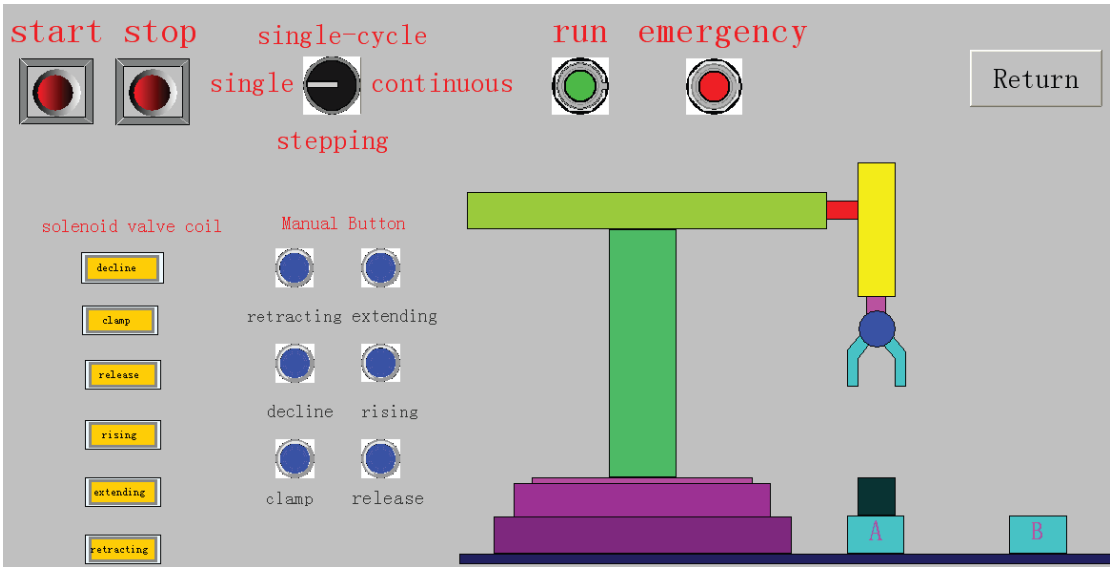

Figure 1. the initial interface

The cylinders are respectively driven by two solenoid valves [6] [7] of double-coils, which is to make up / down, left / right action to perform. When a solenoid valve coil is energized, it has to maintain the existing mechanical action. For example,once the solenoid valve coil of controlling down is energized,manipulator hands down. Even if the coil is off, the existing status is still maintained until the opposite direction coil isenergized. In addition, the cylinder movement is driven by single-coil solenoid valve to achieve gripper movement. The gripper is designed to perform clamping when the coil is energized and to relaxation when it is not. In order to move to the destination with accuracy, the four corresponding limit switches are installed on the ultimate positions to limit up/down, left / right action of the manipulator, which can send the input signals to PLC.

III. DESIGNING OF PLC HARDWARE

A. Selecting Machine Model

PLC is a kind of industrial control system and its control object is the industrial production equipments. Its connections with industrial production course are realized through the I/O interface modules. PLC employs many types of I/O interface modules including switch quantity input module, switch quantity export module, simulated quantity input module and simulated quantity export module as well as some special modules. According to the analysis of the control requirements, the system is a sequence control. Considering the number of input and output points, a small PLC, the CPU 224 of SIEMENS S7-200 was used in the control system. The machine integrates 14 inputs / 10 outputs of the total of 24 digital I / O points, and the I / O interface

module can be easily disassembled as a whole.Also, the machine has switch quantity I/O interfaces which can take over signal from sensor and switch and control equipment. Typical AC I/O signal is 24~240V, the DC I/O signal is 5~240V. EM221 module is used as Digital expansion, which expands 8 inputs.

B. I/O Wiring

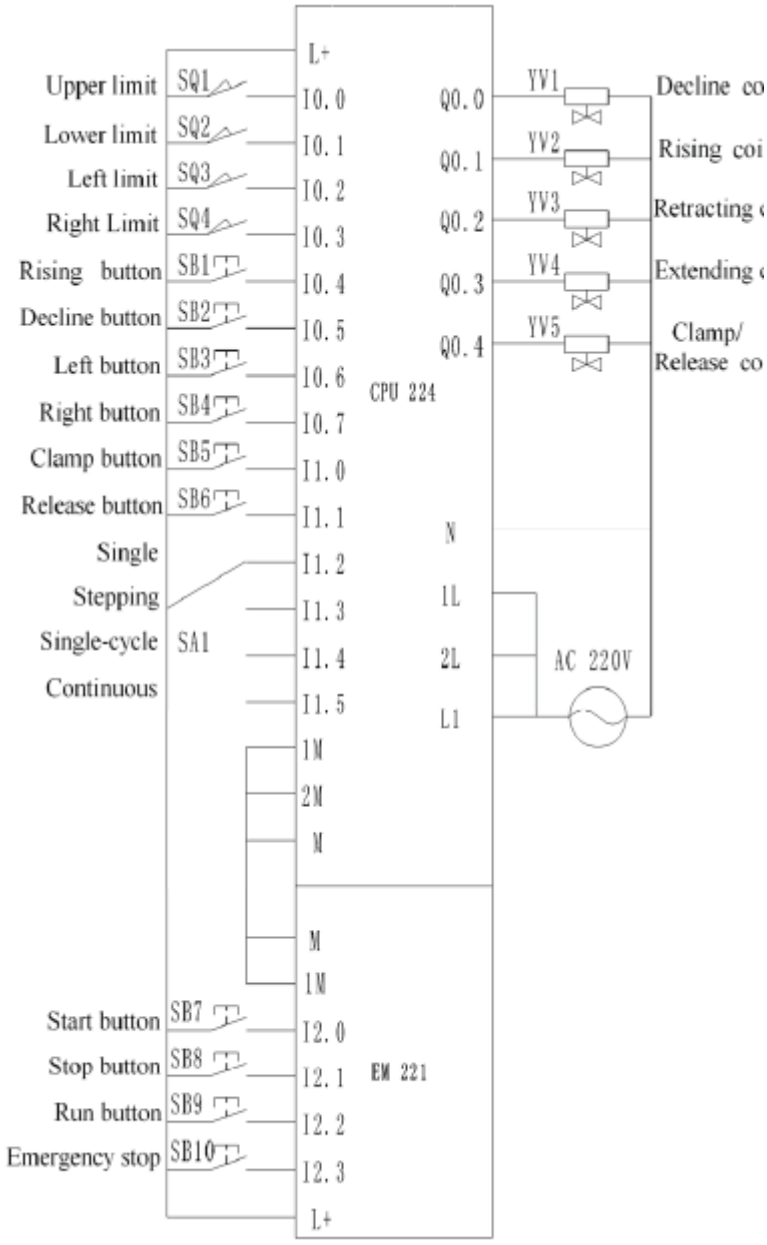

Figure 2. I/O wiring diagram

The input and output wiring diagram of PLC control system is shown in Figure 2. The input circuit, powered with the S7-200's own 24 V power, includes the buttons, limit switches and a manual switch. The output circuit includes the solenoid valve coil, which used 220V AC external power supply.Because the solenoid valves need less power, the electrical

output from the PLC can be used to drive directly.

IV. PLC PROGRAMMING

As the control system has multiple work modes, the program are compiled in a modular structure [9]. The four modes of manipulator can be divided into manual and automatic modes,the later including stepping operation, single-cycle operation and continuous operation. The manual program and automated program can be compiled in the independent subroutines modules, which can be called through program instructions. When the single operation is selected, I1.2 is on and the manual procedure is performed. When the automatic mode (stepping, single-cycle and continuous) is selected, I1.3, I1.4,I1.5 are respectively on, and the automatic control procedure is carried out. The entire main program is shown in Figure 3.

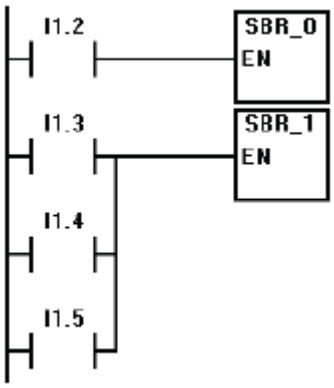

Figure 3. the main program

Manual operation is to accomplish the various actions with single control in random order. The program is designed in the normal relay contactor control system. Manual program is shown in Figure 4. In order to maintain the safety of the system, it is necessary to set protective measures. One such is that the manipulator is only allowed to run in left or right at the upper limit position (I0.0 = 1). Because the clamping and relaxed are controlled by a solenoid valve of single coil, the program is written in the Set, Reset commands, which have the keeping function. It also set up a mechanical interlock. The clamp and release movements are allowed only when the manipulator is at the lower position (I0.1 =1).

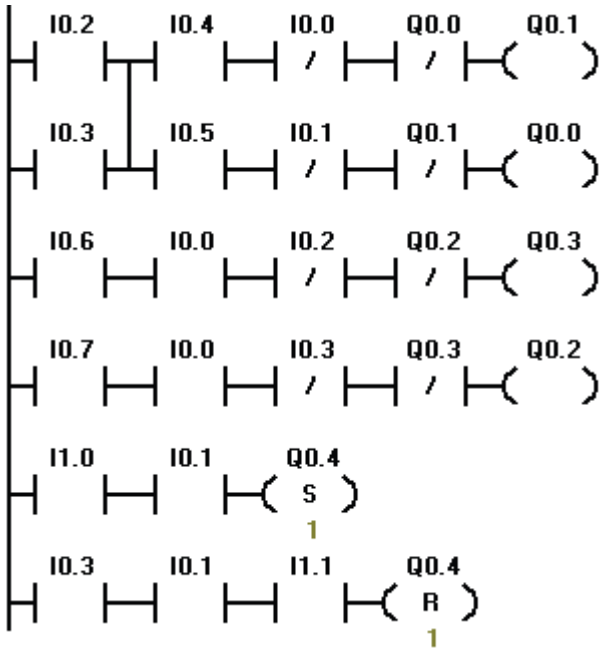

Figure 4. the manual program (0 subroutine)

The manipulator can be automatically operated in sequence.It has a variety of methods for programming [10]. This system is easy to control by programming in SFC (sequential unctionchart), in which the conditions for conversion is decided by the state of limit switches and timers. The detection of pressure,location or time can be used as the principles to control the clamping an relaxation. The timer T37 is used to control the clamping time, and T38 to control the relaxation time. The Sequential Function Chart of automatic operation is shown in Figure 5.

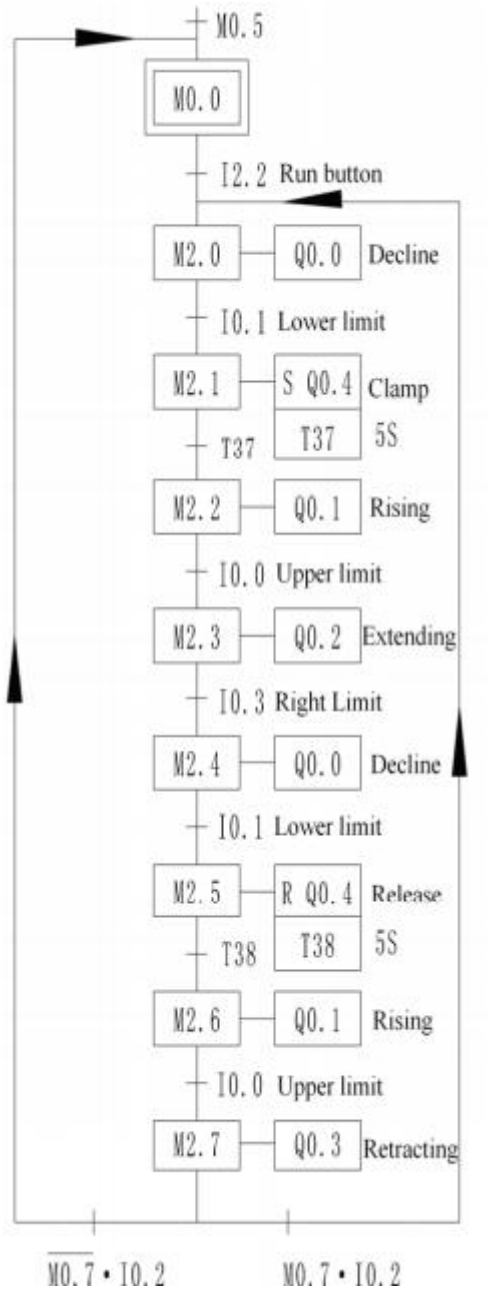

Figure 5. the SFC of automatic operation (1 subroutine)

As shown in Figure 6, M0.5 is the initial condition. The program of automatic operation controls the continuous, singlecycle or stepping movement, depending on the selector of the work mode switch. When the continuous mode is selected, I1.5 and I2.2 set M0.7, which can ensure the manipulator to perform each cycle of the action repeatedly. The ladder is shown in Figure 6. If the stop button I2.1 is pressed in the process of the continuous action, M0.7 is reset to ensure the manipulator to complete the current cycle until it returns to its original position. When the single-cycle mode is selected,M0.7 is reset. Each time the run button I2.2 is pressed, the robot automatically run from the initial position and stops after a cycle of action. When the stepping

mode is selected, the internal relay M0.6 is used in the conversion condition of each step. M0.6 is set every time the run button I2.2 is pressed and the conversion condition is met. The manipulator then moves one step according to the order.

The movements of manipulator include rising, decline,clamp, release, extending and retracting. In the program, the internal relay M2.0 and M2.4 are respectively used to controlthe output of decline Q0.0 in the left and right. M2.2 and M2.6 are respectively used to control the rising Q0.1. M2.1 and M2.5 are respectively used to control the clamp and release of Q0.4.M2.3 and M2.7 are respectively used to control extending and retracting.

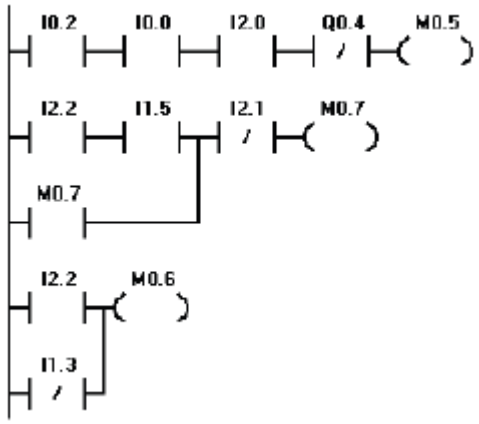

Figure 6. the ladder of M0.7, M0.6, M0.5 (1 subroutine)

From the sequential function chart, it is easy to transform into ladder program. Figure 7 shows the running interface of configuration simulation in King view software. The manipulator is declining at the right to transport the workpiece to Table B.

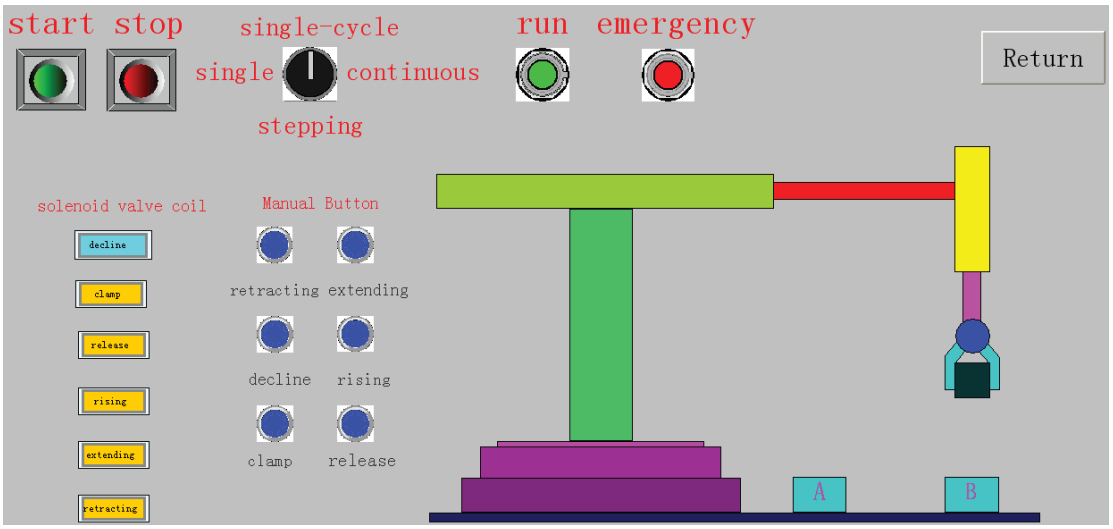

Figure 7. the running interface

V. CONCLUSION

This paper presents a scheme in the control system of manipulator transportation. The system used S7-200 as the programmable controller with high reliability. The whole control system runs with accuracy and is easy to maintain. In addition, the system has multiple work modes to meet a variety of production needs. The control scheme has been applied to the teaching and practice of production controlling, and achieved good results.

ACKNOWLEDGMENT

This study is the school research project. Thanks for the persons and organizations which provide direct and substantial assistance in the research.

REFERENCES

[1] Xiong Xingming, Cao Caikai. PLC Control of a Industry Manipulator[J]. Control Automation, 2006,22(31):120-123(in Chinese)

[2] Zhou Xiwei. Key Techniques on Industrial Control System Based on PLC[J]. Computer Knowledge and Technology, 2009, 5(16):4340-4341(in Chinese)

[3] Guo Yanping, Zhang Chaoying. Control System of Industrial Manipulator Based on PLC[J]. Instrument Technique and Sensor,2007,(9):31-33 (in Chinese)

[4] Long Wei, NIE Guanhong. The Realization of Real-time Communication Between S7-200 PLC and PC[J]. Journal of Nanchang University(Engineering Tchnology), 2002, 24(5):81-83 (in Chinese)

[5] Yuan Yunlong. Realization of PLC Control System Based on Configuration Software[J]. Process Automation Instrumentation, 2006,27(5):57-59 (in Chinese)

[6] Gong Zhiyuan. The Monitoring of Production Line's Hydraulic Power Slipway[J]. 2009, 31(9)41-43(in Chinese)

[7] Li Ming, Li Quanqing. Design of the Hydraulic Conveying Manipulator Based on PLC[J]. Machine Tool & Hydraulics, 2009, 37(6):99-101 (in Chinese)

[8] Huang Weiling. Design on Pneumatic Transition-manipulator Based on PLC[J]. Coal Mine Machinery, 2009,30(10):20-22(in Chinese)

[9] Liao Changchu. PLC Programming and Applications of S7-200 [M]. Beijing: Mechanical Industry Press, 2007:56-80 (in Chinese)

[10] Zhao Meining, Wang Jia. PLC Control System Design of Automatic Feeder Manipulator[J].

Chinese Hydraulics & Pneumatics,2007,(9):57-60(in Chinese)

PLC 控制系统的运输机械手和仿真调试

摘要：PLC（可编程逻辑控制器）是一种一般具有高可靠性的工业控制平台类型。基于西门子 SIMATIC S7 - 200 系列 PLC，本文引入了一个交通管制计划控制系统操纵者。硬件设计和 PLC 程序在细节上作用。此外，配置模拟控制系统是国王视图的应用程序软件。这种系统具有高可靠性的优势，简单连接和低功耗，可广泛应用于教学实践和工业应用。

关键词：可编程序控制器;机器人;仿真;查看。

一．导言

机器人是在新的设备类型生产的机械化和自动化发展的应用。它可以模仿手臂的一些功能，例如，抓，释放，处理对象等，按照固定的秩序，广泛应用于工业生产和其他领域。机械手的应用可以减少工人反复操作，并取代人类在危险有毒的环境，从而大大提高了工作效率和准确性的工作。它还具有保护人身安全，改善的工作环境，减少了工人的劳动强度的巨大意义。

可编程序控制器，简称 PLC，是一般的工业控制平台，最早是在 20 世纪 60 年代。 PLC 提供几个优点，包括高可靠性，简单的编程，容易学习，用法方便和体积小，它已被广泛采用，在工业领域生产于德国的西门子 PLC，已被广泛使用在中国，尤其是 S7 - 200 系列，由于其紧凑，成本效益，宽 CPU 的尺寸范围和易于编程，一般一个小规模的控制系统。

基于西门子 SIMATIC S7 - 200 系列 PLC，这本文介绍了一种机械臂交通控制系统，它使用水平/垂直位移结构。 机械臂是由气缸驱动。相应的电磁阀驱动的气动执行器来完成行动，由 PLC 控制。该控制系统很容易地使用在各种工业生产线完成固定在一个位置的部分运输，从而实现生产过程自动化。

二．控制要求分析

操纵器的配置模拟接口交通控制系统如图 1 所示。这是国王查看配置模拟的

初始界面软件。可用于工件从表 A 至表 B，显示该系统是在初始位置。

为了满足生产要求，控制系统有四个工作模式，单人操作，加强操作单周期操作和连续操作。每个工作安装相应的开关，可以设置模式操作面板。单人操作，是完成工作在人工控制的行动。设备保养我经常这样做。连续运动过程中，我分为 8 个步骤，在一个周期内，包括下降，夹紧不断提高，延伸，下降，释放上升和回缩但操纵者必须确保启动的开始位置。连续运行是设备反复执行每个周期的动作。单循环模式是操纵自动运行的举措一个周期的行动后的位置和停止。当步进模式的选择，操纵移动一步根据命令。

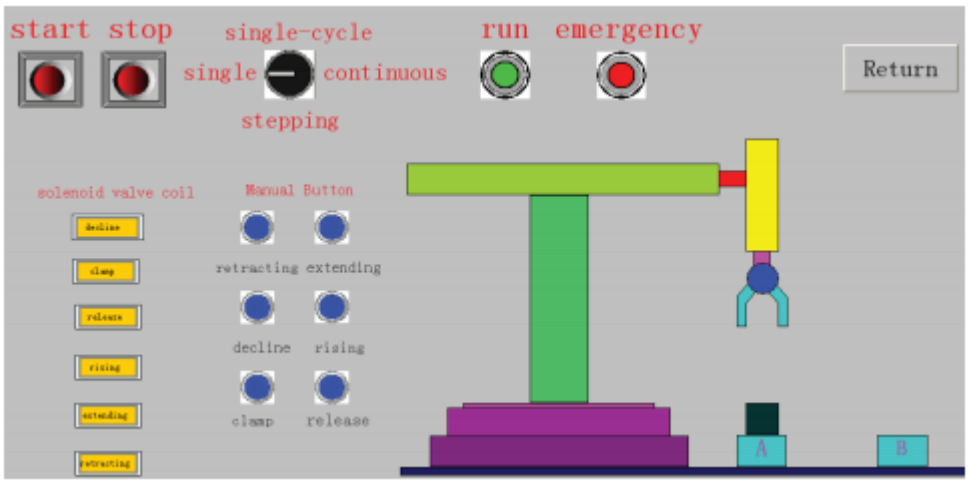

图 1. 初始界面

气缸驱动分别由两个电磁阀双线圈，即控制上/下，左/右要执行的动作。当电磁阀线圈通电时，它要保持现有的机械动作。例如，一旦电磁阀线圈通电了控制，操盘手动了。即使线圈是关闭的，现有的状态依然保持，直到线圈相反方向通电。此外，气缸运动是由单线圈电磁阀，实现夹具的运动。当线圈通电，该夹持器进行夹紧，线圈不通电以放松。为了移动到准确的目标，这四个相应的限制开关安装在极限的位置上/下，左/右行动的机器人，它可以发送输入信号给 PLC。

三．PLC 的硬件设计

A. 选择机型号

PLC 是一种工业控制系统，其控制对象是工业生产设备。它的连接与工业生产过程中通过 I/ O 接口模块得以实现。采用 PLC 多种类型的 I/ O 接口开关量输入模块，包括模块，开关出口量模块，模拟量输入模块和模拟模块的出口数量，以及一些特殊模块。

根据控制要求分析，系统是一个控制序列。考虑到输入的号码和输出点，小型 PLC，西门子 S7- 224 CPU200 是控制系统。本机集成输入/输出的 24 位 I/ O 点总数，I / O 接口模块可以很容易地分解为一个整体。此外，该机拥有量开关 I/ O 接口，可接管和开关从传感器和控制设备的信号。典型的 AC I / O 信号为 24～240V，直流 I / O 信号 5～240V。 EM221 模块作为数字扩展，这
8 输入扩展。

B.I / O 接线

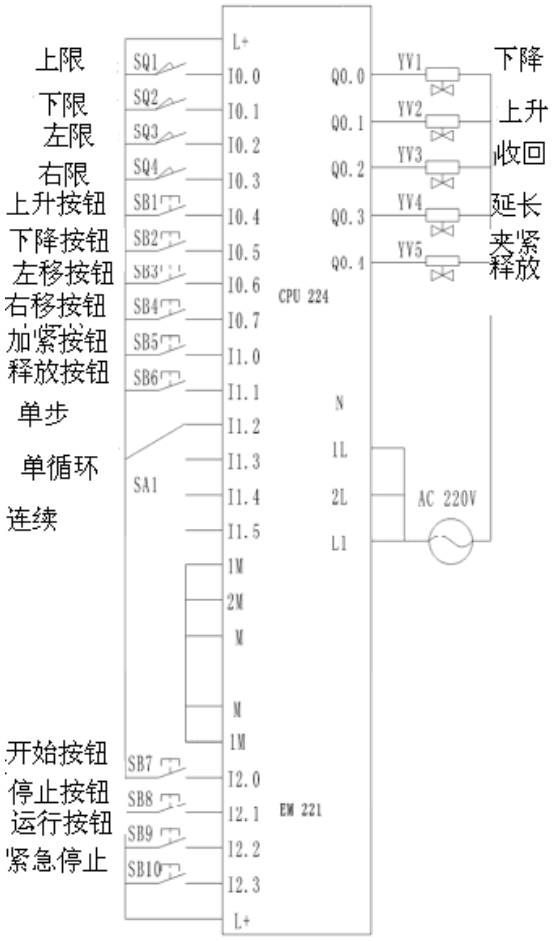

图 2. I / O 接线图

在 PLC 控制系统的输入和输出接线图见图 2。输入电路，与供电 S7 -200 自己的 24 V 电源，包括按钮，限位开关和手动开关。输出电路包括电磁阀线圈，它使用 220V AC 外部电源。由于电磁阀需要较少的功率，电机从 PLC 输出可用于直接驱动。

四. PLC 编程

由于工作的控制系统有多种模式，程序在一个模块化结构汇编[9]。这四个模式机械手可分为手动和自动模式，后来包括加强操作，单周期操作和持续运行。该方案手动和自动可以在编译程序的独立子程序模块，可通过程序指令调用。当单个操作被选中，I1.2 上手册程序执行。当自动模式（步进，单周期和连续）被选中，I1.3，I1.4，I1.5 分别为上，和自动控制程序十月进行整个主程序如图 3 所示。

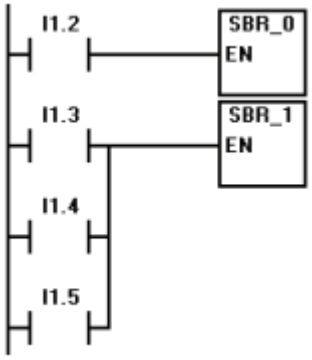

图 3. 主程序

手动操作来完成的各种行动单一控制在随机顺序。该计划的目的是在正常继电器接触器控制系统。手册程序如图 4 所示。为了保持安全系统，它需要设置的保护措施。其中一个是该机器人只允许在左或右的运行上限位置（I0.0= 1）。由于夹紧和轻松控制由单线圈电磁阀，程序是写在设置，复位命令，其中有保持功能。它还建立了一个机械联锁。该钳和释放的变动只允许当机械手在较低位置（I0.1= 1）。

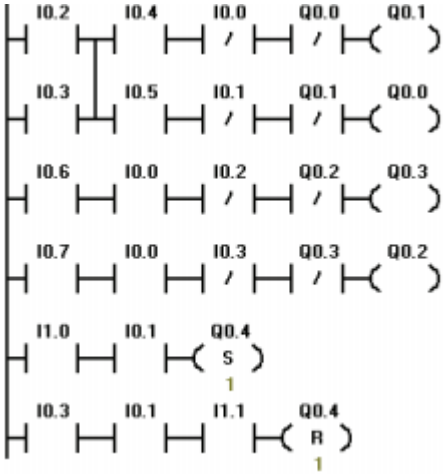

图 4. 程序手册（0 子程序）

该机器人可自动操作顺序。它有一个编程[10]各种方法。该系统很容易

通过编程控制 SFC（顺序功能图表），其中转换的条件是由决定国家的限位开关和定时器。压力检测，位置或时间可以用来控制原则的夹紧和放松。在 T37 定时器用于控制

夹紧时间，T38 控制放松的时间。该自动操作顺序功能图所示图 5。

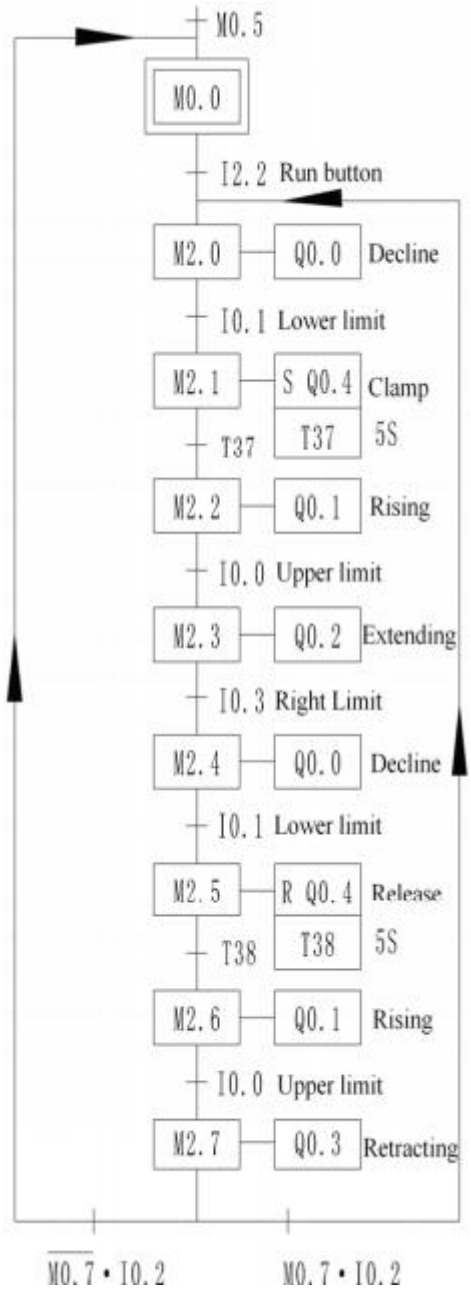

图 5.自动操作的 SFC（子程序）

在图 6 中，M0.5 显示的是初始条件。该程序控制自动连续，单操作循环或加强运动，在不同的选择工作模式切换。当连续模式时，I1.5I2.2 和 M0.7 九月，能保证，到机械手每个周期执行的动作反复。梯子如图 6 所示。如果停止按钮被压在 I2.1 连续动作过程，M0.7 被重置为确保机械手来完成当前

循环，直到它返回到其原来的位置。当单周期模式时，M0.7 被复位。每次运行按下按钮 I2.2，该机器人自动运行，从最初的立场，停止后行动周期。当步进模式被选中，M0.6 内部继电器用在每个条件转换一步。 M0.6 设置每当运行按钮被按下的时间和 I2.2 转换条件得到满足。然后移动的机器人跟据每步顺序行动。

该机器人运动包括上升，下降，钳，发布，扩展和回缩。在工作中，内部继电器 M2.0 和 M2.4 分别用来控制在左，右下降的输出 Q0.0。M2.2 和 M2.6 分别用于控制上升 Q0.1。 M2.1 和 M2.5 分别用来控制钳和 Q0.4 释放。M2.3 和 M2.7 分别用于控制和扩展回缩。

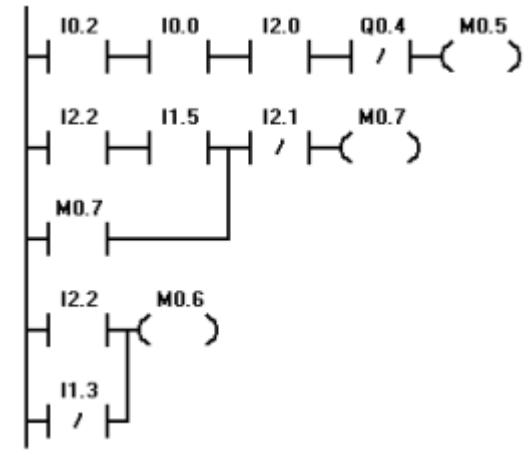

图 6.阶梯的 M0.7，M0.6，M0.5（子程序）

从顺序功能图，很容易转化成梯形图程序。图 7 显示了运行界面配置视图景仿真软件。该机械手下降是运输工件表 B。

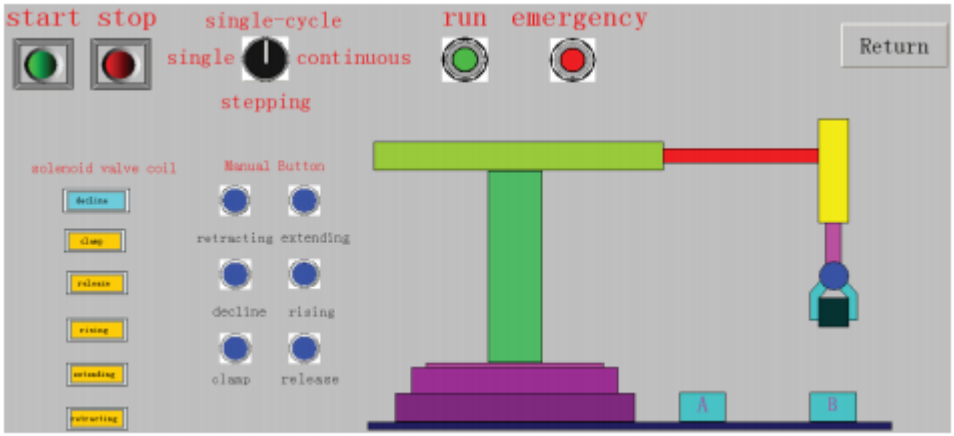

图 7.运行界面

五. 结论

本文提出了在控制系统中的计划操盘运输。S7- 200 系统可编程控制器具有高可靠性。整个控制系统运行准确，易于维护。此外，该系统具有多种模式工作，以满足品种生产的需要。该控制方案已应用于教学与实践控制生产，取得了良好效果。

致谢

这项研究是学校的研究项目。感谢您的个人和组织提供大量直接和协助研究。

参考文献

[1]熊明 曹 caikai. 一个工业机械手 PLC 控制[J]. 控制与自动化，2006,22（31）：120-123（中文）

[2]周锡玮. 基于 PLC [J] 工业控制系统关键技术分析. 电脑知识与技术，2009，5（16）：4340-4341（中文）

[3]郭艳平 张超英. 基于 PLC 的工业机器人控制系统[J] 仪表技术与传感器，2007，（9）：31-33（中文）

[4]龙尾 聂冠宏. 与 PC [J] S7-200 PLC 之间的实时通信的实现,. 南昌大学学报（工程技术），2002，24（5）：81-83（中文）

[5]元云龙. 基于组态软件的 PLC 控制系统的实现[J] 自动化仪表，2006，27（5）：57-59.（中文）

[6]宫志远. 生产线液压动力滑台的监测[J]，2009，31（9）41（中文）

[7]李明 李全情. 对基于 PLC 的液压搬运机械手的设计[J] 机床与液压，2009，37（6）：99-101（中文）

[8]黄岭. 基于 PLC 的气动转换[J] 机械手的设计，煤矿机械，2009（10）（中文）：20-22.

[9]辽长春. S7-200 PLC 编程及应用[M] 北京：机械工业出版社，2007:56-80（中文）

[10]赵美宁 王佳. 自动送料机械手 PLC 控制系统的设计[J] 中国液压与气压传动，2007，（9）：57-60（中文）

作者：韩维娜 刘立伟

国籍：中国

出处：机械工程系华北航天工程研究所