PLC-Based Pneumatic Manipulator System Design

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Abstract

In this paper, the material handling robot used in automatic production line is designed and the overall design of the robot is determined. That is, the robot uses three degrees of freedom and cylindrical coordinates, and the pneumatic cylinder is used as the actuator to achieve the telescopic expansion,lifting and turning three degrees of freedom and the opening and closing of the gripper, and the principle analysis and design of the manipulator's driving pneumatic system, and finally using the Siemens S7-200PLC to control the manipulator's control system in order to achieve the robot manipulator's automatic control.

Keywords

Manipulator; pneumatic cylinder; pneumatic; PLC

1. Introduction

1.1 Preface

With the advancement of science and technology, the application of industrial production automation equipment has become more and more extensive. Among them, the manipulator is the product of ever-increasing production technology, and is an important technology formed by the combination of modern production and application of science and technology.The application of industrial robots has reduced the labor intensity, improved the precision of product processing, and reduced the risk of production by manual operation, especially in the production of some dangerous industries, such as the production of toxic substances in chemical production; nuclear power plants, etc,where there are radioactive materials; in the production environment where there are flammable and violent dangerous production occasions, it is very suitable to use robots for production.

The manipulator's driving methods include pneumatic transmission, hydraulic transmission, electric transmission and mechanical transmission. The widely used air pressure technology uses compressed air as the medium, and has the characteristics of rapid action, stability, reliability, simple structure, light weight, small size, energy saving, and long working life,especially for applications that are easy to control, easy to maintain, and free of environmental pollution, pneumatics are often the first choice for robotic drive systems.

2. Overall Design of Pneumatic Manipulator

2.1 Coordinates and Degrees of Freedom

Because the cylindrical coordinate robot structure is simple and compact, positioning accuracy is high, and the floor space is small, and the robot arm has lifting, contracting and slewing motion when working, therefore, the robot manipulator uses a cylindrical coordinate type. The corresponding robot has three degrees of freedom.

2.2 Mechanical Design

The manipulator is composed of a gas gripper, an arm translation mechanism, an arm lift mechanism, an arm swing mechanism, and a fixed bracket. The manipulator has three degrees of freedom, that is, the arm's telescopic movement, left-right rotation and lifting movement. The arm's telescoping, swiveling and lifting movements are achieved through the movement of the cylinder. The structure of this robot is shown in Figure 1.

The robot motion diagram is shown in Figure 2.

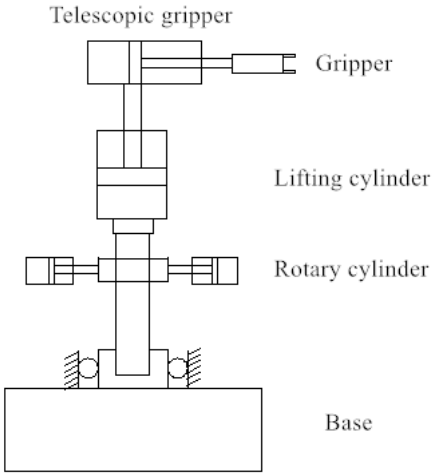

Figure 1. Robot structure diagram

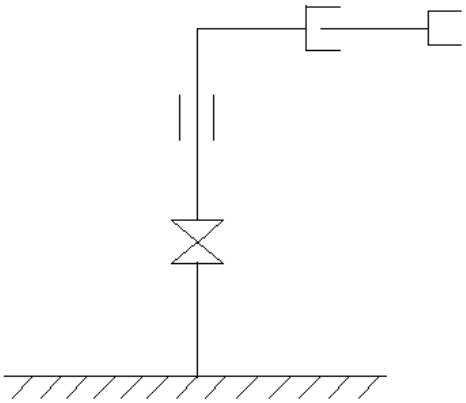

Figure 2. Robotic motion diagram

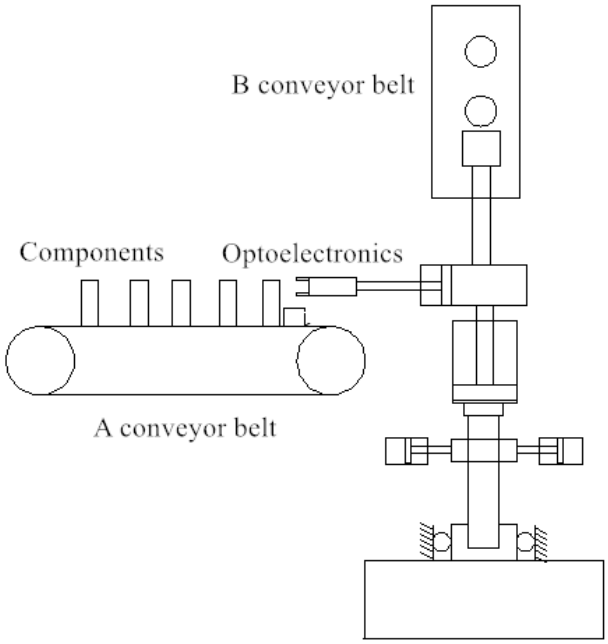

Figure 3. Robotic working process

2.3 Functional Analysis of Manipulators

The pneumatic manipulator mainly completes the work of components, and its working process is shown in FIG. 3. The component is on conveyor A and the photoelectric switch is used to detect the component. When the photoelectric switch detects the component, the conveyor belt A stops operating and at the same time sends a signal to the robot, and the pneumatic robot transports the component from the conveyor belt A to the conveyor belt B.

3. Pneumatic System Design

Due to the need of work, the aircrew, telescopic cylinder, lifting cylinder and rotary cylinder are used to complete the expected actions. Its air source is entered by the air compressor into the gas tank, through the water separator filter, pressure regulator valve, and oil mist filter, into the solenoid valves on each parallel gas circuit to control the cylinder and hand movements.

4. PLC Control System Design

According to the I/O point allocation principle in the PLC hardware, there are 3 points for the automatic, manual, and stop buttons in the design of the pneumatic robot control system. The 7-point limit switch for the pneumatic gripper, lift cylinder, telescopic cylinder, and rotary cylinder action is in place, photoelectric detection 1 point, the above input points total 11 points.

Start and stop lights 2 points, each action 7 points, conveyor belt A, B motor power supply 2 points, the output points above a total of 11 points.

According to the above input and output points, select Siemens S7-200CPU226AC/DC/RLY programmable controller, 24 input, 16 output.

The I/O allocation is shown in Table 1:

Table 1. I/O allocation table

Input		Output	
Input device		Output device	
Auto start button	I0.0	Start indicator	Q0.0
Manual start button	I0.1	Stop light	Q0.1
stop button	I0.2	Conveyor A motor	Q0.2
Photoelectric detection	I0.3	Conveyor B motor	Q0.3
Rising limit	I0.4	Rising solenoid valve	Q0.4
Falling limit	I0.5	Falling solenoid valve	Q0.5
Extend limit	I0.6	Extend solenoid valve	Q0.6
Retract limit	I0.7	Retract solenoid valve	Q0.7
Left-handed limit	I1.0	Left-handed solenoid valve	Q1.0
Right-handed limit	I1.1	Right-handed solenoid valve	Q1.1

5. Summary

Robots based on PLC control can select the corresponding products according to the requirements to complete the complex logic control. The logic control is the main task, but the development workload of the hardware and software is small, the output has the ability of load and anti-interference, and the reliability is good.The accuracy of manipulator operations and the ability to complete operations in various environments have positive implications for improving workers' working conditions, increasing production efficiency and productivity, and they are used more and more widely in various areas of national economic production. The development prospects are worth studying.

References

[1] Xie Keming, Xia Luyi. Electrical Control and PLC [M]. Beijing: Electronic Industry Press, 2010
[2] Liu Hongxian. Design of Pneumatic Handling Robot System Based on PLC [J]. Mechanical Engineer, 2014(9): 124-126
[3] Dai Qin. Application of PLC in Pneumatic Manipulator Control System [J]. Automation Application, 2010(4):37-40
[4] Zuo Jianmin. Hydraulic and Pneumatic Drive (4th Edition) [M]. Beijing: Mechanical Industry Press, 2010
[5] Cheng Yuhua. Siemens S7-200 engineering application example analysis [M]. Beijing: Electronic Industry Press, 2010
[6] Yuan Shihua ,Hu Jibin. The research on the efficiency of multirange hydro-mechanical transmission [J]. Journal of Beijing Institute of Technology,1998(6):32-34
[7] Krishnaswamy Nagaraj. A Low Supply Voltage High PSRR Voltage Reference in CMOS Process [J]. IEEE Journal of Solid-state Circuits,1995(3):62-65