Design of Single Chip Microcomputer Control System for Pneumatic Manipulator

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Abstract

Pneumatic manipulator is a kind of automatic operation device that can imitate some action functions of human hand and arm, and realize the action of grasping and transporting objects according to a fixed program. In this paper, a single-chip microcomputer pneumatic manipulator control system is designed with the advantages of flexible control, convenient configuration and simple programming. The manipulator to be developed by the project can pick and place objects in the space, and the action is flexible and diverse. The control program can be modified at any time according to the changes of the working environment and conditions and the requirements of the motion process to meet the work requirements and increase the flexibility of the manipulator application.

Keywords

Pneumatic, single-chip microcomputer control, manipulator, system design.

1. Introduction

In most factories in our country, the work of loading and unloading workpieces and carrying articles on production lines or assembly lines is still done by manual work, which leads to the low production efficiency of the workers due to the heavy labor intensity. In order to increase production efficiency and reduce costs, manipulator have been widely used. Manipulators are mainly used in production lines or assembly lines to realize the automation of processing, assembly process (loading and unloading) and handling, thereby replacing workers' labor, saving work hours and reducing labor intensity. Manipulators have also been used in some dangerous industries to promote safe production and the safety of human beings.

2. The structure of the Manipulator

The manipulator in this article is mainly composed of a base, a big arm, a small arm, a wrist, and a claw. It is mainly used to grasp components or small workpieces on an automatic production line to complete a predetermined action[1]. The degree of freedom of the manipulator is 3 degrees of freedom, and the coordinate type of the manipulator is cylindrical coordinate type. The structure of the manipulator is shown in Figure 1.

3. Overall design of Manipulator

Pneumatic drive is one of the effective means to automate the production process and mechanize the production process. The compressed air is used as a power source to drive the pneumatic actuator to complete a certain movement. There is no cost for air, and the supply of air is sufficient, it is available everywhere. More importantly, air is a clean energy source, it does not cause pollution to the

surrounding environment and is not affected by temperature changes. It is generally used for small and medium-sized loaders, controlled by single chip microcomputer. The control method is flexible, easy to configure, simple programming, high reliability, small size, low price, easy to product and have a strong intelligence. Comprehensive comparison, due to the rapid development of China's small and medium-sized enterprises, the high demand for cheap and high-quality production equipment. Therefore, the single-chip microcomputer as the core of the control equipment has certain advantages and has become the first choice for many companies [2]. The overall design is shown in Figure 2.

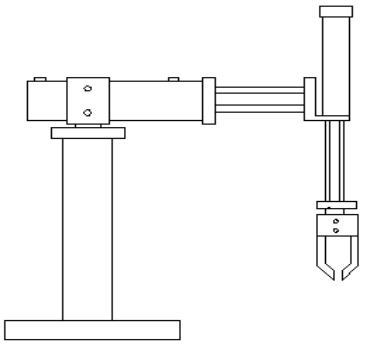

Figure 1 Mechanical Structure of Manipulator

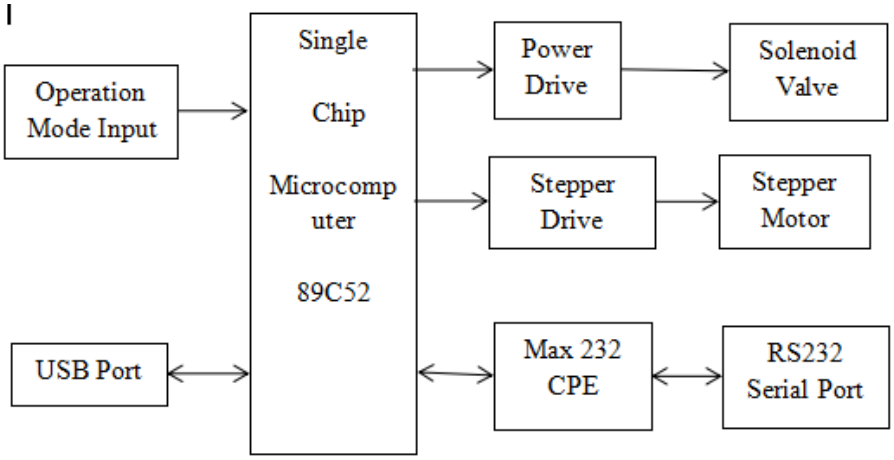

Figure 2 overall design diagram

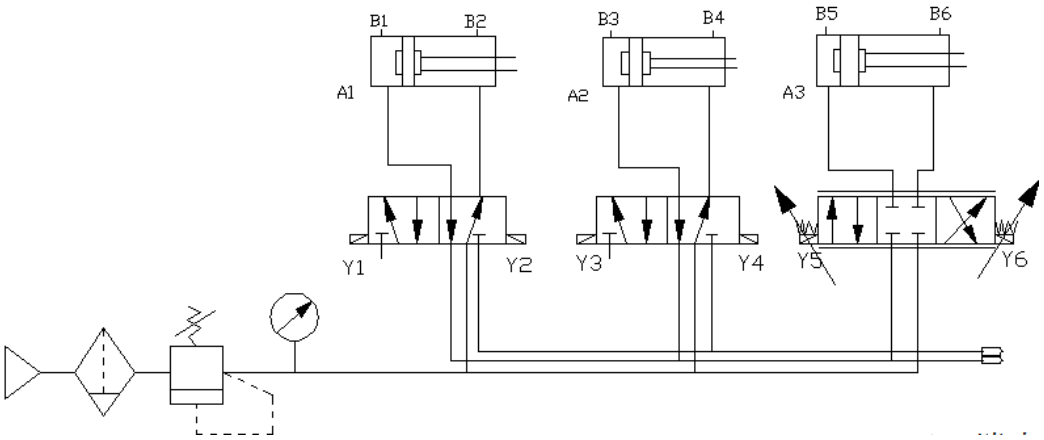

Fig. 3 Pneumatic control circuit

4. The composition and operation control of pneumatic manipulator

The pneumatic manipulator is mainly composed of three parts, namely two linear cylinders (lift cylinder and telescopic cylinder) and one pneumatic jaw. The lift cylinder is mounted on the front end of the cylinder rod of the telescopic cylinder for extracting workpieces[3]. The telescopic cylinder is used for horizontal extension and retraction. Pneumatic jaws are used to grip workpieces. The horizontal rotational displacement of the manipulator is achieved by a 1.8-degree step angle stepper motor with a rotation angle of ±180 degrees. Pneumatic control circuit is shown in Figure 3.

5. Hardware Design of Control System

The single-chip microcomputer is an abbreviation of a single-chip microcomputer, and is a computer that integrates all kinds of functional components of microcomputer into a single chip. The single-chip microcomputer is mainly composed of a microprocessor (CPU), a data memory (RAM), a program memory (ROM), an interrupt system, a timer/counter, a serial port, a parallel output interface, and a clock circuit[4]. The single-chip computer system designed in this article is based on STC89C52 single-chip computer. STC89C52 series single-chip computer is a new generation super anti-jamming, high speed, low power consumption CMOS 8-bit microcontroller that Hong Jing Technology introduces[5]. The communication between the single-chip computer and the computer is through the serial mouth, the serial communication technology is one of the commonly used communication technologies. Since the input and output levels of the microcontroller are not the same as the standard of the RS232 in the computer, the levels of the input and output of the microcontroller cannot be used for long-distance transmission. Therefore, when communicating between a microcontroller and a computer, it is first necessary to switch the level by the level converter chip MAX232.

The power drive circuit is mainly used to control the solenoid valve group. This circuit controls the various actions of the manipulator by receiving signals sent by the program of the single-chip microcomputer. The power driver chip used is ULN2003. ULN2003 is a high voltage, high current composite transistor array consisting of seven silicon NPN transistors.

6. Software Design of Control System

The manipulator's motion control mainly comes from the handle, and the control of the manipulator action is achieved through the buttons on the handle. Many of the motherboards for PCs have now eliminated the serial port interface. The robot's communication and program download uses a USB-to-analog serial port solution. Although the use of USB cable to communicate with the computer to connect, but the actual use of serial communication, the specific communication method and ordinary real computer serial port is almost no difference. The USB communication between the handle of the manipulator and the main control board connected to the computer through the USB cable is not the USB communication in the real sense, but is realized through a USB to RS232 interface chip PL2303 to achieve USB to serial communication (called analog serial port Or virtual serial port)[6].

The software design of the single-chip microcomputer control of the pneumatic manipulator is the key to the reliable operation of the manipulator. The interrupt system is an important part of the single-chip microcomputer. Through the interrupt function, the CPU can start multiple external devices at the same time to work and manage simultaneously, and can quickly respond to external device interrupt requests, collect real-time data or fault information, and process the system accordingly. This will greatly increase the efficiency of the CPU.

The watchdog is a unique feature of the 52 single-chip microcomputer. The use of the watchdog is to enable the microcontroller to run back to normal operation when it flies through the reset function of the watchdog. The watchdog monitors the operating status of the microcontroller in real time and restarts whenever there is a problem with the system.

7. Conclusion

Due to different shapes, weights, and materials of different workpieces, the robot gripper can easily damage the workpiece if it does not give a certain speed control to restrain the gripping force when gripping the workpiece. Therefore, when gripping the workpiece with the gripper, it is possible to use exponential acceleration and deceleration control and electro-pneumatic proportional/servovalve, which can avoid excessive clamping of the gripper and damage the fragile and easily deformable workpiece. Index acceleration and deceleration refers to the sudden change of speed when the machine is turned on or off, to a more rounded curve that can change according to a certain exponential law. The valve opening of the electro-pneumatic ratio/servo valve controls the size of the opening according to the law of exponential acceleration and deceleration so as to control the flow of the air flow and further control the speed of movement of the hand. In this design, through the quick and slow buttons on the handle, when it is necessary to hold a fragile, easily deformable workpiece, press the slow button to let the claw slowly move to avoid excessive force and damage the workpiece. When holding a normal workpiece, press the quick button to increase the working speed.

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