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Research on mechanical precise positioning device based on PLC control

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Abstract. In large-scale automated production, the production process often requires the use of conveyor belts to smoothly transport the product to the appropriate location. However, during the entire transmission process, due to the long-term operation and wear of the machine, the condition of the conveyor belt is easily degraded, so that the required product cannot be accurately transported to the corresponding fixed position. In order to solve this problem, this paper uses the PLC which is often used in mechanical control to study the precise positioning of mechanical devices. Through the use of high-precision couplings, with the PLC electronic control part, optimize the structure of the precise positioning device. Practice has shown that the PLC-based mechanical precise positioning control device greatly improves positioning control accuracy and control stability than conventional devices.

Key words: PLC; control; Mechanical device; precise positioning; Stepping motor.

1. 1 Introduction

During the process of automatic production line control, the processing, sorting and warehousing of the product often require the control system to be able to achieve rapid and accurate positioning,[1] the commonly used control of the stepper motor position control, the servo motor closed loop control and the asynchronous motor frequency control closed loop control, and so on, based on the traditional control method cost high It has the characteristics of complex maintenance, poor stability and so on. In this paper, [2] a mechanical precise positioning system based on PLC is proposed to realize precise positioning closed loop control.



The traditional multi axis and complex motion control usually uses motion control card or industrial control machine [3]. As a control unit, it has high speed, high precision, high cost and complicated maintenance. In contrast, using programmable logic controller (PLC) as a motion control unit, it can control step motor, servo motor and so on. It has the advantages of low cost and simple design under the condition of relatively simple motion and low speed. At the same time, PLC can also be used as the control unit of non-motion control in the instrument, [4] simplifying the instrument design and giving full play to the advantages of PLC's stability and reliability.

The development of precision motor positioning helps to automate the automation of production line equipment, and the precision of the motor positioning control depends on the design of the servo control system. This paper mainly studies the location of industrial conveyor belts. In the industrial application, the servo positioning control technology with PLC as the core is quite mature. It usually includes the PLC host, the positioning control module and the servo motor, and the controller is mainly based on the PID controller. [5] The servo positioning control, which is based on PLC, usually gets good control. Even after long time operation, the motor can be transferred to the set position accurately according to the operation command. In this paper, a set of mechanical precise positioning control platform is studied [6].

(1) Use multiple loop control architecture.

(2) Using PLC based control architecture: because of its high anti-interference capability, the system has good stability in positioning control of servomotor.

(3) Build PC-Based VB monitoring system to facilitate the operator's system monitoring and management.

2. Structure design of mechanical precise positioning control system

The structure of the mechanical precise positioning control system is very complicated, and the functions of the device are also various. In general, [7] the mechanical precision positioning control system is mainly composed of two important parts: mechanical and electrical control.

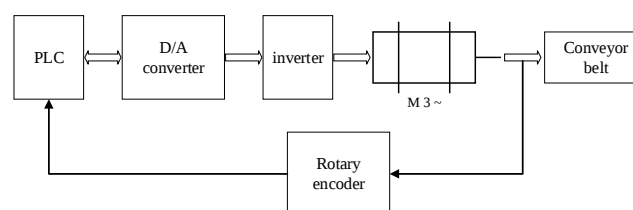


Fig.1 Block diagram of control system

(1) The mechanical part is mainly made up of ball screws and couplings. Because of the precision positioning device, the ball screw is the key transmission component, and it is more important to

strengthen control on the accuracy of this transmission. In practical work, the transmission of force and motion between ball screws can be realized by contact between screws, balls and inverters [8]. There are great differences in contact stress between ball and lead screw. In the device, the coupling is also an important part. The coupling in the precise positioning device is the connection between the shaft and the shaft, then the separation process is carried out and the force is transferred and the interruption control is carried out. There are many types of coupling components. In the actual application, the coupling mainly plays the role of compensation, and the resonance speed of the shaft system is changed.

(2) For the precise positioning device, the electronic control part is also more important [9]. The common step motor is the important component of the digital control. The motion of the stepping motor can be effectively controlled under the application of the pulse number of the coil and the pulse frequency. The application target of the step motor ring pulse distributor can be realized through the hardware. In the specific application process, the single pulse string is input first, then the pulse is allocated to the phase winding power amplifier of the stepper motor in turn according to the steering and working mode, thus the rotating magnetic field can be formed [10]. It can also be realized by the software of the step motor ring pulse distributor, the generation of time series pulse, the sequence of the phase winding of the stepper motor and the control of the pulse frequency can help to improve the control efficiency.

The method of realizing the step motor ring pulse distributor by hardware is to assign the input single pulse string to the power amplifier which is connected to the phase winding of the stepper motor in turn, in order to form a rotating magnetic field [11]. This is the working principle of the pulse ring distributor, and the special integrated circuit is used, for example. CH250 and so on is made up of a ring pulse distributor. By amplifying the weak signals of each phase through the power amplifier of each phase, sufficient electromagnetic torque is produced and the motor is rotated. The designers often spend a lot of energy and labor on the selection, design, connection control system and the matching of the interface signals. The reliability of the whole system is affected by the quality of components.

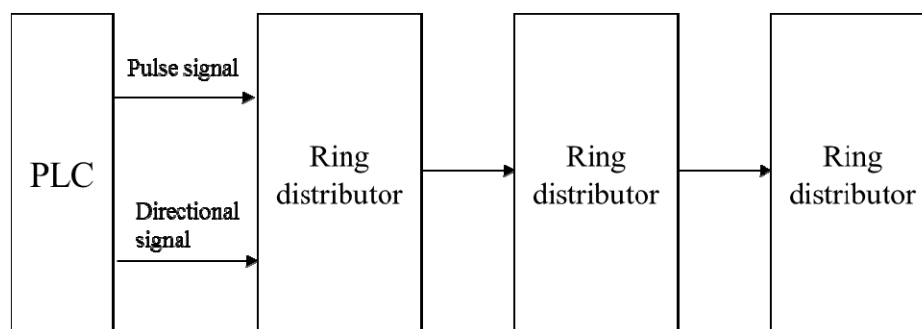


Fig.2 The application of PLC control step motor

The method of loop pulse distributor for stepping motor by software is implemented by software, which makes two special requirements for PLC hardware. One is that the programmable logic controller must have a real-time refresh technology type PLC, which makes the output frequency up to thousands of Hertz or higher to drive the ring pulse distribution to achieve higher distribution speed requirements. Second [12], in order to achieve the requirements of stepper motor drive voltage and current, programmable logic controller is a high-power transistor as output port.

3. Software design of PLC control system

When the conveying unit sends the workpiece to the conveyor belt and is detected by the photoelectric sensor in the material inlet, the Q0.0 terminal of the PLC outputs a high-level signal, starts the inverter, controls the AC motor to run at a frequency of 30Hz, and the encoder starts. A pulse signal is sent and the PLC's high-speed counter starts counting pulses. Since the diameter of the active shaft of the sorting unit is $d=43\text{ mm}$ and the encoder is 500 lines, the pulse equivalent $\mu=\frac{\pi d}{500}\approx 0.273\text{mm}$. According to the installation dimensions of each part of the sorting unit, approximately 614 pulses are emitted when the workpiece is moved from the feed port to the center point of the first chute; approximately 96 pulses are emitted when the workpiece moves to the center point of the second chute. When moved to the center of the third chute, approximately 1284 pulses are issued. When the workpiece on the conveyor arrives at the specified position, the pusher pushes it into the designated chute [13]. When the PLC needs to compare with the input signal whose scanning frequency is high, in order to avoid the loss of the input pulse signal, a high-speed counter is used to realize. In the sorting unit's PLC, there are six high-speed counters whose address numbers are HSC0~HSC5. The count rate of the high-speed counter is independent of the scan cycle of the PLC and there are 12 different operating modes. The HDEF instruction function of the high-speed counter is the selected operation mode; the HSC instruction function is to start the high-speed counter and make the high-speed counter settings take effect. The input of the high-speed counter is specified by the system. Each high-speed counter is divided into different input points. Each input point has special functions such as pulse input, direction control, reset and start. For example, the high-speed counter HSC0 occupies three input points I0.0, I0.1, and I0.2. If its operation mode is 9, then I0.0 is the A-phase pulse input, and I0.1 is the B-phase pulse input. There is no reset. Start function. The rotary encoder outputs pulse signals in the form of A/B quadrature pulses with no external reset and start signal. Therefore, the working mode is 9, the counter is HSC0, the phase B pulse is input from I0.0, the phase A pulse is input from I0.1, and the count frequency is set to 4 times frequency [14]. Guided programming with STEP7-Micro/WIN programming software.

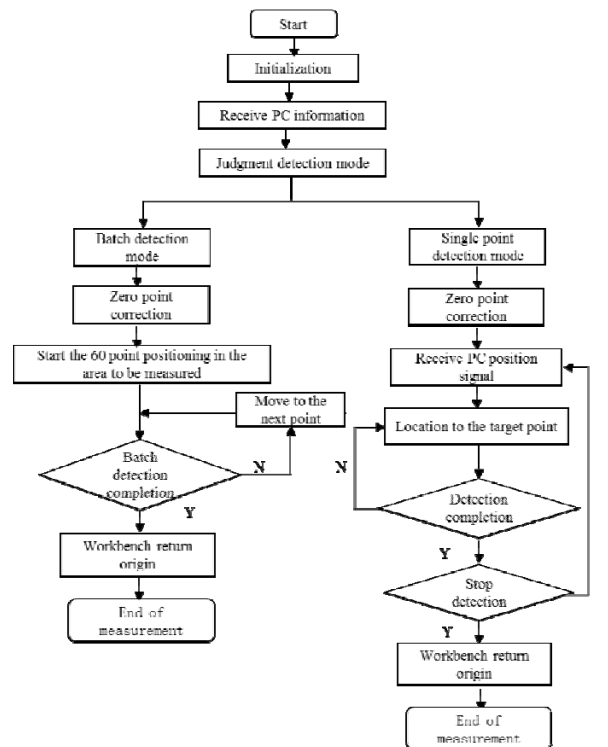


Fig.3 PLC program flow chart

4. Conclusion

This paper presents a relatively simple PLC-based precise mechanical positioning system, using PLC's rapid processing capabilities, through precise control of the stepper motor, to achieve accurate positioning control of the conveyor belt on the transmission, sorting. This system has very good theoretical and practical guidance for the automation of mechanical equipment.

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