

Design and Implementation of Electrical Control System for Trackless Machine Tool

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Abstract: With the rapid development of computer technology and microelectronics technology, the automation level of trackless machine tools has been improved obviously. At present, there is still room for optimization in the electrical control system of trackless machine tools. It can be seen that the electrical system design of trackless machine tools is very important for the improvement of machinery and manufacturing technology and the development of machining industry. This paper summarizes the use properties of PLC, analyzes the composition of electrical control system of machine tools from two aspects of basic structure and special structure, points out the design points of electrical control system, and studies the design and application of electrical control system through hardware control and software control.

1. Introduction

As the carrier of advanced manufacturing technology, the development of non-orbital motion machine tools is closely related to the development of various fields, so the development trend of non-orbital motion machine tools has attracted much attention, and its reliability has become the key index of concern [1]. When PLC technology is applied in the electrical control system of machine tools, it can analyze the running state and operation performance of machine tools. Trackless machine tool, especially high-end trackless machine tool, reflect the comprehensive strength of the country's economy, science and technology, and have a strategic position. In some cases, they even affect the survival of the country and the nation [2].

With the gradual development of modern social science and technology, the industrial production process tends to be automatic and intelligent. As a very important part of the current social processing industry, the automation of the mechanical manufacturing process plays a very positive role in improving the level of industrial automation in China. In practical application, the electrical control system of trackless machine tools should be optimally designed according to the actual needs of different industries, each module of the system should be reasonably designed, and various control functions should be realized based on PLC programming, so as to continuously improve the running efficiency of trackless machine tools.

2. PLC Program

PLC program is often regarded as the key part of electrical control of trackless machine tools, among which PLC program of trackless machine tools can reach processing time of tens of milliseconds to hundreds of milliseconds, which can meet the requirements of most information processing, but for some signals with high response speed, this processing speed also has some limitations. Data information is transmitted in an integrated way to realize the data scanning cycle, and repeated instructions are executed under the action of the content master control module. When collecting data information, PLC analyzes the information through the data input interface, and maps it to the corresponding unit module to realize the collection and classification of data information. Any set must have its own purpose. The key is to collect and store the client program

and related data according to the performance of the sequence given in the program. At the same time, the form and data received by the field input equipment are collected in the form of scanning and stored in the storage equipment [3]. In view of this, the vertical machining center divides PLC program design into two parts: low-level program and high-level program, in which the low-level program is divided into several modules for compiling from the angle of control function.

3. Design Principles and Steps of Control System

3.1. Design Principle of PLC Control System

The key purpose of the electric control system is to ensure that the technical requirements of the controlled target can be met, and to promote the manufacturing speed and product quality to be greatly improved. When the data transmission changes, the reference value of the data mapping area will not change, so as to ensure the comprehensiveness of data collection. The sensor detects the cutting tool through a transmitting point and a receiving point, and its output is a switch value, which is convenient to use and meets the requirements of reliability. It realizes cutting speed control of head stock, position control of feed servo motor, automatic adjustment of spindle center position by servo system, automatic control of unit, etc. In the control of the spindle, the rotation of the spindle is mainly completed, which requires the start-up control of the spindle, the speed control of the spindle and the electric adjustment of the spindle. The linearity of coordinate axis movement is determined by the guide rail of machine tool structure, and the movement speed of coordinate axis can be adjusted within a certain range. There is also a bit control function [4].

3.2. Design Steps of PLC Control System

In the actual operation process of machine tools and equipment, the wear of machining tools and improper operation will make the machine tools and equipment unable to work normally. In order to avoid the negative impact caused by operation errors, the general automatic machine tools and equipment are set with emergency stop buttons and limit procedures to ensure the integrity of equipment operation. The premise of designing the control system is to have full knowledge and understanding of the controlled system. Designers need to conduct on-the-spot investigation, collect relevant data and fully communicate with operators. When testing is needed, the status of digital optical fiber sensor can be directly read through I/O to know whether the cutter is broken or worn. At the same time, this sensor has multiple positioning modes, and the point positioning mode selected by this system is just to detect the state of the knife tip. Through the functional study of the electrical control system, it is divided into three different modules, namely hardware circuit, parameter setting and PLC program [5]. Then, according to the specific functional applications, these modules are divided into many different small modules.

4. Design Process Analysis of Electrical Control System for Non-orbital Machine Tools

4.1. Hardware Design of Electrical Control System for Non-orbital Machine Tool

There are some risks in the operation of non-orbital machine tools. In order to ensure the personal safety of operators and production personnel, the design of monitoring circuit and emergency stop protection circuit is necessary. The main function of monitoring and emergency stop protection circuit design is to detect the pressure of the machine tool, and to stop the operation urgently without abnormal monitoring data of the orbital motion machine tool. Using the powerful information processing ability of PC and the reliability of motion control system and detection system of machine tool, it is very important to fully improve the effective combination of control system of trackless machine tool. A control system whose servo system adjusts according to the input control command signal can obtain accurate position data and speed data under the guidance of the input command. Through the design of this module, the circuit of the trackless machine tool is protected. The circuit design of this module mainly includes the pressure detection and emergency stop operation of the machine tool. Through the analysis of these parameters, it is

determined whether the normal operation of the trackless machine tool can be continued. And can automatically transfer the processing parameters of blanks with different specifications, shorten the processing time and improve the working efficiency. In addition, HMI can display and call current or historical fault alarm records at any time through the information fed back to MLC by each slave station of the unit.

Operating software of upper computer and executing software of lower computer are needed in the working process of trackless machine tools. The host computer mainly reads the user's processing files and provides the user with an operation interface, and transmits some processing information and set parameters to the lower computer. In order to improve the control accuracy of machine tools, we should study the electrical control system, and formulate the corresponding control program according to the modular control function of the system. In the working process, the machine tools generally focus on the movement of X, Y and Z axes, and under the control of PLC, the internal integrated control is the main one [6]. It is necessary to frequently switch on or off the switching capacity of the direct, main and control circuits, and the electrical equipment and remote control. The main control object is the motor, which can also be used to control other electrical loads, such as electric water heaters, electric welding machines, capacitors and lighting. The method of reducing the profile error in multi-axis system by reducing the tracking error of single axis can still be adopted. The main reason is that every pulse step angle of this motor needs to be proportional to the control pulse, and there is no accumulated error. Only in this way can we ensure the accuracy of the open-loop system of the non-orbital machine tool and lay a solid foundation for the safe and stable operation of the numerical control system.

4.2. Software Design of Electrical Control System for Trackless Machine Tools

The convenience of compiling and debugging should be considered when determining the PLC programming language, which is mainly customer-oriented. In practice, there are two common PLC programming languages: ladder diagram programming language and instruction statement table programming language. PLC is a controller capable of free programming, which can set the corresponding parameters for the mechanical production and processing process of trackless machine tools according to their functions and structures. That is, the electrical control system is divided into three modules: parameter setting, PLC program and hardware circuit, and then these three modules are divided into several small modules from the angle of control function, so as to improve the design efficiency and quality. So as to ensure that the running state of the equipment can be fed back to the main control system in time. The controller can complete the actual operation and control function, and expand its function. The controller is connected with the system through interface connection, so that it can receive the equipment operation information from the grating ruler of the system, and can accurately execute the data instructions of PLC.

Communication between the upper computer and the lower computer is through TCP/IP protocol. In consideration of special circumstances (for example, it is uncertain whether the upper computer or the lower computer is turned on first every time, or one side suddenly breaks down and shuts down during work), both the upper computer and the lower computer should have the function of automatically establishing connection after communication interruption. According to the given value of speed and the actual value of speed fed back by the encoder, the speed loop control can calculate in real time, and the motor speed can be adjusted accurately by speed closed loop control. When setting the parameters of trackless machine tools, it needs to combine the functions of trackless machine tools with its own structure, and the same is true for the electrical control system of trackless machine tools. PLC program is divided into two parts: low-level program and high-level program. The electrical control system is divided into different modules, and the corresponding program operation is selected according to the different functions and functions of each module. The high-level program and low-level program cooperate to realize the accurate control of the control system of trackless machine tools by PLC program. Therefore, to develop the electrical control system of the trackless machine tool based on PLC, it is necessary to optimize the system according to its working principle and existing problems, so that the electrical control

system of the trackless machine tool based on PLC can give full play to its important role.

5. Conclusion

To sum up the above, the electrical control system is the most important component in the running process of the trackless machine tool, which can ensure the scientific and efficient operation of the trackless machine tool. The machine tool equipment is constructed by designing the working mode, programming and operating parameters of the electrical control system, so as to ensure the integrity of the internal data information feedback of the equipment and enable the machine tool equipment to be operated automatically. The electrical control system of trackless machine tools is a special machine tool with high precision in China's machinery manufacturing industry. Combining PLC with the electrical control system of trackless machine tools effectively and strengthening the electrical control system of trackless machine tools based on PLC can provide sufficient guarantee for further optimization of the control system of trackless machine tools. Therefore, it is very important for the development of the machinery manufacturing industry to actively analyze the importance of the design of the electrical control system of trackless machine tools and the ways to improve it.

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