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Research and Design of Automatic Loading Robot Automatic Control System

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Abstract: This project is based on the actual project of the company, and is designed for the automatic loading robot control system based on the CODESYS software for the purpose of meeting various performances and business needs. In the later stage of the project, the actual site conditions and problems occurred were debugged and modified. The actual operating conditions under different parameter files were tested and the automatic loading robots were able to meet the design requirements of the enterprise. The programming of upper computer CODESYS software was completed, including the motion control program, data transmission and communication design, and the design of man-machine interface. The actual test of the automatic loading robot control system was carried out at the production site of the company. The feasibility and efficiency of the control system have been verified by example applications and can meet the application requirements of the enterprise automation.
Keywords: Automatic loading robot, CODESYS, Human-machine interface design.

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1. PREFACE

In recent years, research on industrial robots has attracted widespread attention from scientific research institutes at home and abroad. Under normal circumstances, the first thing to do in the research of industrial robots is to analyze the structure and motion characteristics of robots, because this is the basis for understanding the robot's performance characteristics, and it is also a prerequisite for the robot's dynamic analysis, trajectory planning, and other more in-depth research. The main advantages of the gantry type Cartesian coordinate robot are: large stroke, large load load, stable operation, and good support rigidity, so it is more suitable for applications where the load is large or the rigidity is high[1]. Of course, the gantry robot also has certain Disadvantages: Due to the large robot travel, the space structure is relatively large, and should not be used under conditions where the working space is relatively narrow and the working environment is relatively strict.

2. OVERALL ANALYSIS AND DESIGN OF CONTROL SYSTEM

The automatic loading robot control system based on CODESYS software is an open PC-based control system[2]. The open control system can realize various applications, and the application interfaces have consistency and can communicate with each other. The advantages of an open control system include: openness to the future; ease of network integration; standardization of programming languages; good portability of application software; strong system flexibility; and friendly man-machine interface.

The open motion control platform consists of a hardware platform, a software operating platform, and an application development environment. The hardware platform shall be provided by the manufacturer with a universal controller and a standard control module. The user may combine and configure the axis number, digital quantity, and other external devices according to the actual application needs. The software operating platform is the backbone of the entire system platform, which is generally provided by a motion control system manufacturer or a software developer to provide a cross-platform universal system. The application development environment is a host computer development and debugging tool specifically provided to users. Users can use the application development environment to implement motion control functions and information exchange on corresponding hardware platforms and software operating platforms.

The control system selects the high-performance industrial PC as the control core and is responsible for all control tasks[3]. The upper computer adopts the Visual C# language development algorithm. Based on the Windows 7 operating system, the entire system adopts a modular, bus-based design concept, which simplifies the hardware design of the system. Installation and debugging. The automatic loading robot control system has a strong openness and stability, mainly as follows: Industrial PC model selection open. The PC-based control strategy is different from the dedicated controller approach. Because the PC interface is standardized and has common hardware resources, different industrial PC can be selected as platforms based on the control system's performance requirements and actual cost constraints. The openness of CODESYS software. CODESYS software integrates PLC programming, CNC, and SoftMotion into a programming environment. Program designers can flexibly design motion control and logic control methods according to their own needs. Openness of fieldbus selection. The system supports most of the bus protocols. The user can flexibly select and use different bus modules. Commonly used bus types include EtherMAC, EtherCAT, Sercos, CANopen, TCP/IP, and Profibus. Open Servo System Selection.Supports many brands of bus-based servo systems. For non-bus servos, users can also use the pulse generation module to connect with the system. System connection reliability[4]. Based on the choice of PC control system and bus-based servo, the connection of the system is simple, the industrial PC has strong stability, good anti-interference, and the system has extremely strong reliability.

In summary, a PC-based robot control system can use different hardware platforms, free from the constraints of hardware performance, and users can selectively integrate with other

hardware products and systems. CODESYS software meets the needs of most control platform developments.

3. AUTOMATIC LOADING ROBOT CONTROL SYSTEM PROGRAM DESIGN

The motion control program of automatic loading robot control system mainly includes logic control, servo motor control module, EtherMAC communication module, system parameter setting, human-computer interaction interface and so on. The logic control in the robot control system selects the manual logic control or the automatic logic control according to the instruction input by the user in the man-machine interface[5]. The motion control stage calls different function control modules according to the corresponding variables, and the main program controls the robots to perform automatic loading operations by continuously cycling the cycle.

The logic control is divided into manual logic and automatic loading logic. The program determines the current working status of each servo axis and cylinder by judging the corresponding flag bit and input and output signals, and sets the input and output variables at the same time. The manual logic needs to control the single-axis motion of the motor. The single-axis motion corresponds to the forward and reverse motion of the four motor axes. This module plays the role of manually controlling the mechanical gripper movement. This function is through the eight buttons in the manual operation interface of the system. To achieve this, when a button is held down, the corresponding motor moves in one direction. When you release the button, the robot stops its movement. Automatic logic is the normal working state of the loading robot. When the control system transfers the planned parameter file, it is controlled by the motion control module, and the program will perform the movement according to the planned results. Therefore, it can be seen that each program The modules communicate with each other to complete a function.

4. AUTOMATIC LOADING ROBOT ON-SITE DEBUGGING

Figure 1 shows the theoretical derivation diagram of the servo motor encoder, Figure 2 is the X-axis motor motion curve tracking diagram, when the X-axis motor moves through the encoder count travel, the motor feedback value The maximum and minimum jumps occur, causing the control system to be powered off and unable to correctly feed back the current state position.

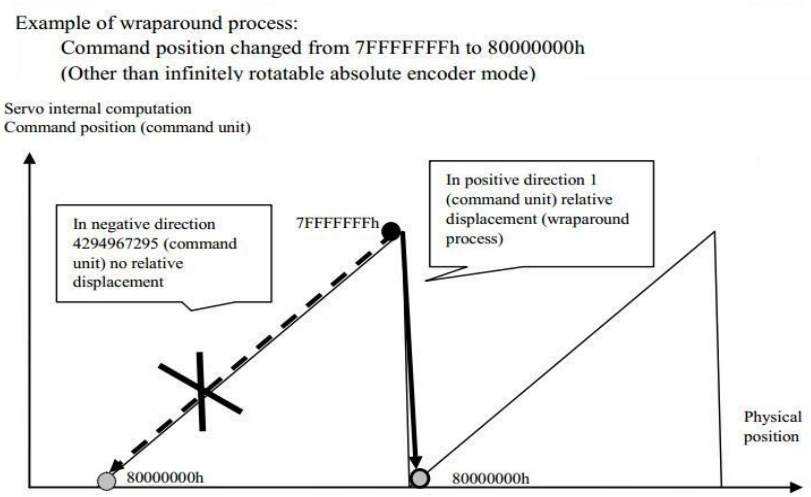

Figure 1 Servo motor encoder theoretical derivation

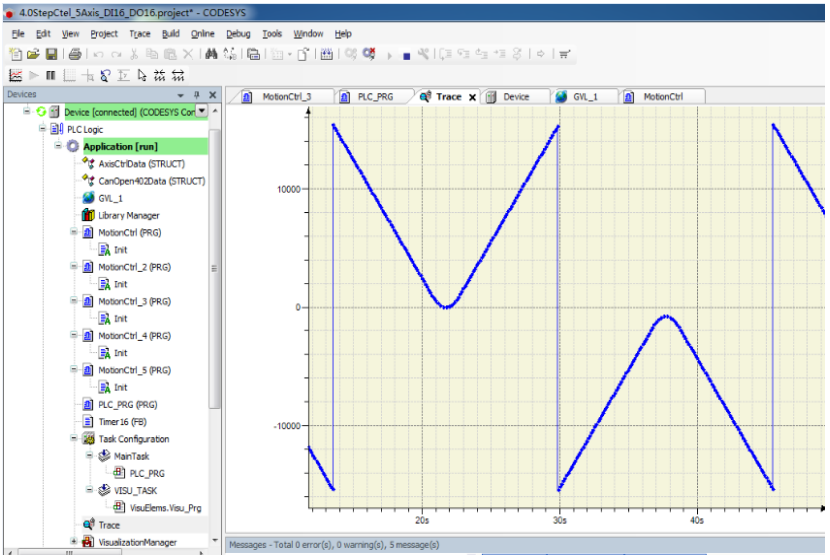

Figure 2 X-axis motor motion curve trace

During the movement of the robot, the trajectory tracking is performed on a loading cycle of the robot. As shown in Figure 3, it can be seen that the four axes of X, Y, Z and C are running smoothly during the movement of the robot by observing the actual trajectory of the robot. , efficient and shock-free shock phenomenon. Figure 6-5 shows the automatic loading robot working site map. Through the actual loading test, the robot can reach a loading rate of 800 bags/hour, the robot arm is placed neatly, and the anti-interference ability is strong, which can meet the design of the enterprise production line automation. demand.

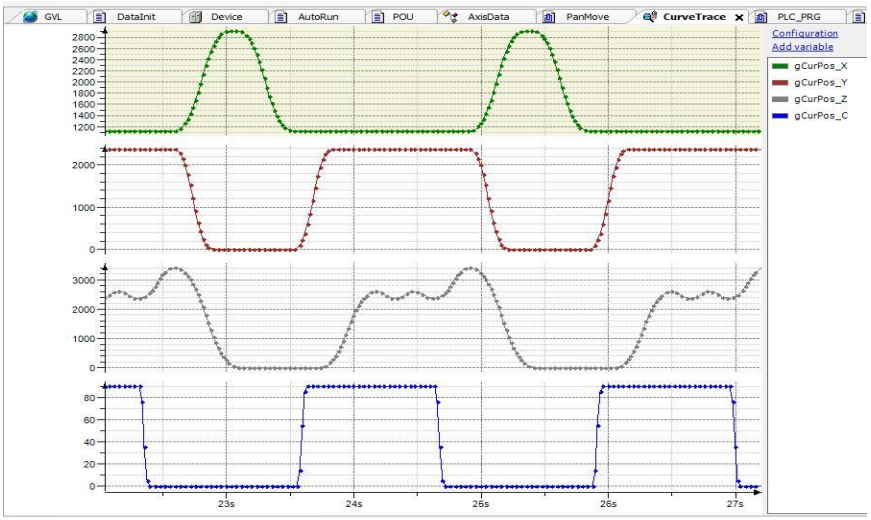

Figure 3 Trajectory tracking

5. CONCLUSION

The use of modular, bus-style programming ideas eventually achieved the software programming design of the control system, including motion control program design, data transmission communication design and man-machine interface design. The actual test of the control system was conducted at the production site. The feasibility and efficiency of the control system have been verified by example applications and can meet the application requirements of enterprise automation.

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