Integrated design and Research on driving and controlling structure of robot intelligent joint

Zhenlong Sun,Huimin Yu
Liaoning Institute of Science and Technology, Benxi City, Liaoning Province 117004

Abstract: at present, the robot industry is widely concerned in China, and there are more robot production and R & D enterprises. However, robots are subject to many restrictions in the application process, including industry development, enterprise structure, robot R & D and robot manufacturing. Many small enterprises have a series of characteristics such as low production and short cycle, so it is necessary to continuously optimize and update the robot to meet the needs of enterprises. The emergence of integrated design of drive control structure can effectively solve these problems. In the current development process, there is a high demand for the personalization and intelligence of robots. Therefore, this paper designs and studies the drive control structure integration of robot intelligent joint, in order to promote the development of robot industry.

Key words: robot; Intelligent joint; Integrated design of drive control structure

At present, people's demand for labor in daily work and life is gradually increasing, and the emergence of robots can significantly improve production efficiency. Since the beginning of the 21st century, robots have been included in the advanced technology industry, which has brought China's robot industry into a stage of rapid development. At present, the industry scale and market scale of robots in China are expanding, and they have also received more attention and recognition. Although the development of robot technology in China is fast, there is still a large space for development, and there are also many problems in the design and manufacture of some high-end robots. The integrated design and research of the drive control structure of robot intelligent joint is an important content of the robot industry in China, so it is necessary to strengthen the research and improve the development speed of the robot industry.

1. Mechanical structure design

1.1 Parameter design

In the actual design process of the drive control structure integration of the robot intelligent joint, the parameter design needs to meet the current actual needs and relevant regulations. The length of the robot shape should be about 110cm, the diameter should be about 90cm, the maximum torque should be 20n · m, and the rotation speed of the robot joint should be about 35rpm. And in the actual design process, lightweight design is needed as much as possible to reduce the overall weight of the robot.

1.2 Functional design

The engineering design process of robot intelligent joint drive control structure integration includes the following aspects: first, intelligent function. The robot can provide users with various parameters and data. Users do not need to master more complex knowledge and content in the actual application process, and can operate the robot quickly. Second, drive control integration function. In the process of robot design, a variety of sensors and actuators need to be integrated into the joints. Users do not need to purchase the actuators separately in the application process. First, multiple combination schemes. In the actual application process, it can provide users with a variety of combination schemes, and users can assemble the integrated joint according to their own strength needs and actual use conditions, so as to better meet their own needs.

1.3 Structural design

Reducer, encoder, sensor and motor are important components in mechanical system. In order to reduce the backlash and improve the positioning accuracy, hollow harmonic reducer can be selected in the actual design process, and hollow brushless DC motor is also used in the electromechanical design. Through this design method, the joint wiring can be directly led out through the central hole, which simplifies the traditional wiring method, The problem of friction and winding in the application process can be effectively solved. At present, the transmission type photoelectric encoder is usually used for the relative type of robot joints. In order to optimize and innovate the robot, the reflection type photoelectric encoder can be applied. Although this encoder has the same accuracy and resolution as the transmission encoder, it is relatively small in size and can be placed in the inner wall of the link shell, which can reduce the occupied space as much as possible and will not occupy the axial space of the joint, and can well meet the requirements of lightweight design. And in the actual design process, Hall sensor can be used to replace the traditional absolute photoelectric encoder. Due to the high price of photoelectric encoder, this method can not only reduce the cost to a great extent, but also improve the reliability, and also improve the integrity of the joint. The traditional joint hole location has a series of shortcomings in the process of fixing, such as being unable to redeploy and the hole location is fixed. Therefore, when designing the shape, in order to better meet the needs of users, the octagonal shell can be used. The connecting hole location needs to be set on all faces of the octagon, and some connecting pieces matching with the hole location should be designed, In order to optimize the overall structure of the robot and improve the functionality and overall use effect of the robot, it is necessary to reduce the processing cost while ensuring that the configuration can meet the diversification, and avoid the application of connecting rods with high processing difficulty and complex structure.

2. Hardware circuit design of drive control system

2.1 Motor circuit design

Brush motor has a series of characteristics such as low price, convenient control and simple speed regulation, and is widely used in servers. In the steady state, the electrical equation of DC motor is U1 = E1 + IDR. In this formula, U1 represents the voltage of the external DC power supply of the driving motor, and E1 represents the induced electromotive force of the motor in the steady state, ID represents the

armature current of the motor under steady-state conditions. R is the actual resistance of the motor. The formula of induced electromotive force of armature winding of Brushless DC motor is E1 = CenΦ, In this formula, CE is a constant, which is determined by the whole electromechanical structure, and N is the speed of the motor, ΦRepresents the excitation flux, so the speed expression formula of DC motor can be obtained: n = (U1 IDR) /ceΦ, Through this formula, we can get a variety of methods to realize motor speed regulation, including changing the motor armature resistance, changing the excitation flux and changing the power supply voltage. In this paper, the PWM square wave is used to control the motor speed, so only by changing the motor voltage can the motor speed be changed. If the appropriate chip is selected in the bridge circuit, the complexity of the circuit can be reduced, and the stability of the circuit can be significantly improved.

2.2 Buck module design

During the design of step-down module, the voltage of 7.4v needs to be reduced to 5V, and then the voltage of 5V needs to be reduced to 3.3V. LM317 step-down chip is used in the process of reducing from 7.4v to 5V, and ams1117 step-down chip is used in the process of reducing from 5V to 3.3V, which can better meet the needs of different voltages. The LM317 step-down chip is an adjustable chip with a maximum difference of 40V, which can effectively meet the current demand. Ams1117 step-down chip is not adjustable. It is a fixed value chip that directly reduces the voltage to 3.3V. This chip does not need to adjust the resistance in the application process. The maximum voltage is 15V and the maximum current is 1a, which can meet the current demand.

2.3 Design of current acquisition module

In the process of current acquisition, it is necessary to design a reasonable current acquisition circuit. The chip used is max44248. Outa and outb can represent channel A and channel B respectively, the positive and negative inputs of channel a are ina+ and ina-, the grounding is represented by VSS, and the 5V power supply interface is represented by VDD. The positive and negative inputs of channel B are represented by inn+ and inb- respectively. A resistor is connected in series at the grounding terminal, and the differential filter is composed of resistors at different points. In order to effectively reduce the zero drift, a 0.8V lifting voltage can be connected at one point to optimize the overall structure and overall effect.

2.4 Position detection module

In the process of robot joint control, position detection plays an extremely important role and influence. The commonly used detection elements include hall type position detection elements and encoder type position detection elements. In comparison, hall type position detection element has a series of advantages such as low cost, high reliability and simple structure. In this paper, the as5600 magnetic encoder is taken as an example. The hall principle is applied, and more signals are obtained through the magnetic detection method. 0 ° to 360 ° belong to the measurement range. The application of 12 digital to analog converter output resolution can improve the accuracy. This principle has a wide range of applications, and has high cost performance. In terms of magnetic field acquisition, the circuit has two methods: integrated circuit and PWM mode. The application of integrated circuit can effectively improve the efficiency and accuracy of transmission.

2.5 Communication module design

In the actual design process, the communication module mainly exists in the control board, control board communication, driver board communication and upper computer. Serial communication is applied between the control board and the upper computer. Ch340c is selected as the chip, which can realize the effective conversion between USB and TTL. The peripheral circuit of this chip is relatively simple, and there is a built-in crystal oscillator. The driver board communication uses can communication. The chips used are sn65hvd230d and tja1050. The biggest difference between the chips in this circuit is the power supply voltage. The voltage of tja1050 is 5V, and the voltage of sn65hvd230d is 5V and 3.3V, which are mainly placed on the driver board. The application of can to realize signal transmission is a series method, but 120 Ω resistors are installed at the beginning and end respectively, so that the circuit can be controlled in series, and the operation is more convenient.

2.6 Control module design

Stm32f103t8u6 chip is used in the drive circuit control module in the design process of the robot. This chip has high cost performance, high overall performance and low power consumption. The passive crystal oscillator with a crystal oscillator frequency of 8MHz uses PWM square wave. The two pins are the complementary PWM control output terminal and the motor forward and reverse PWM terminal respectively. The motor braking and speed are controlled by changing the duty cycle.

3. Software design of drive control system

The robot joint circuit consists of a drive board and a control board. The control board can act as a transfer station to realize the connection between the drive board and the upper computer. The driving plate is mainly used to drive the motor and monitor the operation of the motor. The upper computer can transmit the signal to the control board through the serial port, and then the control board can transmit the signal to the driver board, which can also realize the reverse transmission of the signal. The main program contains can interrupt and serial port interrupt. The driving board is mainly responsible for the joint action of the driving robot. At the same time, it also monitors the temperature and current of the motor in real time. The program mainly includes external interrupt, advanced timer interrupt and can interrupt. Current protection and temperature protection belong to the highest level interrupt. The actual control process is that the control board sends signals, can is responsible for the transmission of signals, the drive board receives the signals, and then immediately generates can interrupt, compares the position signals and data of the magnetic encoder, and turns the motor to the correct position.

4. Integrated design of joint drive control structure

4.1 Joint structure

The design and customization of the core parts of the drive control structure integrated robot joint include the following aspects: first,

the reasonable matching between the torque range and the torque motor can effectively avoid the problem of torque waste and insufficient torque. Second. According to the requirements and characteristics of joint braking, the scheme of non band brake, friction band brake and gear pin band brake can be selected. Thirdly, the joint shell and reducer are designed reasonably to ensure the lightweight and compactness of the robot. Fourth, reasonably design the parameters of joint torque and torque sensor to ensure that the torque is within the detection range. Fifthly, according to the characteristics of DSP digital processing technology and parameter identification, select the driver reasonably, and give full play to the characteristics and performance of torque motor. Sixth, select the encoder technology with high accuracy according to the principle of capacitance and magnetic field.

4.2 Frameless torque motor

In the actual design process of the integrated robot joint, the frameless torque motor is applied, and the motor stator and joint shell are usually connected with high temperature resistant resin adhesive, and the motor shaft and motor rotor are also connected with resin adhesive. The large diameter length ratio of frameless torque motor can ensure the speed characteristics and output performance of the motor.

4.3 Central control encoder

Most integrated robot joints are designed with double encoders, including single turn absolute encoder and incremental encoder. Incremental encoder can be applied to motor detection, and single turn absolute encoder is applied to reducer output detection. Double encoder structure scheme to improve the rotation accuracy of the joint, it is necessary to compensate the backlash of the harmonic reducer during the movement. The application of multi turn absolute encoder in the integrated joint structure has the characteristics of simple structure, but it needs to be powered by the encoder battery, which can not guarantee the accuracy.

4.4 Harmonic reducer

High precision and high transmission ratio are important contents in the joint design process of the integrated robot, so the application of harmonic reducer can achieve high-precision transmission and reduce the volume. Custom reducers usually choose lengthened structure. The rotor of frameless torque motor needs to be directly connected to the lengthened structure. The application of harmonic reducers can make the overall structure more coordinated and compact, but if the accuracy is not high, there may be a risk of vibration.

Concluding remarks

In general, at present, many enterprises in China have high demand for robot technology, which can not be met by traditional robots. Therefore, according to the needs of enterprises, an intelligent joint robot with drive control structure integration is designed. In this paper, the mechanical structure design content, drive control system hardware circuit design content, drive control system software design content and joint drive control structure integration design content of the robot are analyzed and studied in detail, so as to improve the overall design effect and design level, make the robot better meet the current needs of enterprises, improve production efficiency, and promote the development of various industries.

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