Six-degree-of-freedom robot design

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Abstract

The technology of robot is a complicated combination which includes mechanical, microelectronics, computer, automation control and drive, sensing, signal processing and artificial intelligence interdisciplinary technology.With the development of economy and the requirement of modern production, the application field and scale of the robot is gradually expanding, and the research and application level of the robot also reflects a country's economic strength and development level. In reality, the definition of different industries of the robot is not the same, generally speaking, the robot can defined as a kind of automatic detection, reprogrammable, multifunctional multi degree of freedom manipulator, material handling, workpiece or manage tools, to finish all kinds of assignments. In the actual production line, workers on the items of the operation often need with a higher degree of freedom mechanical arm to complete, while at the same time with manual operation and path planning of the robot arm can bring great convenience to the specific needs of the staff, based on the above, the design completed a with operation keys and path planning of six degree of freedom mechanical arm, on the one hand can be according to the actual needs of the operator to control for each degree of freedom adjustment, on the other hand of repetitive movements can also be for path planning, in order to meet the actual needs of the production staff, greatly improve the production efficiency.

Keywords

Robot; STM32 Microcontroller; Robot arm; Path planning.

1. Introduction

Robotics is a multidisciplinary technology that integrates mechanical, microelectronics, computer science, automatic control theory and motor drive, sensors, signal acquisition and processing, and artificial intelligence. With the development of the economy and the requirements of the modern industry, robotics The field of application and scale are expanding, and the level of research and application of robots also reflects the economic strength and level of scientific research in a country.

In reality, the definition of robots varies from industry to industry. Generally speaking, robots can be defined as an automatic detection, reprogrammable, multi-degree-of-freedom manipulator that can carry materials, workpieces or tools. To complete a variety of homework. Robots generally have three things in common: first, a mechanical device that can carry materials, parts, tools, or perform a variety of operational and operational functions; second, can be reprogrammed, with a variety of program flow; Third, there is an automatic control system that can automatically complete the operation and action functions without any participation. Industrial robots are high-tech automated production equipment developed in recent decades. Industrial robots are an important branch of industrial robots. It is characterized by the ability to program a variety of expected tasks, both in terms of construction and performance, and the individual and machine advantages, especially the human intelligence and

adaptability. The accuracy of robotic operations and the ability to complete operations in various environments have broad prospects for development in all areas of the national economy.

In actual production lines, workers' operations on items often need to be accomplished with the help of a highly free robotic arm. At the same time, robots with manual and programmable paths can bring great convenience to workers with specific needs. Based on the above situation, the design has completed a six-degree-of-freedom robotic arm with button-operable and programmable paths. On the one hand, it can control the adjustment of each degree of freedom according to the actual needs of the operator, and on the other hand, the repeated action. Path planning can also be carried out to meet the actual needs of production personnel and greatly improve production efficiency.

2. Path can plan the overall design of the six-degree-of-freedom manipulator system

2.1 System design requirements

(1) Mechanical installation, commissioning, power drive, power control and path planning for a six-degree-of-freedom robotic arm.

(2) Status display: LED module with display power and control panel status, LCD module showing freedom of servo status.

(3) Control panel: The control of each degree of freedom servo can be completed by two common switches, including clockwise and counterclockwise.

2.2 Ntroduction to overall system functions

The system mainly realizes the function of cargo transportation based on the fixed arm of the fixed base, and the object is to grasp, carry, place and set the items to be gripped at a fixed position. The system can be controlled manually or by path planning, and repeating an action to complete the above functions.

Mainly reflects in:

(1) Manually manipulating the robot arm.

In order to facilitate the artificial control of the system, the design of the operation panel has 12 keys key1, key2....key12, wherein each of the two buttons controls a steering gear, which can realize clockwise and counterclockwise rotation respectively. When two buttons are pressed at the same time, the invalid button state is entered, and the LED will blink continuously.

(2) The planned path can be repetitive.

In addition to manual operation, the system can complete semi-intelligent manual planning of fixed tracks, complete simple cargo picking and handling functions.

(3) Status display.

The system has an LED status reminder function. When a button is pressed alone, the LED will change state intermittently, and the two LEDs respectively correspond to two different direction buttons; when two buttons are pressed at the same time, the rudder opportunity remains in the previous one. The termination state, that is, the hold action is unchanged, the LED will flash continuously to remind the button that the status is wrong. At the same time, it has an LCD module that displays the current state of the servo, which is convenient for the operator to check the working state of the servo.

(4) Dynamic and static control of each degree of freedom.

The system has six degrees of freedom mechanical joints, namely the gimbal, waist, back, neck, rotor, and clip. Each degree of freedom can set a dynamic or static action posture through the PWM wave sent by the control center STM32 to complete the cargo transportation process with higher difficulty.

(5) Automatic reset.

The system can perform the reset state before the work and in any state, and the reset state can be set manually, which greatly helps the system control.

(6) Design that is convenient for staff to install and debug:

1) Each degree of freedom of the robot arm is provided with a separate power switch, which can realize dynamic and static block control;

2) The power module is equipped with a power indicator. When the system is properly powered on, the power indicator lights up to make it easier to determine whether the system is powered.

3) LCD12864 module can display the working angle and running state of the steering gear in real time, which can make the operator understand the state of the steering gear more intuitively;

4) The software sensitivity debugging is set in the button operation, so that the manual control process is smoother and more in line with people's control expectations.

3. Path can plan the hardware design of the six-degree-of-freedom manipulator system

The hardware design of the system is mainly based on the assembled mechanical arm. The functional modules are: power module, controller module and LED, LCD module, button control board module, circuit board integration module.

3.1 Functional module design

3.1.1Controller Module

At present, the mainstream controllers mainly include PLC, ARM, and MCU. The PLC is essentially a computer dedicated to industrial control. Its hardware structure is basically the same as that of a microcomputer, and its anti-interference ability is strong. But the price is expensive and bulky. The ARM processor is the first RISC microprocessor designed by Acorn Computer for low budget markets. Small size, low power consumption, high performance can be equipped with linux and other processing systems, ARM relatively affordable, rich applications, for this design of the system is just right.

Based on the ultra-low-power ARM Cortex-M3 processor core, the STM32 family uses ST's two unique energy-saving technologies: a 130nm dedicated low-leakage current manufacturing process and an optimized energy-efficient architecture to deliver industry-leading power savings. The family is part of ST's powerful 32-bit STM32 microcontroller family, which has more than 200 products in its family. The full range of products share most of the pins, software and peripherals, and the excellent compatibility brings developers Maximum design flexibility.

3.1.2 Power Module

The main function of the power module is to output the power required by the whole system. There are mainly 6.5~7.0V power supplies required by the single-chip microcomputer and the robot module. The controller needs 5V power supply, which is provided by the USB cable to the PC terminal. The power of the button control module is output by the controller. 5V power supply. Among them, the control panel system and the manipulator system need to be co-processed to ensure that the signal transmission of the steering gear is stable and effective.

3.1.3 Power Module

The steering gear is also called servo motor. It was first used to realize its steering function on the ship. Because it can continuously control its rotation angle through the program, it is widely used in the smart car to realize steering and various joint movements of the robot. This design uses six steering gears as the power module of the manipulator. Two of the digital servos have a degree of freedom of 360° and four analog servos have a degree of freedom of 180°. Two digital servos with large degrees

of freedom are applied to the two parts of the mandrel system and the rotor to ensure the maximum utilization of the path and the effect of the action.

There are three input lines for the steering gear, of which red is the power line in the middle and black is the ground line. These two lines provide the most basic energy guarantee for the steering gear, mainly the rotation consumption of the motor. The remaining one is the signal line that acts as a signal input port to control the rotation of the servo. The PWM control signal generated by the STM32 enters the signal modulation chip from the channel of the receiver to obtain a DC bias voltage. It has a reference circuit inside, which generates a reference signal with a period of 20ms and a width of 1.5ms, and compares the obtained DC bias voltage with the voltage of the potentiometer to obtain a voltage difference output. Finally, the positive and negative voltage output of the voltage difference to the motor drive chip determines the forward and reverse of the motor. When the motor speed is constant, the potentiometer is rotated by the cascade reduction gear, so that the voltage difference is 0, and the motor stops rotating. The control of the steering gear generally requires a time base pulse of about 20 ms. The high level portion of the pulse is generally an angle control pulse portion in the range of 0.5 ms to 2.5 ms, with a total interval of 2 ms.

3.1.4 Line Integration Board Module

There are a large number of terminals in this design, including the power supply line of the servo (6), the signal line, the LED wiring, the power line of the operating handle, the signal line and the controller's large number of pin outputs, so the circuit board module is very necessary.

The circuit integration board module used in this time is relatively simple, and is composed of a large number of connected pins, which can mainly realize power supply distribution and signal transmission. For example, the power and ground wires of the six servos can be connected to the power supply by the two power strips, and then the signal wires are connected to the output pins of the controller, so that the power supply output can be stabilized and the power supply can be stabilized. The lines are neat and tidy, preventing the robotic arm from interfering with motion.

3.1.5 Button Control Module

The button control module consists of 12 common switches. For power supply and soldering, all power inputs and all ground terminals are combined into one port. The button circuit uses a pull-down resistor to ensure that the button is low in the floating state.

In the actual circuit, KEY0 and KEY1 are responsible for the positive and counterclockwise rotation of the grip position servo, and so on. Each of the two buttons is responsible for the control of the rotor, neck, back, waist and pan/tilt.

4. Conclusion

This design implements the functional indicators of the six-degree-of-freedom manipulator from the following aspects:

1. The angle of the steering gear can be controlled to realize the deployment of degrees of freedom. Each steering gear can play a rotating role in the mechanical structure to realize the action command of the robot.

2. The timer comparison function is used to generate multi-channel PWM signals to control the angular rotation of the steering gear. Changing the duty cycle of the PWM signal can accurately control the deflection angle of the steering gear with an error of ±3° (this error comes from mechanical factors).

3, using the ordinary switch, supporting circuit and software programming to achieve the control of the button to the steering gear; for each button control of the steering gear range, the sensitivity of the training can achieve smooth operation of the robot.

4. Power supply plan. The power demanding module in this system includes STM32 control core, steering gear and LED. Among them, the number of steering gears is large, and the circuit board needs to be matched to ensure reasonable power distribution and clear lines.

5. LED status prompt module, the single-chip computer controls the LED module to display the state of the control button press, and reminds the different function states of the button through different blinking modes.

6, using STM32103C8T6 microcontroller control. Combine the information of each sensor, use STM32103C8T6 microcontroller programming control to achieve various functions required.

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