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Design of multi degree of freedom manipulator

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Abstract: The robot uses five degrees of freedom and uses full hydraulic drive to clamp the workpiece. A robot is a robot's drive mechanism consisting of a hand, a wrist, an arm, and a stand. The gripper is a clamping device that is used to hold or relax. It functions like a human finger. The manipulator adopts hydraulic transmission, which has a compact layout, a very stable operation, shock resistance, shock resistance and explosion-proof performance. Hydraulic technology is mature, with high power, large inertia ratio, fast response, it is easy to achieve direct drive and so on. The five degrees of freedom are: the degree of freedom of rotation of the arm, the degree of freedom of grasping of the claw, the degree of freedom of the arm extension, the degree of freedom of the pitch of the wrist, and the degree of freedom of the arm spacing.
Key words: Manipulator; Hydraulic system; Five degrees of freedom.

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1. INTRODUCTION

Industrial robots replicate the functions of human brains and hands and feet on machines. They can help people work under conditions that are dangerous, harmful, toxic, cold, and hot.
The growth of Chinese manipulator is increasing the scope of application. The application scale is mainly forging and heat treatment. When the professional machine hand is used, the general machine hand is also growing slowly. Now robots use more on machine tools. It is now necessary to study the contact and vision capabilities of servos, video reproductions, and robots [1].

2. ARM DESIGN

The arm has three degrees of freedom, which can be divided into length movement, left and right movements, up and down movements. In normal circumstances, the speed change of the arm when it is extended is not very big, and the speed of the arm movement changes at the beginning and the end. In order to prevent this from happening, it is necessary to start from the start-up time, so that its time is shortened, or it will cause the blow and vibration. This is a new highlight in preventing arm deformation during arm movements. According to the layout of the

arm, the weight of the grab, etc., it is possible to make the grip force reliable without causing a moment of gravity during the grip.

The pitching operation of the arm is driven by a single-acting cylinder. The body and the bottom of the hydraulic cylinder are connected in one body, and the portion of the piston rod that is formed is connected with the arm. When the pressure oil enters the cylinder, it will drive the piston rod to start moving back and forth. After the piston rod is driven, the piston rod of the connecting arm will form a pitching motion.

About cantilever robots, the most important thing is to arrange the above layout. The main consideration is the arrangement of the components on the arm, focusing on what is the focus, what is the non-key, and then select the torque according to the movement. If too much emphasis is placed on the torque, it will cause the arm to vibrate. When you get up and down, you will see a countersink and it will also affect the maneuverability of the movement. When you are severe, your arms will break. When we study the arm, we must make the center of the arm's weight pass through the center of rotation [2] [3].

3. LOAD CALCULATION OF EACH COMPONENT OF A MANIPULATOR

3.1 Design of finger clamping mechanism

This article uses a four-finger V-shaped structure, the surface of the finger is smooth, to prevent damage to the clamp. The finger is driven by a spring-return single-acting hydraulic cylinder. The drive section uses a wedge-type compound rotary drive. The tension spring is installed on the lever and the finger is clamped to drive the hydraulic cylinder to recover. Fingers are determined by the clamped work piece.

The clamping force of the workpiece is the main basis of the hand structure design.

The result is:

$$F_N \geq K_1 K_2 K_3 \mathrm{G} \tag{1}$$

Medium: K1—— the safety factor is 1.2 to 2;

K2---Working situation coefficient, About it:

$$K_2 = 1 + \frac{a}{g} \tag{2}$$

a--The acceleration in the vertical downward direction

$$\mathrm{a} = \frac{v_{max}}{t} \tag{3}$$

v_{max}----The maximum velocity in the vertical downward direction, v_{max}=0.7m/s.

t----When you get to the fastest speed, take 0.2-0.4

k3-- Direction coefficient, $K_3 = 0.6 \sim 0.9$

The result is:

$$F_N = K_1 K_2 K_3 G = 1.0 \times \left(1 + \frac{0.07/0.35}{9.8}\right) \times 1.0 \times 156.8 = 160N$$

The force of the hydraulic cylinder to complete the work of the finger is:

$$F_{clamp} = 160\mathrm{N}$$

3.2 Calculation of load of arm expansion mechanism

Two used hydraulic cylinders for stretching and shortening movement, the first to overcome the friction caused by resistance, including oil and piston rod and support between the sliding friction between the friction and orientation, in the starting process to stop the torque.

The result is:

$$\mathrm{F} = \left(F_f + F_a\right)/\eta_m \tag{4}$$

Formula:F_f---- Resistance of different parts(N), The result is:

$$F_f = \mu(G + F_N) \tag{5}$$

Formula:F_N-- The force to bear outside(N), The result is the result.

$$F_N = G_{workpiece} + G_{hand} + G_{wrist} \tag{6}$$

u--resistance coefficient,F_A-- inertia force(N)

$$F_a = \frac{G_{total}}{g}\frac{\Delta v}{\Delta t}$$

The result is:

$$F_f = \mu(G + F_N) = 0.1 \times (980 + +156.8 + 196 + 294) = 162.7N$$

$$F_a = \frac{G_{total}}{g}\frac{\Delta v}{\Delta t} = \frac{1626.8}{9.8} \times \frac{0.07}{0.1} = 116.2N$$

$$F_{Telescopic} = \left(F_f + F_a\right)/\eta_m = (162.7 + 116.2)/0.95 = 293.6N$$

4. HYDRAULIC PRINCIPLE

The actuation signal of the actuator of the hydraulic system controls the electronic control system of the corresponding solenoid valve or electrohydraulic valve. According to the process of the motion step, the working hydraulic system is controlled by a hydraulic cylinder and a solenoid-operated solenoid valve.

The key of brake location and buffer operator is stable and reliable operation. In order to improve the productivity, it is hoped that the manipulator can work faster and better, but the speed is higher, the moment of inertia is larger and the start and stop will be bigger. It will not only affect the positioning accuracy of the manipulator, but also damage the parts. Therefore, in order to achieve the robot positioning accuracy and movement stability requirements, generally used before the buffer location. The robot is controlled by a pressure sensor.

Manipulator control including work order, position, movement time, speed and acceleration. The control mode can be divided into two types, position control and continuous control, with more than 90% control points. In controlling the design of manipulator, PLC can be used for position control. PLC is a digital electronic system operating into industrial environment and application design. It has a flexible computer programming control, full function and wide application of the relay system. It has the advantages of simple and easy to use, strong anti-interference ability, low price, small volume, light weight, low power consumption. In order to improve the flexibility of using the manipulator, the manipulator can be set to manual and automatic operation mode.

5. CONCLUSION

(1) According to actual needs, a scheme of five degrees of freedom manipulator is proposed.
(2) According to the actual work needs and the characteristics of the hydraulic transmission, the driving force and torque of the manipulator are calculated, and a hydraulic drive scheme is put forward.
(3) Select suitable hydraulic components according to actual working requirements.

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