Journal of Applied Science and Engineering Innovation Vol.2 No.4 2015, pp.123-125
ISSN (Print): 2331-9062
ISSN (Online): 2331-9070

Design of Manipulator Based on Motion Controller

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Abstract: With the development of science and technology, the requirements of measuring instruments are also increasing, three coordinates measuring instrument is a widely used measuring instrument, but how to place the large complicated workpiece on the measurement table has become a major problem. This article has carried on the analysis about the manipulator used on the three coordinate measuring instrument, a kind of manipulator is designed based on motion controller, it adopts the double CPU structure of " PC + motion controller", which can guarantee the response speed and control accuracy. The manipulator has a certain practical significance in industry.

Keywords Manipulator; Control system; Motion controller

INTRODUCTION

With the improvement of the automation of the production, the requirements of measuring instruments are becoming higher and higher [1]. Three coordinates measuring instrument is a kind of precision measurement equipment in large scale, it is widely used in automatic production, it has the characteristics of high precision, high degree of automation, it is widely used in various fields[2]. It is difficult to measure the accuracy of some very complex workpieces by man, it can only with the help of the equipment such as three coordinate measuring instrument to complete the test work. But in the process of how to make the workpiece accurately and rapidly placed in the three coordinates measuring instrument is a problem to be solved. Manual handling has disadvantages of high cost and low efficiency, it also exists security risks [3]. To overcome this problem, the workpiece can be performed using assembly manipulator. Assembly machine hand clamping can greatly reduce clamping time, improve the clamping efficiency. Some workpiece has large size and high weight, the human is difficult to complete, it can only use the manipulator to clamp [4]. This paper describes the design of manipulator for three coordinate measuring instrument, which uses the motion controller as the core control, it can improve the reliability of the system, and can be matched with the three coordinate measuring machine perfectly.

THE MANIPULATOR OVERALL DESIGN

Requirements analysis

The main function of assembly manipulator in this paper is to grab a large work piece to be measured from the starting place, then transport it to the three coordinate measuring machine steady, and place it on the clamping position correctly. According to the needs of the work, the functional requirements are as follows:

1）Work piece placement location is random, manipulator can automatically find the work pieces of different position, after clamping a workpiece, it will transport according to setting routes, manipulator requires steady movement in the process of movement, and flexible steering.

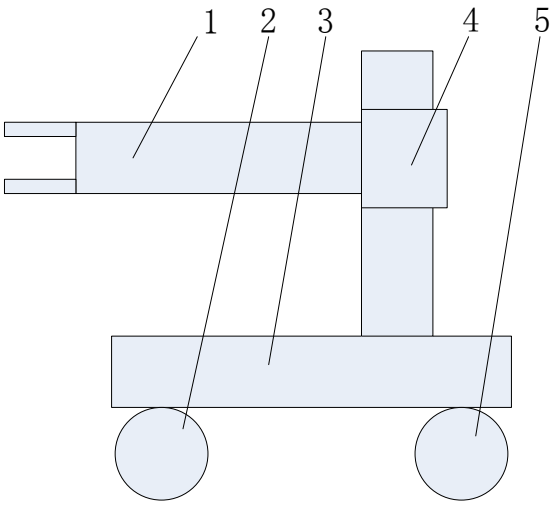
2）The force intensify the workpiece need to detect, the force can not be too large, so as not to clamp tightly, then the workpiece is damaged; force can not be too small, so as not to cause the workpiece clamping too loose, then it may fall off in the process of movement.

3) Manipulator has manual and automatic two models, in the automatic mode, it only need to input the path planned in advance. In the working process of the manipulator, it can flexibly realize perpendicular to the direction of motion, and can stop at any position.

Mechanical structure design

As shown in Figure 1, according to the requirements of the manipulator using, a three coordinates measuring instrument is designed. Manipulator mainly comprises a positioning mechanism, body, movement mechanism and a fixture. The body is equipped with three wheels, the front wheel is a universal wheel, it can ensure the body travel in all directions, the wheel is two non universal wheels, they can guarantee the stable running. Moving mechanism is arranged in the vertical direction on the column, it can start and stop at any time in each position. The fixture is connected

with the moving mechanism, it can also move up and down along with the motion mechanism.



1. Fixture 2. Universal wheel 3.Body
4. Movement mechanism 5. Non universal wheel
Figure 1. Mechanical structure of the manipulator

Mechanical structure design

As shown in Figure 2, the manipulator in this paper uses the motion controller as the control core, and adopts the "+PC motion controller" double CPU structure, which can guarantee the processing speed of the system. The communication between the motion controller and PC uses Ethernet. The signal is detected from the sensor, then the signal feedbacks to the system, system will do the control according to the setting procedures, which can ensure accurate operation of the manipulator.

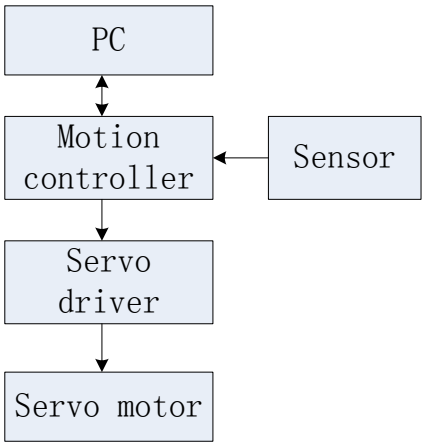


Figure 2.Control system design of the manipulator

SOFTWARE DESIGN

Software structure design

The control system in this paper adopts the "+PC motion controller" double CPU structure, so the structure of software takes the form of upper and lower computer. As shown in Figure 3, the PC serves as the upper computer, it is mainly used for program development and management; motion controller serves as lower computer, it is mainly used to control the movement of the manipulator. As shown in Figure 4, the software adopts modular design, it not only can ensure the stability of the system, but also can guarantee the corresponding velocity, wherein the upper computer is the management module, the lower computer is the control module, each sensor signal is feedback module.

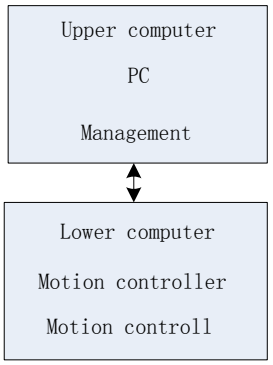


Figure3. The overall design of control system

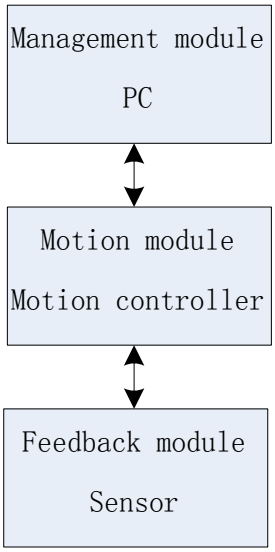


Figure4. The modular design of program

The program flow design

The program flow of the system is shown in figure 5. First of all, do the system initialization, and detect system, if the system is working properly, then do mode choice, if the choice is manual mode, the manipulator can do manually control, if choose automatic mode, first carry on the design of the motion path. After the path design is completed, the manipulator automaticly searches for the workpiece, when the sensor detects the signal of the workpiece, the fixture clamps the workpiece, the manipulator continues to move, until the workpiece is placed in the specified location on the three coordinate measuring instrument, the clamping work is completed.

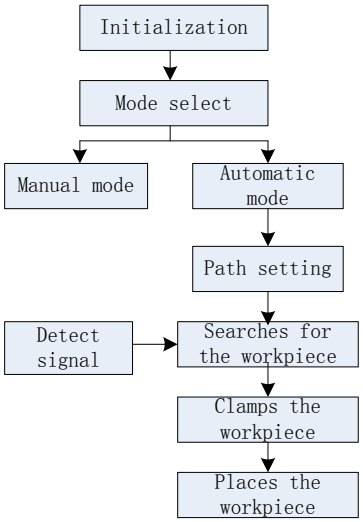


Figure5. Program flow design

I/O design

The motion controller has I/O interfaces, each sensor connects with and motion controller through the I/O interfaces, control system receives and sends signals through the I/O interface of the controller. The system design of I/O is shown in table 1.

Table1.System I/O design

Input		Output	
IN0	Position signal 1	OUT0	The indicator light 1
IN1	Position signal 2	OUT1	The indicator light 2
IN2	Position signal 3	OUT2	The indicator light 3
IN3	Limit signal 1	OUT3	The indicator light 4
IN4	Limit signal 2	OUT4	The indicator light 5

CONCLUSION

Three coordinate measuring instrument is used more and more in the field of automation, the attendant problem is how to place the large workpiece on a measuring table, this paper carries out the design of the manipulator using on the three coordinates measuring instrument, the motion control system as motion controller as the core, using the "PC+ motion controller" manner, ensuring the response speed and the control precision. The system has two types of mode of automatic mode and manual mode, it can be flexibly applied in different occasions, the manipulator can be applied to three coordinate measuring instrument, it has the certain practical significance.

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