Design of a Teaching Robot based on Fischertechnik Model

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ABSTRACT: *This paper designed and developed a teaching robot - three degrees of freedom manipulator based on Fischer creative combination model platform. Firstly, the overall structure of the robot was analyzed to determine the drive programs, and then the manipulator structure was assembled and established in accordance with the modular design approach. Finally, the robot control system was studied. This paper focuses on the hardware design and control system of the robot. Practice has proved that the teaching robot we designed has the advantages of low cost, easy to regulation, good repeatability and it has good promotion and application prospects in the teaching field.*

Categories and Subject Descriptors
I.2.9 **[Robotics]:** Workcell Organization and Planning; K.3.1 **[Computer Uses in Education]**

General Terms:
Robot Control, Computer-assisted-learning

Keywords: Fischechnik Model, Teaching Robot, PLC Control System

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1. Introduction

In recent years, China's robot education has enjoyed a great development and the robot technology courses are gradually becoming comprehensive practical courses in universities. In the traditional teaching method of the field of robotics education, it tends to emphasis on imparting knowledge but underestimate the ability training; emphases on teaching the theory but underestimates the practical aspects. It makes students just to be satisfied with rote knowledge. We are not focus on training the students' independently and comprehensively ability to analyze and solve problems. Especially in experiment and practice teaching, the robotics course of experimental teaching is basically around the basic theory of validation experiments and the lack of design and comprehensive experiment cannot give students a sense of innovation and free play space. Because students rarely have the opportunity for reflection and creativity, their sense of innovation and innovation potential cannot be fully cultured. Therefore, the reform and exploration on the robotics course of experimental teaching is very necessary, and the emergence of Germany Fischertechnik model provides a good carrier for the robot experiment teaching reform [1]-[5]. In this case, we designed and developed a teaching type robot system based on Fischer creative combination model platform for exploration and research on students' innovation experimental course.

Fischertechnik creative combination model is a teaching aids produced by the German Fischertechnik company. It is a family of structural parts and a innovation system composed of mechanical components, electrical components, sensors, pneumatic components computer controller and software. The model design uses modular design and it can be unlimited expanded and repeatedly disassembled; its products are systematic and variety, it can realistically perform the mechanical components and scientific principles; It can also programming control to comprehensively understand the electromechanical

integration process [6]-[8].

Fischertechnik creative combination model belongs to the engineering model, its control which includes control software and control method is similar to what in engineering fields [9]-[10]. It can demonstrate scientific principles and technical processes to provide a preliminary analog and demonstration for the study and design of industrial automation machines. Moreover, the application of this model can be very flexible. Firstly in structure, you can assemble any mechanism by using the Fischertechnik model, which can reflect the mechanical innovation. Secondly in software, the application of this model is very broad, and it can be controlled with a computer and even in a computer, you can control it by using different software.

2. Overall Design

The Fischer creative combination model is the design platform of the three degree of freedom robot. The manipulator can rotate left and right, the arm can move up and down, the clamp can open and close in order to clip objects and PLC is used to control the robot so that it can appropriately respond in accordance with the requirements of the programmed. Figure 1 shows the overall structure of the teaching robot.

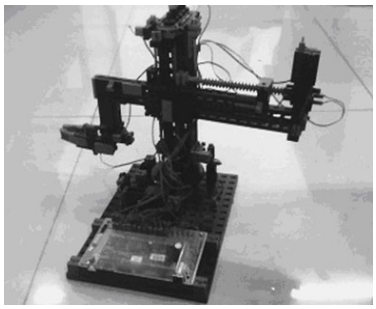
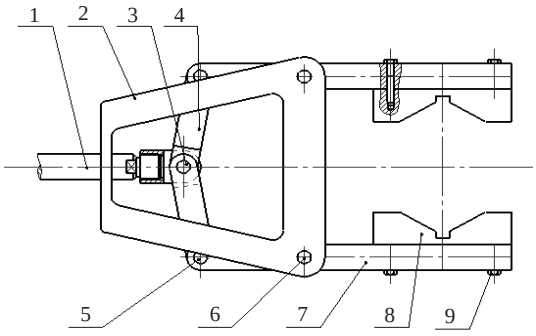


Figure 1. The Overall Structure of The Robot



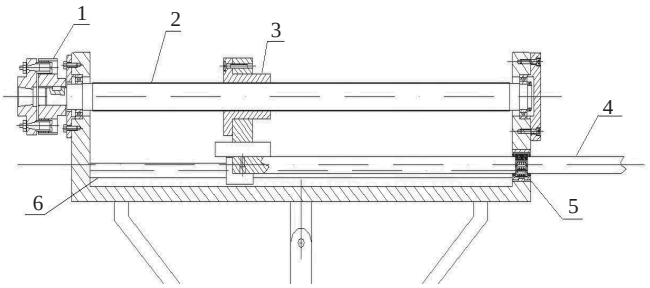
1-Driving rod; 2-Shell; 3- Hinge pin; 4-Ling ; 5,6- cylindrical pin; 7-fingers; 8-V-shaped fingers; 9- Screws

Figure 2. The Structure of The Robot Gripper

3. Hardware design

The robot gripper is designed. The structure of the robot gripper is showed in Figure 2. It mainly uses linkage mechanism. The rotating movements around the pivots of each finger are driven by connecting rods. Two touch sensors are installed on the gripper to sense and control the open and close range of the gripper.

The arm mechanism is designed. The structure of the robot arms are showed in figure 3. The arms use the ball screw drive to achieve the telescopic movement of the arm. Its structure is simple and assembly and disassembly convenience. The two guide columns designed are to prevent rotation of the arm on the ball screw to ensure that the rotation of the arm and the end of the actuator are together.



1-The coupling; 2- Ball screw 3- Screw nut pare; 4-Arm; 5- Arm bushings pare; 6- Linear rolling guide

Figure 3. The Structure of the Robot Arms

The arm telescopic mechanism is designed. Fig.4 shows the structure of arm telescopic mechanism. It can be seen that the telescopic of the arm is in the horizontal direction (X-axis). The horizontal direction moving parts of the arm X-axis are composed of small power motors, telescopic boom, the limit switch and gear box. It is responsible for the vertically retractable function of the mechanical arm.

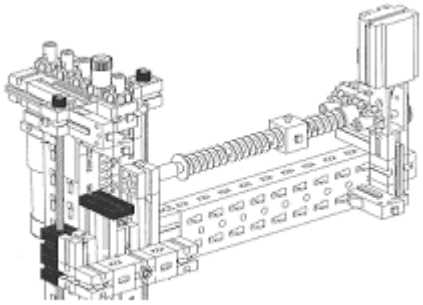


Figure 4. The Structure of Arm Telescopic Mechanism

The arm lifting mechanism is designed. Figure 5 shows the structure of arm lifting mechanism. It can be seen that the lifting movement of the arm is in the vertical direction (Y-axis). The mobile part of the arm Y-axis is responsible for the function of the vertical movements of the mechanical arm, and it is composed of small power motors, lift arm, the limit switch and gear box.

There are two limit switches, zero limit trip switches and the count limit trip switch. The motor provides the power for the vertical movement. The selected motor is DC motor, given a positive voltage, it will start positive rotation, and given a negative voltage, it will start reverse rotation.

The zero limit trip switches limit the vertical movement

limit position, which is the starting position of the vertical movement. The count limit trip switch is used to measure the rotations number of the motor, which can accurately calculate the distance of vertical movement, and play a role in positioning. The vertical movement of the movement process can be divided into two stages: the positioning stage and reset stage. In the positioning stage, the driving motor makes the arm back to the zero position, and then begins to decline from the initial position, stops on the designated location by positioning limit switch count; in the reset stage, the driving motor reverse to make the arm rise until it encounters the limit switch.

The waist rotation mechanism id designed. Figure 6 shows the structure of the waist rotation mechanism. The main structure is worm, which is driven by DC motor drive. The chassis is composed of dial, worm mechanism, motors and limit switches. DC makes the chassis motor rotation to drive the worm, which makes the vertical mechanical arm (vertical rail) do a 360-degree rotation to increase the activity area of the mechanical hand. Two limit switches are used to control the angle of rotation of the mechanical arm.

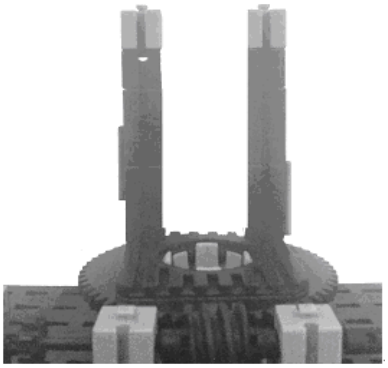


Figure 5. The Structure of Arm Lifting Mechanism

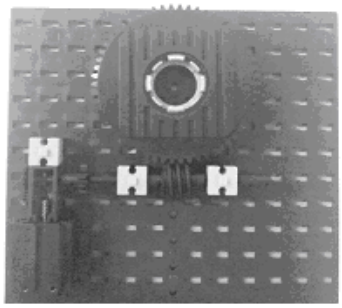


Figure 6. The structure of the waist rotation mechanism

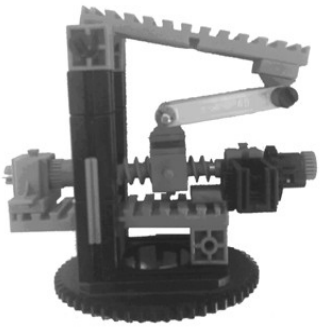


Figure.7 The structure of the arm luffing mechanism

The arm luffing mechanism is designed. The structure of the arm luffing mechanism is showed in Figure 7. The movement of the arm luffing is achieved by the motor - gearbox - the screw nut pares- link transmission.

4. Conclusion

A teaching robot based on Fischer creative combination model platform is designed. The teaching robot can help students visually to analyze the overall mechanical structure and control system structure of the robot, and it can also help students to understand the laws of robot kinematics comprehensively, to master the manipulation of the robot proficiently. The robot has high promotion and application prospects in the teaching field.

5. Acknowledgment

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