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Design of the indoor golf robot for automatic picking up and putting the ball based on fischertechnik model

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Abstract: As a kind of innovative teaching system, the fischertechnik model provides a best carrier for educational innovation and experimental innovation. Based on the fischertechnik model, we design the indoor golf robot to pick up the ball to put it properly. The paper's idea fills the technical gap of automatic picking up the ball of indoor golf in the current market and briefly introduces a kind of structure design and its prospect.

Introduction

With the gradual improvement of the level of people's life, more and more people begin to choose a variety of sports activities in spare time. As for golf, it's always been regarded as a sports activity of noble in that it is hard for the common people to play considering its tough requirements for the playground. In order to make more people contact this sport, an indoor golf mat became popular in recent years. And owing to its simple facilities convenience to fold and many other advantages, it has made a hit and got widely applied. However, it's very inconvenient to pick up the ball every time when you hit it. In light of this inconvenience, we have specially designed this robot, whose function is a combination of picking up the ball whether it is in hole or out of hole and putting the ball back into the place.

The introduction of fischertechnik model

The modularized fischertechnik model ,also called "engineering building block"， is an innovation teaching tools with great advantages in assembly ,flexibility and systemization. Also it has various types and sizes of parts which needed in general engineering machinery manufacture [1]. Fischertechnik model consists of mechanical components, micro motors, sensor (photo, thermal, magnetic susceptibility and touch sensitive, etc.), pneumatic components, computer interface board and control software [2], and characterized by its simplity, stability, systemization and flexibility [3]. In a word, this model is an ideal teaching tool to show scientific principle and technical process, and provides the best carrier for innovation education and innovation experiment.

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Working principle

Firstly we set up a photoelectric sensor on the hole. When the ball falls in the hole, the photoelectric sensor will be covered, then the control system gets the information to drive block arm to put down. So the robot will be blocked as it hit the arm, because there is a micro switch on the arm. Then the robot will stop to execute the program picking up the ball in the hole. The golf (table tennis instead in test) will be picked up and sent back to the initial point finally. If the ball isn't in the hole, the photoelectric sensor will not accept any instructions that the robot will executive the program searching for the ball along the track. There is a magnetic sensor on the robot, and when it feels the magnetic signal coming from the ball, the robot will stop to execute the program picking up the ball. And then robot sends it back to the initial point. Finally the control system will come back to the initial condition. The whole structure of the robot is shown in Figure 1.

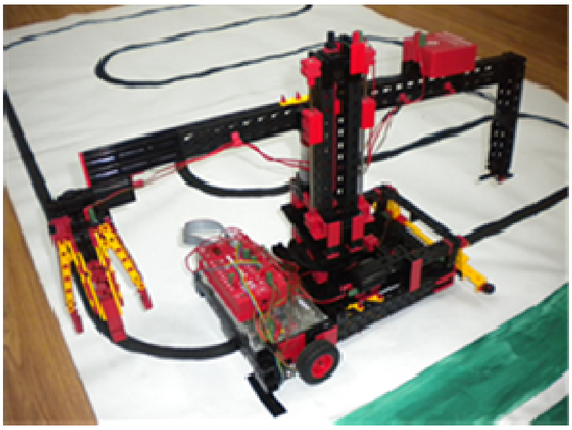

Fig.1 The whole structure of the robot

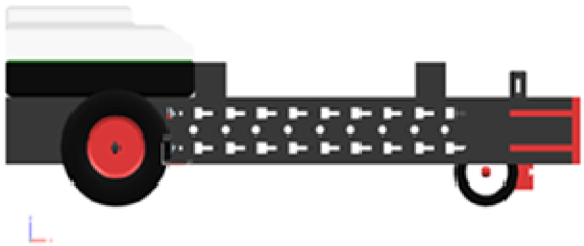

Fig.2 The travel mechanism

The structural design

The indoor golf robot consists of travel mechanism, lifting mechanism, mechanical arm mechanism and control system.

Travel mechanism

The travel mechanism is shown in Figure 2. The travel mechanism of the robot is three mobile agency which is composed of two independent driving active wheels and a small training wheel. The training wheel is designed to support the body and change direction. And two dc servo motors drive the two active wheels respectively. So it's possible to control the movement speed and direction of the robot through adjusting the speed control voltage of the two motors within the rated load scope.

Mechanical arm mechanism

The total length of the mechanical arm is 510 mm including the beam, the mechanical gripper in front of the arm, the battery in the back of the arm, and the terminal magnetic sensor. Compared to the mechanical gripper structure of two-fingers, the four-fingers one is heavier. To avoid the robot leaning backward or forward, we put the heavier battery in the back of the arm so that it can keep the arm stable. The mechanical arm will move along the vertical direction through transmission of the lifting mechanism, and its travel distance is 135 mm. The structure of the mechanical arm is shown in Figure 3.

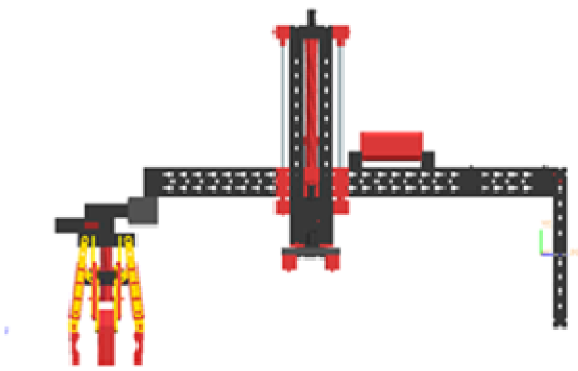

Fig.3 The structure of the mechanical arm

Under the precondition that the structure has the most simplified mechanical gripper and battery quality can't be changed, we can only simplify the beam to make the mechanical arm lighter.
When using the most simple parts to assemble the beam, we analyze its stress to ensure stability trough ANSYS [4], and the results is shown in Figure 4. As the strength of the general plastic is 40-70 MPa, the mechanical arm is stable.

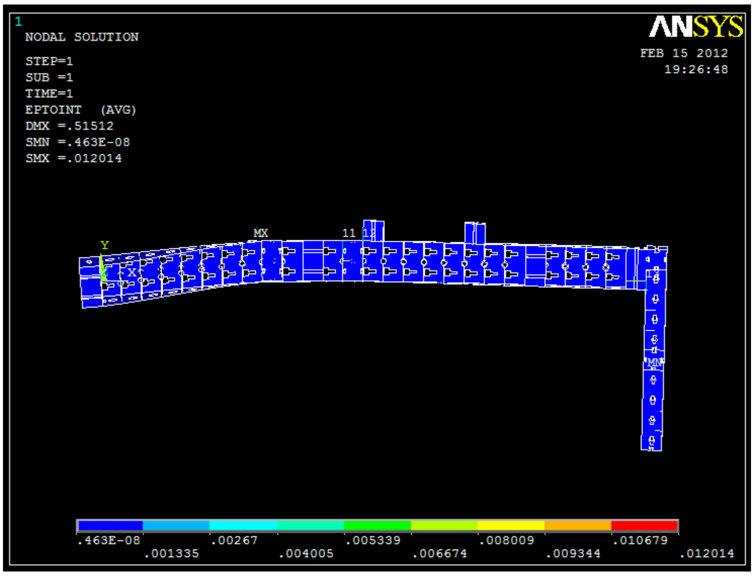

Fig.4 The arm stress analysis of ANSYS

Lifting mechanism

Lifting mechanism is a transmission mechanism whose mechanical arm can move up and down and also it is a link mechanism which links upper and the lower section of the robot. So the lifting mechanism must have enough rigidity to prevent it from serious bending deformation caused by the gravity torque of the mechanical arm. What's more, it also has to be light to relief the burden of the frame of this machine. Choosing the thread transmission mechanism is not only easy to improve the stiffness of the mechanism but also more powerful than super-modulus gear transmission.

The calculation of the driving force of the lifting mechanism:

$$P = Fa * U / 60\ \eta$$

The lifting force is about the gravity of the mechanical arm:

$$G = Fa = 0.5\ KN$$

The hosting speed: $U = 1.5$ m/min;

The efficiency of transmission: $\eta = 0.60$;

The driving power of the lifting mechanism of the ball: $P = 0.021$ KW = 21 W;

The power of the powerful motor: $Po = 24 > P$

So we choose this type of motor as a power-supply device.

Control system

The control system includes two searching path: the external searching path which functions when the ball is out of the hole and the tracking path to search for the ball after it goes into the hole. After finding the ball it begins to return by the original way according to record of the travel counter. When back to the origin point the counter will be reset to 0 waiting for the next time the ball goes into the hole [5]. The flow chart is shown in Figure 5.

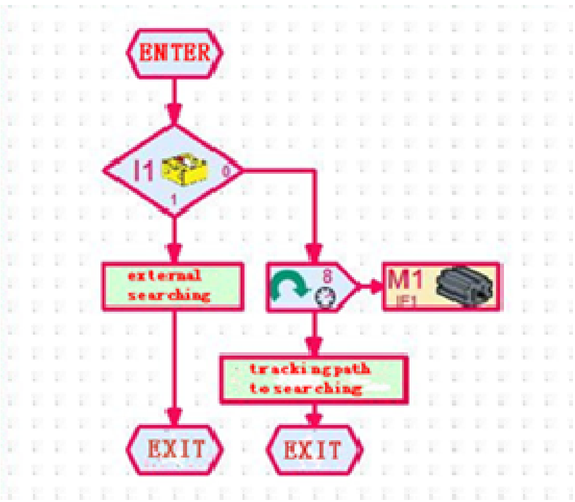

Fig.5 The flow chart of whole control system

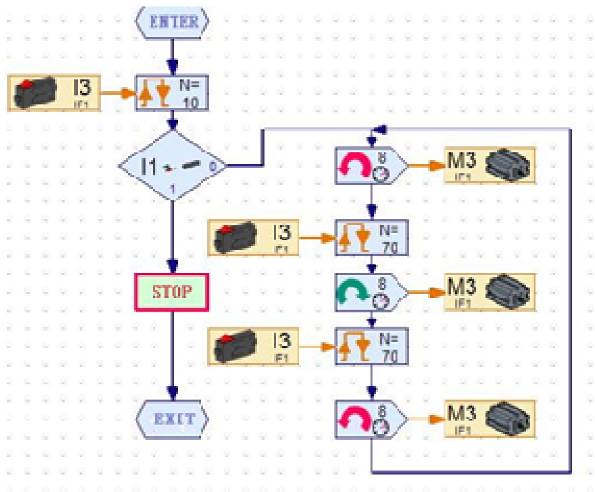

Fig.6 The flow chart of external searching path

The tracking path to searching for the ball

This program is to realize the function of fetching a ball in the hole. As described above, when the micro switch in the front of the car hits the obstacle, the car stops, turning the arm and clipping the ball, then reverses to the origin point.

The external searching path

This program consists of two subprograms operating synchronously, as it's showed in following Figure 6.

The left part of this program is to keep the car moving on the defined track. The method of tracing sensors is used to make the car move accurately, because we do the magnetic treatment to the ball. When magnetic sensor inducts magnetic material, it will produce the digital signal "1", otherwise "0". The robot won't stop until the magnetic sensor induces to ball.

The right one is to make the arm swing around to look for the ball. Only when the magnetic sensor induces to magnetic material, can the arm stop. Then the control system carries out the left program to pick up the ball and the robot returns to the origin along the certain track, puts down the ball and waits for the next shot finally.

Conclusions

Considering the current popularity of the indoor golf mat, it makes sense that our "indoor golf robot" will be very popular after the launch. It helps people put and pick up the ball and fills the technical gap of automatic picking up the ball of indoor golf. In addition, this robot will cost about 50-100 dollars after mass production, a reasonable price the general public can afford. The robot can also sales as an attachment to the indoor golf mat to boost its market, and we can make sure it will have a promising future.

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