

Design of Sports Service Robot for Golf Sports

Chunlai Tian, Yuping Jiao, Guangjin Xiao, and Tian Zou^{a,*}

School of Mechanical and Electronic Engineering, Pingxiang University, Pingxiang 337000, China

^a tianchunlai@bit.edu.cn

*Corresponding author

Keywords: Sports Service Automation; Golf Sports Robot; Mechanical Design; CAD

Abstract: Golf sport is a kind of aristocratic movement. Its predecessor can be traced back to the shepherd sheep tools, can also be linked with the Chinese Ming Dynasty hammer pill movement. This paper introduces a kind of golf service robot, which mainly serves the contestants in golf competition to alleviate hard work of caddie. The robot is designed using Inventor three-dimensional design software to complete the basic work of recycling balls, releasing balls, changing clubs, recovering clubs, and storing small amounts of golf.

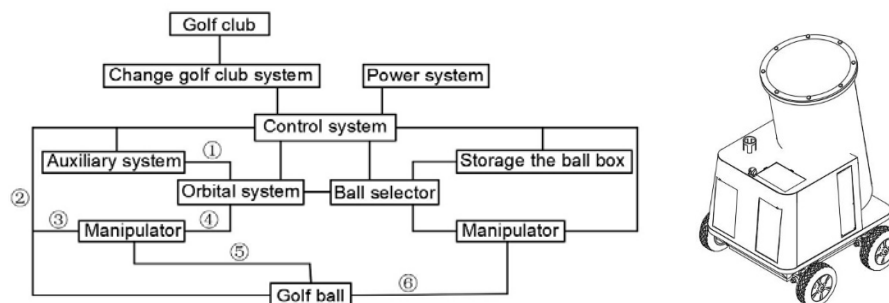
1. Introduction

Golf is a sport that combines physical activity, enjoyment of nature's life, and a popular game. While enjoying the fun of golf, persons are tired out by the tedious process of the sport itself. For example, it needs to repeatedly pick up the ball, put the ball, change the pole, and carry the golf and so on. Although golf caddies can relieve athletes' troubles, they work hard. To alleviate hard work of caddies, the design of the robot is carried out with the idea of the daily necessary work of caddies. Robots can take the place of most of the caddie's work [1, 2].

2. Function and structure of golf services robot

2.1 Function Description and Structural Design

This golf service robot is used with players in golf competitions. Under the premise of not violating the rules of the Golf Rules Q&A, the robot auxiliary players can achieve the following functions [3]. It mainly includes taking and putting golf clubs, recycling and putting back golf balls, and storing small amounts of golf balls. As shown in Fig.1, the Golf service robot is composed of power system, auxiliary system, track system, control system, gripper manipulator and rod changing system in the composition of the system.



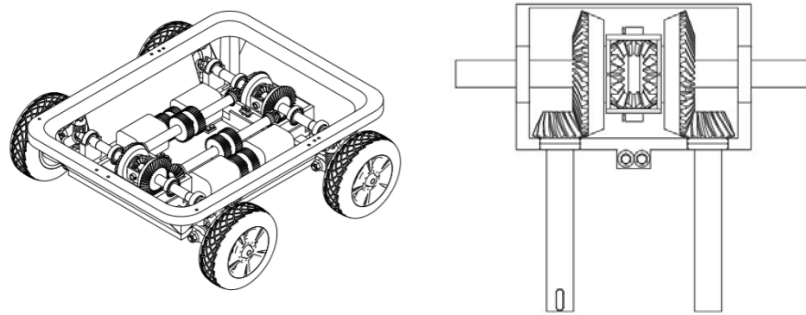
- ①The small car picks up the ball ②Identify the location of the golf ball ③Send the instruction to pick the ball
④Recycle the ball ⑤Pick up the ball ⑥Put the ball

Figure 1. The overall operating structure of the machine and the whole machine appearance diagram

3. Description of working principle

3.1 Power System

The power system adopts four drive motors, as shown in Fig.2. It makes up for the shortcoming of the lack of driving force due to the large playing field (the area of 70-105 times standard football fields). It realizes the continuous and efficient work of the machine. The robot steering applies the use of large and small bevel gears between the reasonable coordination [4]. It gives the speed difference of four drive motors. The turning radius is very small. That helps to obtain the ability to turn in situ, which makes the robot in the arena more flexible and better adapt to the playing field.

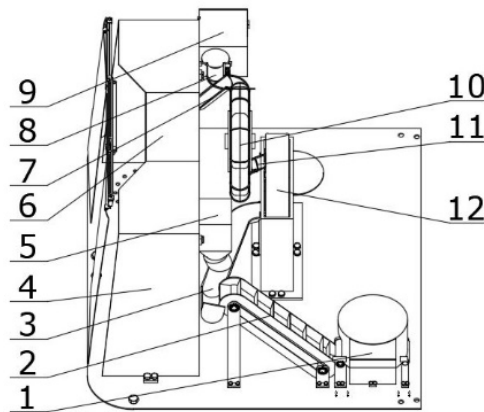


(a)The chassis structure (b) Differential structure

Figure 2. Chassis and differential structure drawing

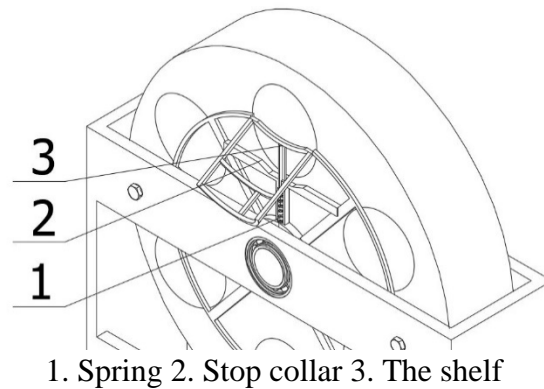
3.2 Orbital System

The orbital system is an important part, and it achieves the suborbital transmission of golf balls as shown in Fig.3 and Fig.4. Firstly, there are two ways to recycle the ball. When the small car picks the ball out of the bushes and groves, it puts the ball in the small car and out of the guiding orbital. Then the ball moves out of the orbital conveyor belt to orbital 1. Through the orbital 1 conveyor belt, the ball is transmitted to the orbital 2. By the gravity effects of the ball itself, it will slide to the front wheel, which is the first way to recycle. The manipulator is set in the content catcher box. When the ball is get by the manipulator, it passes the ball into the gripper to release the box. After that through the gripper, it put the ball box slide into the orbital 2, and then slide into the front wheel. It is the second way to recycle the ball.



1.The small car pulls out of the guiding orbital. 2. Orbital 1 3. Orbital 2 4. Box for catching a ball manipulator 5. The manipulator puts the ball box. 6. The box where the ball manipulator is placed. 7. Orbital 5 8. Orbital 4 9. The box where the ball is stored 10. Rear rotating wheel 11. Orbital 3 12. Front rotating wheel

Figure 3. The internal structure of the orbital system



1. Spring 2. Stop collar 3. The shelf

Figure 4. Partial sketch of the front wheel

The front wheel is the core of the ball selection. Continually when the ball enters the front wheel, it uses the motor drive front wheel to rotate the vertical height of the lifting ball. When the ball reaches the highest point, the control shelf controller receives the command and pulls the shelf down. Then the ball slips into the orbital 3, and jump into the rear wheel after completing this step. The spring bounces the shelf back to its position, which realizes the selection of the ball. The ball that enters the front wheel turns back. The rear wheel has a retaining ring connected to the orbital 5. It helps that the ball to be attached to the rear wheel. After the wheel gets to a certain angle, the ball slid to the orbital 5. Finally, the ball goes into the content of the box and the other manipulator waiting early to grasp the ball. It put the ball in the ball set point.

3.3 Control System

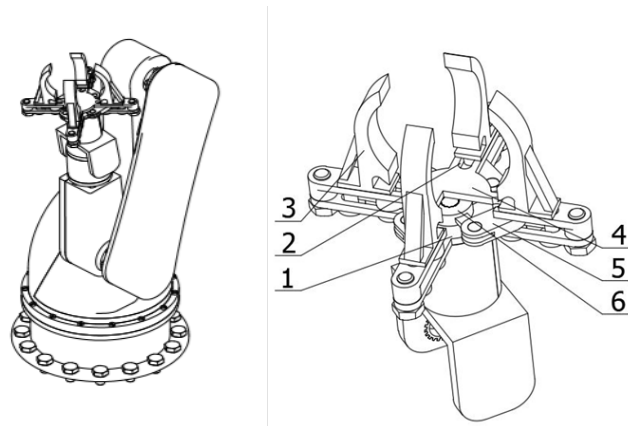
In the whole robot, the panoramic camera and the ball radar belong to the important device of information acquisition. Since the contestant can hit the ball long distances (the first shot of each hole) and check the performance of various detectors, we choose small radar and panoramic cameras. The operation of the main screen and internal processor is the core of the robot can operate normally. The player entrant through the operation of the main screen input required commands, and the processor will command to the relevant actuator and control the operation of the actuator. The control system plays a vital role in the whole robot.

3.4 Auxiliary System

The small car in this robot has played a good auxiliary effect, is an essential part. It solves the robot in the bushes, groves and other special terrain cannot enter picking the ball disadvantage [5]. Through controller with intelligent optimization algorithms, image capture and recognition capabilities, the robot has the ability to score autonomously. It can display the scores of contestants in real time by operating the main screen. The robot can also demonstrate the real-time match situation of the game. It helps the referee to determine whether the score of the robot is in line with the rules. The real-time match situation can be transmitted to the TV, so that off-field fans or fans in front of the TV to feel the wonderful performance at close range.

3.5 Catching Manipulator

As shown in Fig.5, the turntable manipulator has an active hinge connected to the connecting rod. It has an active hinge connected to the paw. When the turntable rotates, the movable hinge pulls the connecting rod. There is a card slot, so the paw can only move linearly along the slot. When four claws move along the card slot together, the claws tighten. It applies that the mechanical claw grabs the ball. When the turntable rotates with the opposite steering before, four claws is open to achieve mechanical claw release.

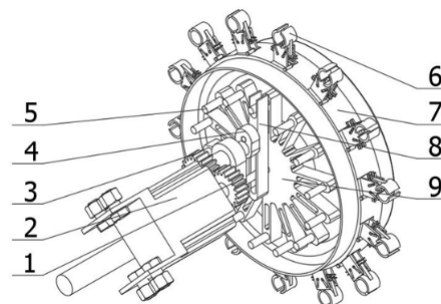


1. The upper cover 2. Restricted motion slot 3. Claws 4. The lower cover 5. Joint lever 6. Rotary table

Figure 5. The appearance of manipulator and the mechanical paw

3.6 Change Golf Club System

As shown in Fig. 6, when the player switches the club, the motor provides power to the gear 1. At the same time, the Gear 1 and Gear 2 can also follow the rotation. Then the Gear 2 takes the connecting shaft to drive the cam rotation with the fork small range swing. The big wheel extension rod engages with the card slot on the fork. The fork pushes the large wheel to rotate. The big wheel stops at one time while the cam is still turning. The formation of cam-crank rod device uses of its intermittent nature with the large wheel on the small angle of rotation. The turntable and the large wheel through the key connection runs on with the large wheel rotation. In all, the device has a selection effect on the club and gives better play experience. The gripper holder uses it to hold the golf club.



1.Gear 1 2. Electromotor 3. Gear 2 4. Cam 5. A pole protruding from a large wheel 6. Clamping frame 7. Revolving shelf 8. Fork 9. The big wheel

Figure 6. Choosing rod device

4. Conclusion

The robot has panoramic camera and radar as the information acquisition tools. It uses the four drive motors as power and differential as steering drive device. The periodic sliding rail fork mechanism applies the club selection device. It uses the six-degree of freedom manipulator for catching and releasing the ball. The track system is designed for achieving ball separation and selection. The central processor as the core of the whole robot is configured in the control system for the stable operation. It could carry out the basic functions of auxiliary players on the court to receive the ball, release the ball, save the ball and change the club, which can alleviate the scarcity of golf caddy. The robot has a well appearance with small overall size. It can be integrated into the arena. The investigation found that such auxiliary robot products vacancy could be very large with a certain market prospect. It could give future research for references too.

Acknowledgments

This work was financially supported by Science and Technology Planning Projects of Jiangxi Province (No. 20181BBG78075), National Innovation and Entrepreneurship Training Program for College Students of China (No. 201810895007) and the Major Construction Project of Pingxiang University (No. 201701).

References

- [1] Y.P. Kondratenko, *Robotics Automation and Information Systems: Future Perspectives and Correlation with Culture, Sport and Life Science* (Springer, Berlin, 2015), pp. 45-40.
- [2] S. Verlag, *Field and Service Robotics* (Springer, Berlin, 2006), pp. 120-122.
- [3] J Li, *Golf Rules Q&A* (Law press, Beijing, 2011), pp. 23-24.
- [4] A. Ronkainen, R.F. El-Kati, P.R. Fleming, *Proc. Inst. Mech. Eng. P-J Sports Tech* 224, 259-269 (2010).
- [5] S Mackenzie, D.B. Evansm, *J. Sports Sci* 28, 891-899 (2010).