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Design of Automatic Billiard Sports Service Machine

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Abstract. The billiard sports service machine which adapts to most of the billiards matches now is designed in this paper. It has strong environmental adaptability with the purposes of saving manpower, high efficiency and smooth transport of billiards. It has five main parts, such as billiards collection part, billiards sorting part, billiards push up part and billiards placement part. It is operated according with the working principles of billiard service machine. It uses the color sensor to identify the color of billiard balls. It applies the single chip microcomputer to control the mechanical actors. It makes use of the rubber sucker and the vacuum pump to grab the billiard balls. The waiting time for the new balls arrangement is shorten significantly to help players enjoy the game. The design with the feasibility plan is provided for the realization of the service for the automated billiard sports.

1. Introduction

The form of billiards is very diverse, such as snooker, pall billiard and more. Because billiards can be both competition and entertainment. In recent years, billiards sports have become more and more popular, and billiards competitions are also increasing [1]. Although scholars have a lot of research on billiard sports. However, scholars mainly focus on billiard robots, such as: visual recognition, intelligent algorithms, etc. [2, 3]. There is not much research on the billiard sports service machine. Researchers have studied the billiard tables [4, 5]. Their research has played a positive role in the development of billiards. The service of billiards sports is just in the stage of manual service. In this paper, a billiard service machine is designed to reduce the waiting time of players in entertainment or in competition.

2. Working process and overall structure

2.1. Working process

After the game, billiard balls dropped into the holes and rolled to the bottom left of the pool table. The billiard division car part is driven to the specified position according to the specified path. The baffle plate is opened under the billiard table. The billiard balls that gathered together could roll into the ball box of the car part. After all the billiard balls enter the ball box, the pneumatic push rod under the ball box will lift the wider end of the ball box. The billiard ball will roll. The billiard ball is hindered by the ball blocking device.

A color sensor is set at the narrow mouth of the ball box. The billiard ball will be identified to prepare for the next arrangement one by one. After the color is identified, the billiard ball will enter the first division plate. It divides the billiard balls into two channels according to its color. One is to handle billiard balls that needs to be rhombus or triangular, and the other one is to handle a single billiard ball.

A billiard ball is needed to be rhombus or triangular enter the second division plate. The cam mechanism divides the billiard ball in the second division plate. It is pushed onto the model board by the push plate to complete the billiard shape. However, the single billiard ball can only be raised by the pneumatic putter.

After the collection finished, the billiard division platform will be raised under the driving of the three jaw lifting platform. The three direction manipulator grabs the billiard ball and puts the billiard ball on the billiard table. Finally, the machine is restored as the initial status.

2.2. Overall structure design



Automatic billiards machine mainly consists of three parts, such as power system, transmission system and function module system. The functional modules include four parts. They are the billiard collection system, the billiard sorting system, the billiard lifting system and the billiard placement system.

The system diagram is shown in Fig.1. Firstly, the drive system sends the car to the designated position. Dropped billiard ball is collected by the collection system and will be send to the billiard sorting system. The sorting system separates the billiard ball by color. Then the billiard sorting system on the billiard division car part will put it into the desired shape box. After that, the lifting system on the billiard division car will lift the billiard division platform to achieve the position by the billiard placement system. Finally, the three direction manipulator in the billiard placement system will grab the ball and deliver it to the designated position of the table. The power system provides power support for the automatic billiards machine.

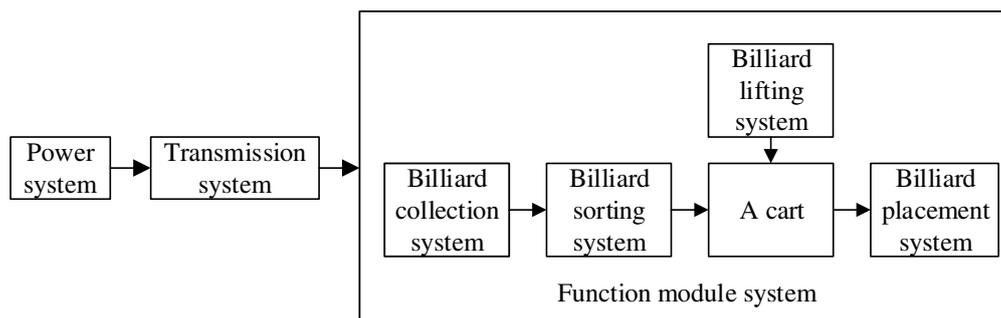
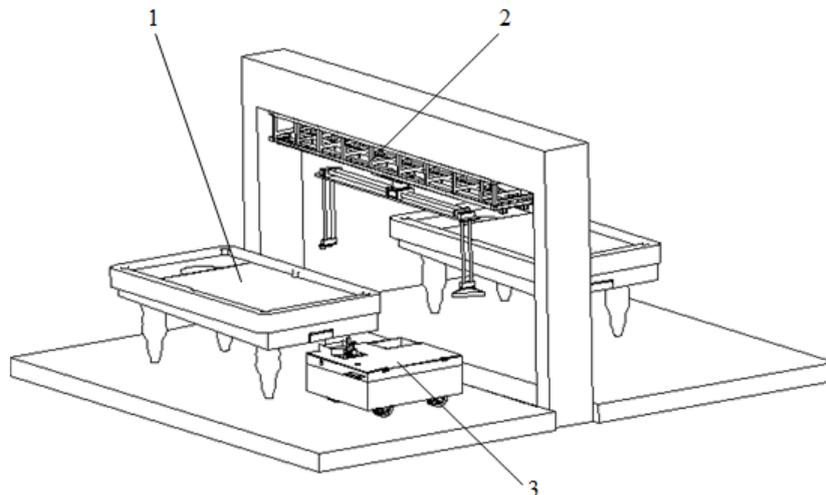


Figure 1. System diagram.

The design of the automatic billiard machine is shown in Fig.2. As shown in Fig.2, the automatic billiard machine axonometric is made up of a billiard table, a three direction manipulator and a billiard division car. It can be reformed on the basis of a traditional billiard table. The billiard collection box is set at the bottom. The billiard division car is placed on the other side of the billiard table. The three direction manipulator can be attached to the top of the billiard table.



1. Billiard table; 2. Three direction manipulator 3. Billiard division car

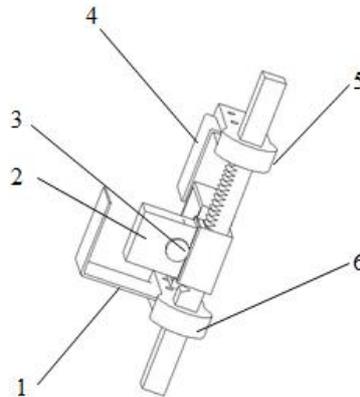
Figure.2. Automatic billiard machine.

3. The design of the billiard division car

3.1. Design of automatic ball blocking device

The automatic ball blocking device is the key part of the billiard division car. It mainly plays the role of billiard buffer. The model is shown in Fig. 3. The power gear drives the rack moving up and down. The power shell protects the power gear. The “L” plate 1 fixed block and the “L” plate 2 fixed block are fixed on the rack. The “L” plate 1 and the “L” plate 2 are fixed on the “L” plate 1 fixed block and the “L” plate 2 fixed block, which can be moved up and down to follow the rack. The degree of engagement between the power gear and the rack

is high to ensure the time of billiard ball color recognition. The power gear and rack are designed to be 7 to 8 stages of machining accuracy.

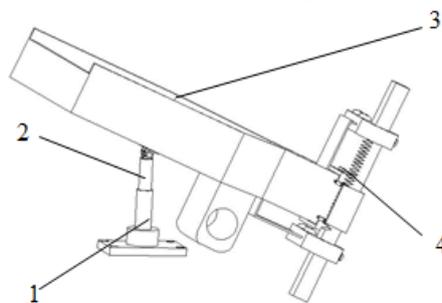


1. "L" type plate 1; 2. Power shell; 3. Power gear; 4. "L" type plate 2; 5 "L" plate 2 fixed block; 6 "L" plate 1 fixed block

Figure.3. Automatic ball blocking device.

3.2. Design of division ball box

The function of the division ball box is to store the balls and identify the color of billiard ball one by one. Its wireframe structure is shown in Fig.4. The outer rod of the pneumatic lifting rod is not fixed. The ball box is pulled by the inner lifting rod of the pneumatic hoisting rod. The color sensor, which is set at the narrow mouth of the ball box, is used to identify the color of billiard ball one by one. The color signal controls the motor rotation and rack moving up and down. In order to prevent the collision between the balls and the box, a layer of cashmere material is added on the box surface to ensure that the noise is reduced. The cylinder stroke is about 50 mm to 60 mm. There is no influence on the efficiency of the divide ball.



1. Pneumatic hoisting rod outer bar; 2. Pneumatic hoisting rod inner rod; 3. Ball box; 4. Identifier;

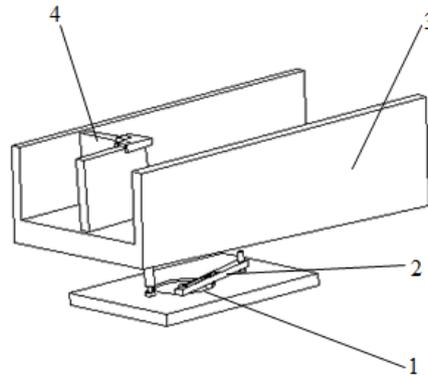
Figure.4. Division ball box.

3.3. Design of the first-level division device

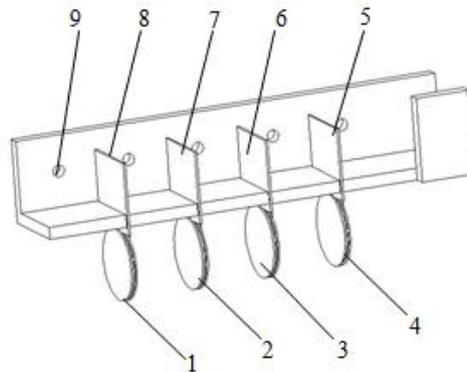
As shown in Fig.5, the rocker active force drives the rocker to rotate at a certain angle. The rocker moves the dial to rotate 90 degrees to achieve the billiard lane separation function. The first channel is a passageway for balls. The core of the device is the rocker mechanism. The rocker lever accurately moves the lower part of the pick to realize the steering pick function. It realizes the lane separation of the balls.

3.4. Design of the second-level division device

As shown in Fig.6, there are four cams and baffles independent applied with each other. The baffle is raised according with the color signal. Then the billiard balls will enter different spaces, and the next step can be achieved. The mechanism uses a cam mechanism to drive the baffle so as to realize the function of the baffle blocking ball. The mechanism is characterized by the movement of each cam mechanism without interference from another one. The rotation of the cam is controlled only by the color signal. The baffle can keep their respective movements for the balls entrance through the different tracks.



1. Rocker active force; 2. Rocker ;3. Primary lane board; 4. Pick
Figure.5. First-level division device.



1-4. Cam; 5-8. Baffle; 9. Push rod jack
Figure.6. Second-level division device.

4. The design of the grab suction cup

The triangle suction cup is shown in Fig.7. It is fixed at the end of the manipulator. It is operated by the gas of inflating and deflating under the control of the single chip microcomputer. The ball is sucked up with the suction of the vacuum sucker, so that it is caught from the billiard division platform to the table. If it is needed by the pall billiard (Nine-Ball) arrangement, the sucker could be set as the rhombus.



Figure.7. Triangular sucker.

4.1. Design calculation of vacuum sucker

It uses a cylindrical sucker configured with an outer diameter of 60 mm, an inner diameter of 56 mm and a height of 30 mm. The material uses soft rubber, which is conducive to the adsorption of billiard balls.

Firstly, the vacuum sucker is connected with the vacuum device (vacuum pump) through the tubing when working. Then the sucker contacts with the billiard ball and starts the vacuum equipment to produce the negative pressure in the suction cup. After that the billiard ball will be sucked up and can be moved by the manipulator. When the billiard ball is moved to the destination, the vacuum pump is steadily inflated into the

vacuum suction cup to make the cup from negative pressure to zero pressure or slightly positive pressure. Finally, the ball is set out of vacuum sucker and arranged well.

The advantage is that it will not damage the billiard table. The billiard material is kept good, because of the sucker is made from more resilient material. The absorbing or putting down billiard balls would not cause any damage to the appearance of billiard balls.

The formula for calculating the suction of a vacuum suction cup is

$$W = (pA / f) \times 1.778 \times 10^{-4} \quad (1)$$

where W is the adsorption force; p is the vacuum degree (relative pressure) in the suction cup; A is an effective adsorption area for the sucker and f is the safety factor.

Usually, the effective adsorption area of sucker is about 80% of the suction cup area, and the vacuum degree takes about 90% of the maximum value. The safety factor varies with the conditions of use. According to the data, the weight of billiard ball is between 154.5 g and 195 g. It gets 200 g as the weight of the target ball. It is assumed that the suction cup needs to absorb the ball's weight. In terms of the safety factor is 5 and the vacuum degree is up to 90%, the suction force of the rated suction plate is 2.52 N, which is larger than the billiard gravity. Therefore, it meets the requirements.

5. Summary

The automatic billiard sports service machine with mechanical design and operation principle research is presented here. It resolves problems of the billiard balls collections after the competitions. The billiard balls are arranged into a triangle or a diamond by the designed sucker. The manipulator could help to obtain the placement of the snooker billiards and pall billiards (Nine-Ball). The rubber sucker and vacuum pump are used as the starting points of the manipulator to avoid from causing damage to the billiard table while the general machine is swinging the ball. In all, the automatic billiards sports machine has great complement to the shortcomings in the traditional manual collecting sports. It provides a feasible scheme for the realization of automatic billiard competitions.

6. References

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