Research and Simulation of Table Tennis Track Prediction Based on Double Concave Round Table Tennis

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Abstract: Double concave round table tennis needs to accurately predict the trajectory of fast-moving table tennis when slapping table tennis. Firstly, the kinematics model and physical model of table tennis collision used in table tennis flight trajectory prediction with biconcave round table tennis are analyzed. Secondly, the algorithm of kinematics model used in table tennis flight trajectory prediction is mainly improved. Finally, the speed feedback adjustment coefficient is not fixed but dynamic coefficient. Through MATLAB simulation, the experimental results show that the prediction effect is very good. Finally, in order to intuitively analyze and predict the trajectory and intuitively reflect the movement law of table tennis, physics will be closer to life, better applied in sports and better serve the teaching of table tennis in colleges and universities.

1. Introduction

Table tennis is known as China's "national ball", not only because table tennis players have made brilliant achievements in international competitions, but also because table tennis has a broad mass base in our country. However, table tennis is a rather difficult sport. For most table tennis enthusiasts, due to its complicated and changeable flight, table tennis often stays in a visual and perceptual understanding.

At present, table tennis racquets are reformed by various methods such as planes, inclined planes, materials, rubber plates, handles and the like. In order to improve the racket surface, the invention relates to a biconcave round table tennis racquet, in particular to a table tennis racquet with a spherical biconcave round surface processed by a lathe. The invention solves the problems that the existing table tennis bottom plate is not conducive to hitting power and pressing the cover to hit an arc ball and the like [16-25]. Lanzhou Industry and Equipment Co. Ltd, Lanzhou University of technology Zhang Wanjun studied some model identification control systems [26-33] of flexible training equipment and control methods.

In 1997, Rui Qing of Shanghai Jiaotong University and others cooperated with Professor Miyazaki of Osaka University in Japan to first theoretically study the prediction and simulation algorithm of table tennis trajectory, and proposed a table tennis trajectory prediction algorithm using local weight regression algorithm [34-38]. The advantage of this method is that it does not need to establish a dynamic model for the controlled object [39-41]. The disadvantage is that it requires a large number of effective samples, and it is difficult to distinguish whether table tennis rotates or not, and it is difficult to analyze the prediction results according to the rotation. The speed of table tennis

before rebound is very important for trajectory prediction after rebound. This paper focuses on improving the calculation method of speed before rebound in reference [42], and analyzes the feasibility of the improved algorithm by using MATLAB 6.5. At the same time, in order to intuitively analyze the predicted trajectory, a 3D simulation platform based on OpenGL is designed.

The speed of table tennis before rebound is very important for trajectory prediction after rebound. This paper focuses on improving the calculation method for calculating the speed before rebounding in reference. MATLAB 6.5 is applied to analyze the feasibility of the improved algorithm. This paper mainly improves the algorithm of kinematic model [1] used in table tennis flight trajectory prediction.

2. Double concave round table tennis bat

The technical scheme adopted by the invention for solving the technical problem is that the biconcave round table tennis bat is of biconcave streamline symmetrical design, and the bottom plate of the table tennis bat is a concave panel with thick edge and thin center. The bottom plate of the table tennis bat has an edge thickness of 6mm and the center thickness of the concave surface of the clapper is 3mm.Top view of double concave round table tennis bat, as is shown in Figure.1.

The double concave circular table tennis bat has the beneficial effects that in the process of catching and hitting balls, the concave surface reduces the failure rate of hitting balls, increases the exciting degree and the viewing power of the match, the arc spinning balls pulled out by the concave surface have higher rotating speed, thus posing greater challenges to the development of technology, achieving more stable hitting balls, easier arc drawing and cutting, more obvious tapping and cutting advantages, and realizing humanized design.

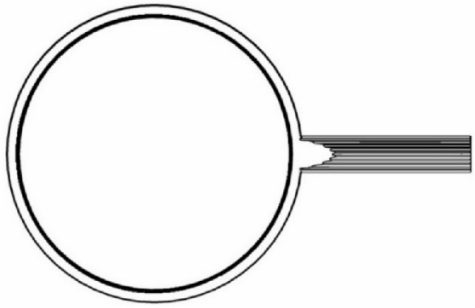
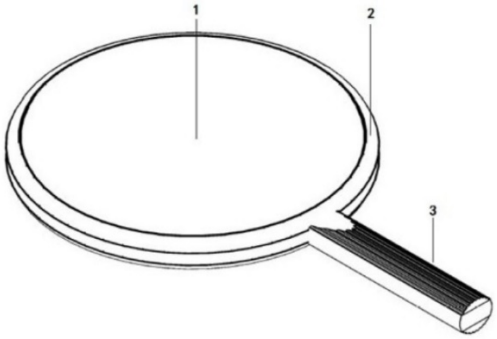


Figure 1. Top view of double concave round table tennis bat.

Diagram of 3D Decomposition of Flexible Trainer for Double Legs, as is shown in Figure.2.



1. Center of the clapper concave surface; 2. Upper edge of the clapper concave surface; 3. Groove handle.

Figure 2. Three-dimensional schematic diagram of double concave round table tennis bat.

The biconcave round table tennis bat comprises a circle center (1) of the clapper concave surface, an upper edge (2) of the clapper concave surface and a groove handle (3).

In order to overcome the defects of the existing design, the invention provides a biconcave round table tennis bat. The biconcave round table tennis bat is provided with a center 1 of the concave

surface of the clapper and an upper edge 2 of the concave surface of the clapper; and the two surfaces of the biconcave round table tennis bat are respectively stuck with positive rubber sheets and reverse rubber sheets. Groove handle 3 is provided with evenly distributed grooves on the table tennis racket handle to enhance the contact area between airflow and palm, reduce sweat absorption to the table tennis racket handle and prevent the racket from sliding from the hand.

The embodiment: the exerciser grasps the groove handle 3 with his hand, and sticks the front rubber sheet and the back rubber sheet on the two sides of the biconcave round table tennis bat respectively. In the process of catching and hitting the ball, the concave surface of the double-concave circular table tennis bat reduces the error rate of hitting the ball, increases the exciting degree of the game and the viewing force. The arc spinning ball pulled out from the concave surface has a rotating speed, which poses greater challenges to the development of technology. The ball hitting is more stable, the arc drawing becomes easier, and the tapping and cutting advantages are more obvious. The groove handle 3 is on the handle of the table tennis bat, and has evenly distributed grooves, which enhance the contact area between the air flow and the palm, reduce sweat absorption onto the table tennis handle, and prevent the racket from sliding from the hand.

Figure 3. Physical picture of double concave round table tennis bat.

3. Operational methods of hip training instruments

The prediction of the flight path of the biconcave round table tennis bat is basically divided into four steps:

(1) Trajectory tracking stage. The speed and acceleration of table tennis at each measuring point are calculated in combination with the collection time.

(2) Trajectory prediction before rebound. The physical mechanism of table tennis flight is modeled, the differential equation of table tennis flight is obtained, and the trajectory and speed of table tennis are solved.

(3) The collision between table tennis and the table. It is mainly to construct the collision model between table tennis and table tennis.

(4) Trajectory prediction after rebound. The same method is used for trajectory prediction before rebound.

4. Table Tennis Flight Model

In the process of table tennis moving in the air, it is mainly affected by two forces: gravity $G = M \cdot g$ and air resistance $F = l \cdot v^2$, where M is the mass of table tennis, g is the acceleration of gravity, and l is the air resistance coefficient. See document [1] for flight models.

(1) In the horizontal direction:

$$\begin{cases} x = \dfrac{M}{l}\ln\left(1+\dfrac{k\cdot v_{x0}\cdot t}{M}\right)+v_{x0}\cdot x_0 > 0 \\ x = -\dfrac{M}{l}\ln\left(1-\dfrac{k\cdot v_{x0}\cdot t}{M}\right)+v_{x0}\cdot x_0 < 0 \end{cases} \tag{1}$$

The Y axis in the horizontal direction has a position prediction expression consistent with the X axis.

(2) In the vertical direction:

$$\begin{cases} z = \dfrac{M}{k}\left|\ln\right|\cos\left(\sqrt{\dfrac{l\cdot g}{M}}t\right)+v_{x0}\cdot\sqrt{\dfrac{l}{Mg}}* \\ \sin\left(\sqrt{\dfrac{l\cdot g}{M}}t\right)+v_0\cdot x_{z0} > 0 \\ z = -\dfrac{M}{2k}\ln\dfrac{\left(1+e^{2t\sqrt{\frac{l\cdot g}{M}}}\right)^2}{4e^{2t\sqrt{\frac{l\cdot g}{M}}}}+z_0+v_{z0}\cdot v_{z0} > 0 \end{cases} \tag{2}$$

5. Collision Model between Table Tennis and Table Tennis

In order to accurately predict the trajectory of table tennis, besides establishing the precise motion equation of the flight process, it is also necessary to model the collision between table tennis and the table top and obtain a more accurate rebound model. See document [1] for the establishment of collision model.

$$\begin{cases} v_{xout} = l_x\cdot v_{xin}+B_x \\ v_{yout} = l_y\cdot v_{yin}+B_y \end{cases} \tag{3}$$

$$v_{zout} = l_z\cdot v_{zin} \tag{4}$$

Indicates the ratio of predicted coordinate error to time and an average velocity error, which is a dynamically corrected coefficient.

6. Experimental results and analysis

Firstly, the kinematics model and physical model of table tennis collision used in table tennis flight trajectory prediction of biconcave round table tennis are analyzed. Secondly, the algorithm of kinematics model used in table tennis flight trajectory prediction is mainly improved. Through MATLAB simulation, the experimental results show that the prediction effect is very good.

Double concave round table tennis needs to accurately predict the trajectory of fast-moving table tennis when slapping table tennis. Firstly, the kinematics model and physical model of table tennis collision used in table tennis flight trajectory prediction with biconcave round table tennis are analyzed. Secondly, the algorithm of kinematics model used in table tennis flight trajectory prediction is mainly improved. Finally, the speed feedback adjustment coefficient is not fixed but dynamic coefficient.

When H=0.3m and inclination angle is 0^0, 60^0,90^0,120^0movement track of table tennis, as is shown in Figure.4, 5, 6,7and Figure.8.

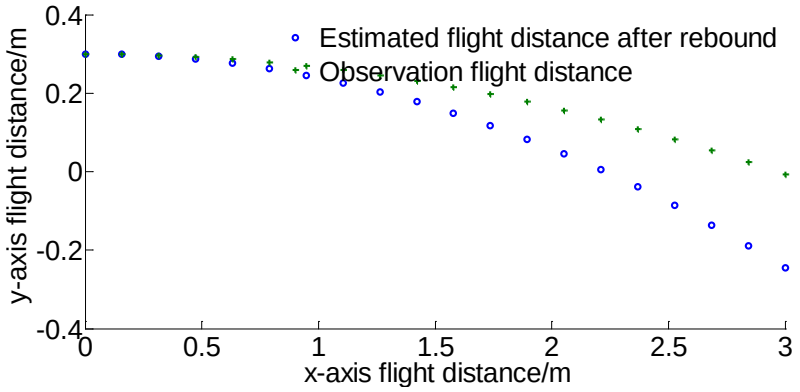


Figure 4. When H=0.3m and inclination angle is 0°, movement track of table tennis.

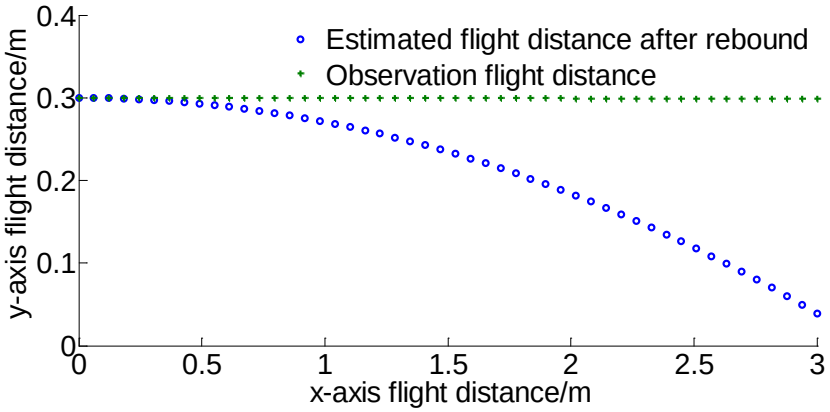


Figure 5. When H=0.25m and inclination angle is 90°, movement track of table tennis.

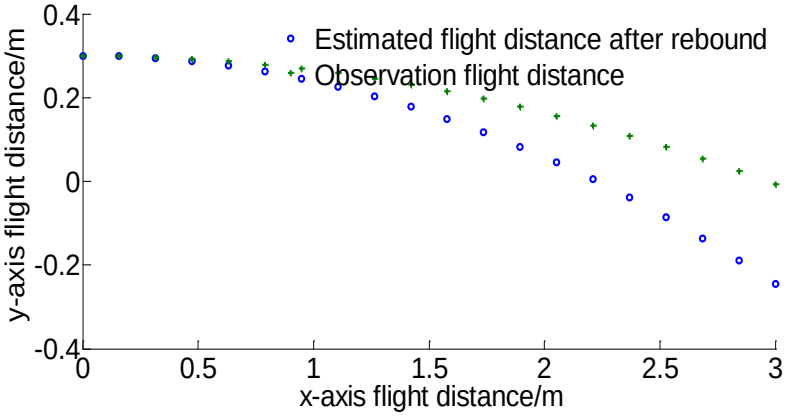


Figure 6. When H=0.25m and inclination angle is 60°, movement track of table tennis.

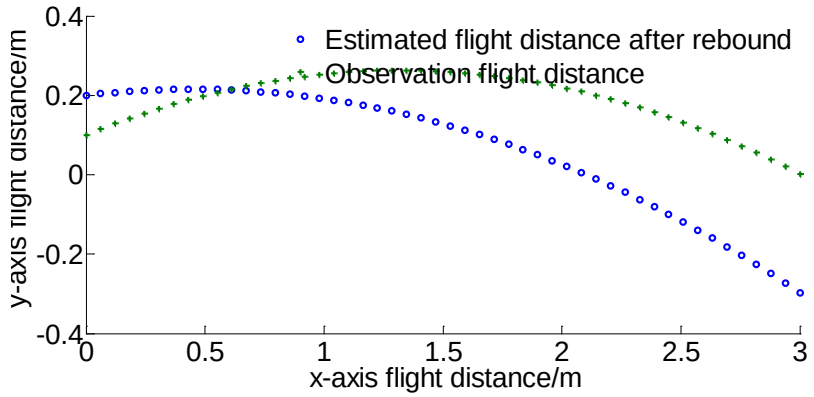


Figure 7. When H=0.25m and inclination angle is 45°, movement track of table tennis.

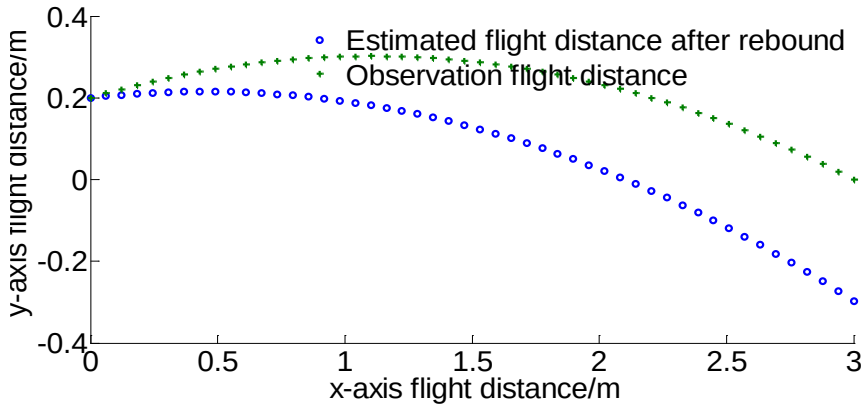


Figure 8. When H=0.25m and inclination angle is 120°, movement track of table tennis.

The results show that there are significant differences between the two sides of the hip splits of young male and female athletes, but the difference in leg flexibility is not obvious, and the maximum strength of extensor muscle is relatively low.

The experimental results show that the improvement of the ratio coefficient and the improvement of the calculation of the initial speed before rebounding can more accurately predict the trajectory of table tennis and meet the requirements of playing table tennis.

7. Summary

(1) Double concave round table tennis needs to accurately predict the trajectory of fast-moving table tennis when slapping table tennis. Firstly, the kinematics model and physical model of table tennis collision used in table tennis flight trajectory prediction with biconcave round table tennis are analyzed. Secondly, the algorithm of kinematics model used in table tennis flight trajectory prediction is mainly improved. Finally, the speed feedback adjustment coefficient is not fixed but dynamic coefficient.

(2) Through MATLAB simulation, the experimental results show that the prediction effect is very good. Finally, in order to intuitively analyze the prediction trajectory and intuitively reflect the movement law of table tennis, physics will be closer to life, better applied in sports and better serve the teaching of table tennis in colleges and universities.

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