

Research on Serve Technology of Badminton Based on Single Closed Loop

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Abstract. The batting point of badminton plays a very important role in the whole badminton match. At the same time, the accuracy of the batting point is also the core content of the badminton course in colleges and universities. Based on the single closed loop badminton serve control method, the batting point can be controlled in real time according to the previous one, which can effectively improve the accuracy of the landing point, and its practicability and popularity have been recognized by students.

1. Introduction

Badminton technology is an important factor to win the game, and badminton technology contains all kinds of contents, and the accuracy of the ball landing point [1-2] is a very important indicator of technical training and even the competition. In particular, the quality of service directly affects the key role of this comparison. In general colleges and universities, badminton teaching courses are only aimed at the number of students hitting the ball, often neglecting the accuracy of the batting point, resulting in a situation where only attention is paid to the process rather than the result, and the integrity of the badminton curriculum is not well understood. In view of this problem, the author puts forward a single closed loop [3] badminton serve point control method through the study of teaching practice, which not only makes the more precise tactical consciousness of batting training more concise, so that the students can systematically grasp the essence of serve technology, thus achieving a purposeful, targeted badminton course teaching.

2. System design

Combined with the electric drive control system, the single closed loop control motor operation technology is applied to badminton serve technology. In the electric drive control system, the single closed-loop control mainly controls the speed of the motor. By controlling the given size and using Pi control, the motor can be quickly promoted to the required speed, which is similar to the badminton serve. The main purpose of badminton service is to control the flight trajectory of badminton. This trajectory is mainly controlled by the speed and angle of the serve of badminton. The angle problem is that when a person's height is fixed, the serve angle is basically unchanged. Therefore, the influence of angle problem on serve can be ignored, and the ideal serve effect can be achieved only by controlling the serve speed of badminton. Fig. 1. shows the whole Control scheme.

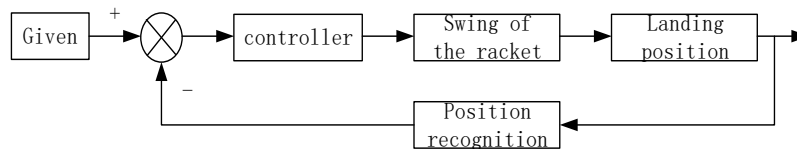


Fig. 2. System overall control scheme

3. Single closed loop control system

The DC motor is used as the research object. When the motor is controlled by open-loop control, the speed of motor speed is directly determined by the magnitude of duty cycle ratio through PWM control, but the speed of motor speed is not proportional to the average voltage at both ends of the motor. When the system is disturbed by the outside, the motor state can not keep the same. When the motor drives the load, if the speed static difference is not high, the open loop control motor speed can also realize the stepless speed regulation of the motor in a certain range. In actual industrial production, the phenomenon of interference in industrial environment is inevitable. Moreover, in the production of large-scale streamline operation, the machine generally requires stable running speed, guaranteed production capacity and high static error rate of motor speed. In order to solve the problem of low static rate of rotational speed, the speed of motor can be kept stable by using closed loop control speed. Speed closed-loop anti-interference is strong.

Single-loop closed-loop closed-loop control includes a feedback loop , a given link , and a control adjustment link , as shown in Fig.2. The feedback step is to measure the motor speed by photoelectric encoder, and then transmit the measured speed to the controller in the form of pulse. In order to change the PWM waveform duty cycle to control the H bridge and then change the speed of the motor, the speed of the motor is changed repeatedly, and finally the motor reaches the given speed. Therefore, the speed closed-loop control with negative feedback has strong anti-interference and high steady-state precision, which can solve the problem of low static error rate in open-loop speed regulation.

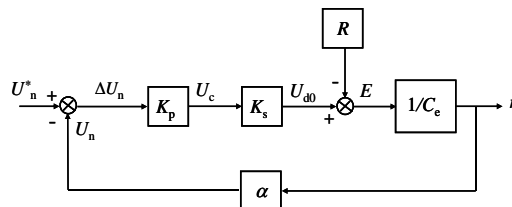


Fig. 2. Single closed loop speed closed loop control block diagram

4. Mathematical Model of Badminton

Badminton is affected by air, gravity, swing, and angle of work during flight. It belongs to a typical nonlinear system, and we can fix a few fixed parameters to make this nonlinear system look like a linear system, and then we can study its stability. In order to simplify the analysis and study of these influencing factors and to reveal the motion characteristics of badminton flying in the air. On the basis of reference [4], all the equations describing badminton motion are given, and the equations of motion are combined into a system equation. This system equation not only considers badminton gravity $G=mg$, air drag lift $F=\frac{1}{2}\rho c_D s v^2$ and pitching torque $M=\frac{1}{2}\rho c_M s v^2$, but also takes into account the Magnus force $H=-\rho v \omega h$ and the associated assembly elements of badminton. The study of badminton system equation is helpful to reveal objectively the actual properties of its flying rotation motion. Based on the coordinate system established in document [4-5], the equations of motion of the center of mass of the badminton are obtained by using Newton's second law.

$$m\ddot{v} = -F - mg \sin \theta, \quad m\ddot{\theta} = L - H - mg \cos \theta \quad (1)$$

In the same way, by using the theorem of moment of momentum, the equation of motion around the center of mass of badminton is obtained by deducing and arranging it.

$$I_t \ddot{\beta} + c \dot{\beta} + \left| \frac{dM}{d\alpha} \right| \alpha = 0, \quad \alpha = \beta - \theta \quad (2)$$

In that formula (2), M is the quality of the badminton, G is the gravity coefficient. ρ the is air density. α is the badminton angle of attack. θ is the badminton pitch angle. β is the sideslip angle of badminton. These three angles are the variables of time. I_t is transverse Mass moment of inertia of badminton. c_D is the air drag coefficient of badminton. c_L is the lift coefficient of badminton. c_M is the pitch moment coefficient of badminton. c_D , c_L , c_M is the connected to the angle of attack of badminton α . S is the area that shuttlecock sweeps through during flight and rotation. I is the total length of badminton, v is the flying speed of badminton, \ddot{v} is the acceleration of badminton flight, ω is the rotation angular velocity of badminton, h is the volume of hair ball. The negative sign in the Magnus force represents the direction of rotation. If the angular velocity of the badminton is clockwise, then it is negative, then the Magnus force is negative; conversely, the Magnus force is a positive number.

5. Landing area design

The badminton area can be divided into the near net area, the middle area and the backcourt area according to the front and back regions. Fig.3 is to list the different positions of the three regions with the single game as an example. According to the upper and lower regions, they are divided into the left, the middle and the right regions, respectively. Fig.4 shows the location of three different regions. The division of regional landing points allows the trainer to clearly recognize his or her position in the course of the game, facilitate better defense or attack, make it easier for him to get the flying ball, and enable the opponent to catch the ball at the furthest distance.

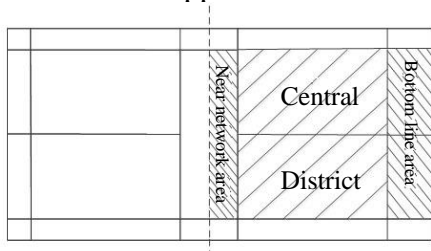


Fig. 3. Front and rear areas of badminton court

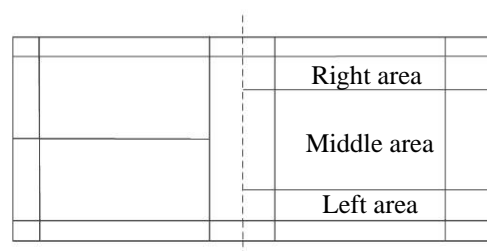


Fig. 4. the upper and lower areas of the badminton court

6. Stability analysis

6.1 Accuracy comparison of landing point in technology implementation

In order to explore the effect of closed-loop control method and conventional badminton technique teaching method in badminton technique training in improving the accuracy of students' batting point, the author used the serve technique to test the students in each group of 5 students for 12 weeks from July 9.4 to November 27, 2017.11. Each student serves eight times and carries out two rounds of testing. The results showed that the test results of the experimental group were significantly higher than that of the control group. Therefore, the single closed loop control method for badminton technical training was effective in improving the accuracy of the badminton batting point, as shown in Table 1.

Table 1. Comparison of conventional teaching methods of close-loop control in French.

Method	Technical combination	Characteristic
Conventional teaching method	Serve at the center line, throw the ball, hit the ball, and finally drop the ball.	The expression is general and tedious, the area boundary is not clear, not intuitionistic, the ball's landing point does not have the regularity, the relatively disorderly, the vast majority cannot reach the backcourt
Closed loop control method	The serve stands in the center line, realizes the throwing, hitting, the final ball drop, according to the previous ball drop point, controls the next batting strength, according to the previous situation, adjusts the batting strength appropriately	The area is clear, the expression is concise, easy to understand, the landing point concentrates above 85% falls in the backcourt area

6.2 Comparison of actual combat capabilities

After 12 weeks' teaching experiment, according to two large groups of random draw to carry on the antagonistic teaching competition, adopt 21 points system rule, implement the no ball scoring system, three innings two wins method. According to this method, the results of the experiment group are obviously better than that of the ordinary group, and the effect of ball control is better than that of the ordinary group.

Table 2. Comparison of results in three rounds after experiment.

	Experimental group	Ordinary group	Score comparison
First round	13	7	+5
Second round	12	8	+4
Third round	11	9	+3

7. Conclusion

Through the comparison between the closed-loop control method and the conventional teaching method, we can see that the closed-loop control method has more practical value, which is convenient for students to adapt to some changes in the rhythm of the field, and can change the batting force in real time according to the landing point of the previous ball. To make it reach the optimal point of the ball, using the shuttlecock closed loop control method has strong practical significance and practical value in actual combat, and is easy to be popularized and popularized. This method solves the key problems in badminton training. It can provide useful reference for improving the teaching of badminton course in colleges and universities.

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