Research on Force Analysis in Curve Sports of Football

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Abstract: When the Sphere Rotates in the Air, Magnus Effect Has a Great Influence on the Trajectory of the Sphere. the Transverse Pressure Difference of the Rotating Object is Generated in Flight Motion, and Then the Transverse Force is Formed. the Transverse Force is Perpendicular to the Direction of the Object's Motion, Forming the Centripetal Force in the Object's Motion, Thus Changing the Direction of the Object's Flight. on the Basis of Force Analysis of Soccer Arc Movement, the Mechanical Model of Soccer Arc Movement is Explored, and the Motion Law of Soccer Arc Movement is Further Obtained by Solving the Model. the Application of the Mechanics Principle in Football Teaching Enables Students to Accurately Grasp the Force and Movement Laws of Football and Help to Grasp the Football. Based on the Dynamic Equation, This Paper Considers the Resistance of Air to Centroid Motion and Analyzes the Force of Football Arc Motion. Based on the Analysis of the Arc Motion of Football, the Mechanics Model of the Arc Motion of Football is Explored, and the Motion Law of Football Arc Motion is Further Obtained.

1. Introduction

When the Sphere is in Air Movement, It is Usually the Result of Superposition of Two Motions: One is the Flat Motion of the Sphere's Centroid, and the Other is the Rotation Around the Centroid Axis [1]. Although the Spherical Shape is Simple, the Physical Phenomena and Trajectories in Motion Are Quite Complex. the Application of Mechanics Principles in Football Teaching Enables Students to Accurately Grasp the Force and Movement Rules of Football, Which is Helpful to Grasp Football [2]. You Can Use the Right Strength, the Right Angle and the Right Time to Make the Football Fly out of the Perfect Arc. in the Current Competition, the Arc Motion of Football is Generally Adopted to Improve the Hit Rate, So the Arc Direct Free Kick is Taken as the Research Object to Analyze the Better Kick Point [3]. According to the Basic Principle of Dynamics, This Paper Explores the Mechanics Model of Soccer Arc Motion Based on the Analysis of Force on Soccer Arc Motion. by Solving the Model, the Motion Law of Soccer Arc Motion is Further Obtained.

2. Optimization and Modeling of Football Curve

There Are Many Factors Affecting the Flight Path of Football: Kicking Techniques, Such as Rotation, Launch Angle, Kicking Position, Wind Speed, Temperature, Humidity, Etc., as Well as the Roughness, Quality of the Football, and the Ball Skin That Constitutes the Surface of the Ball. Physical Properties Such as Number, Material, and Inflation Pressure. If the Forward Flying Ball Does Not Rotate, the Effect of the Surrounding Air Viscosity is Only to Slow the Ball's Flight Speed [4]. If the Ball is Rotated, the Combination of Rotation and Air Viscosity Creates a Circulation within the Ancillary Layer Around the Ball. the Flying Football Generates a Vertical Acceleration of Gravity under the Action of Gravity, Produces a Tangential Acceleration in the Horizontal Direction under the Action of the Differential Pressure Resistance, and Produces a Normal Acceleration in the Horizontal Direction under the Action of Lift [5]. When the Rotating Angular Velocity Vector of a Rotating Object Does Not Coincide with the Flying Velocity Vector of the Object, a Transverse Force Will Be Generated in the Direction Perpendicular to the Plane Formed by the Rotating Angular Velocity Vector and the Moving Velocity Vector. Curved Direct

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Free Kick Flies in Rotation, Not Only under the Action of Gravity and Air Resistance, But Also under the Differential Pressure Perpendicular to the Flight Direction, Resulting in a Small Degree of Bending of the Initial Trajectory of the Soccer Ball.

The rotating object generates lateral pressure difference in flight motion to form lateral force. The lateral force is perpendicular to the moving direction of the object, forming centripetal force in the movement of the object, thus changing the flying direction of the object. There are two problems involved in establishing the system model, one is the parameter estimation of the model, the other is the determination of the order of the model, and the least square method is commonly used to identify the coefficients of the time series model. The model parameter identification assumes that there are data observation points, and the model is:

$$| D_L(x_L) - D_R(x_L - D_L(x_L)) | < 1 \tag{1}$$

Then complete the least squares algorithm at one time to take the criterion function as follows:

$$C = \sum_{i=1}^{m} \sigma_i l_i r_i \tag{2}$$

The estimated value of the parameter is obtained so that the output of the model best predicts the output of the system. Then there are:

$$P_h = \frac{\sum_{i=1}^{h} \sigma_i^2}{\sum_{i=1}^{m} \sigma_i^2} \tag{3}$$

Expand the above formula and apply the following vector differentiation formula:

$$P = \frac{\sigma_i^2}{\sum_{i=1}^{m} \sigma_i^2} \tag{4}$$

$$E_p = \frac{\sum \left(t_{pi} - o_{pi} \right)^2}{2} \tag{5}$$

Have a regular equation:

$$I_\omega \ddot{\delta} = F_r d - K_\omega \dot{\delta} - C_\omega \delta - K_1 e \delta \tag{6}$$

From the physics point of view, the rotation of football is mainly to reduce the air resistance, the quality of the football itself is small, but its cross-sectional area is larger. When the football does not rotate in the air, the air resistance will increase as the speed of the football increases, and the resistance to football will be greater when transmitted over long distances. The process of football translation is only affected by gravity and air resistance, and air resistance causes the ball speed to decrease [6]. In the actual game, the speed of the football is very high, the friction between the football and the surrounding air will be caused, and the gap between the football airflow and the football is destroyed [7]. The football itself is not smooth. When it rotates, it will drive the surrounding air to produce a force consistent with the direction of the football. It can weaken the swirling airflow at the back of the football, thus reducing the resistance of the air. Under ideal conditions, the model is built without considering the influence of external factors, but these factors sometimes play a crucial role in actual kick training, so these factors should be considered.

3. The Arc Motion of Football in Curved Surface

The result of the ball rotating around its own axis directly affects the ball's trajectory. The “banana ball” in football matches and the looping and chopping balls in table tennis have obvious effects of Magnus effect. The magnitude of air resistance is related to the velocity of the object

relative to the air and the shape of the object. In general, the air resistance of the flying body is proportional to the air density, the surface area of the flying body and the waiting speed, and inversely proportional to the smoothness of the surface of the flying body. During the translational flight of a soccer ball, it is only affected by gravity and air resistance, which causes the ball speed to decrease. The streamline shape of the flying body also affects the resistance, and the better the streamline shape, the smaller the resistance [8]. The size of air resistance is related to the speed of the object relative to the air and the shape of the object. Generally speaking, the air resistance of the flying body is proportional to the air density, the surface area of the flying body and the waiting speed. The streamlined shape of the flight body also affects the resistance. The better the streamlined shape is, the smaller the resistance is. The direct arc free-kick is rotated, not only by gravity and air resistance, but also by the differential pressure perpendicular to the flight direction.

The change of three-dimensional motion angle and muscle force of football arc motion in each analysis step is applied to the finite element model as boundary conditions. The motion angle parameters applied to the finite element model are shown in Figure 1.

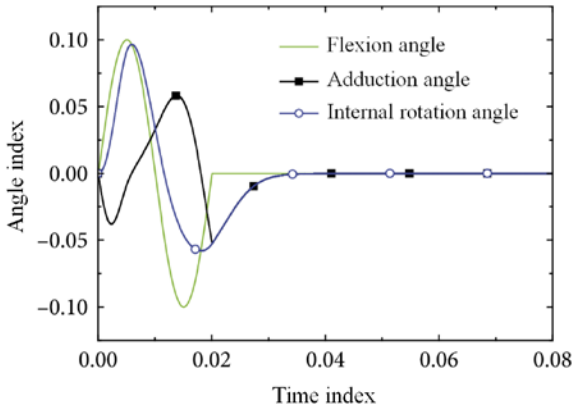

Fig.1 Motion Angle Data Applied to the Finite Element Model

In order to know which part of the football field kicks the arc directly to hit a larger free kick, you can first divide the football field half into a uniform grid and establish the coordinate origin. The rotating football also has the effect of internal friction, and its size is mainly affected by three factors: internal friction torque, air viscosity coefficient and angular velocity gradient. Due to the viscosity of the air, during the progress of the football, the air flow on the surface of the ball will rotate with the ball, thus forming a circulation [9]. Based on the Magnus effect and the effect of air resistance on the ball, it is conceivable that the flight path of the ball is a spatial curve. The airflow around the ball has a certain pressure on the ball. During the forward movement, the airflow above the ball is reduced due to the reverse air resistance [10]. But the air flow in the lower part is the same as that in the front, which accelerates the velocity of the air flow. As a result, the pressure on the upper side of the ball is high and the pressure on the lower side is low, and a certain pressure difference is formed, resulting in an arc. If the ball is passed in close range, the arc trajectory appears earlier, and the curvature of the arc will be very large. At this time, the shank swing is dominant, which can make the ball rotate better. If the long-term pass is made, the football should have enough forward speed, mainly with the thigh to drive the leg swing, the power of kicking is very large, can be added to the ball.

4. Conclusion

The movement of football contains a wealth of knowledge of mechanics. By analyzing the changing characteristics and laws of the trajectory of football arc motion, it is possible to grasp the appropriate kicking power, direction of force, and hitting point. The flying football generates a vertical acceleration of gravity under the action of gravity, generates a tangential acceleration in the horizontal direction under the action of the differential pressure resistance, and generates a normal acceleration in the horizontal direction under the action of the lift. When the football does not rotate in the air, the air resistance will increase as the speed of the football increases, and the resistance to

football will be greater when transmitted over long distances. The process of football translation is only affected by gravity and air resistance, and air resistance causes the ball speed to decrease. The rotating football also has the effect of internal friction, and its size is mainly affected by three factors: internal friction torque, air viscosity coefficient and angular velocity gradient. The combination of physical mechanics and biomechanics enables athletes to apply scientific knowledge to specific operations and practical training, from perceptual to rational. It is convenient for athletes to master and improve the technology, and realize the real higher, faster and more scientific sports spirit, and effectively improve the comprehensive strength of the athletes.

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