Analysis and Research of computer Simulation Technology in Swimming Sports Mechanics

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Abstract: In order to improve the quantitative teaching level of swimming sports, it is necessary to carry out quantitative analysis of swimming sports mechanics. A method of swimming mechanics analysis based on computer simulation technology is proposed. The ARMA model is used to analyze the mechanics of the limb movement of swimming, the Lagrange dynamics model is used to model the characteristics of the mechanics of swimming movement, and the distributed characteristic parameter model of the dynamics of swimming is analyzed in the space of six degrees of freedom. The dynamic distribution space of swimming motion is obtained by using the forward kinematics analysis model, and the inverse kinematics of multiple degrees of freedom is solved by analytic method, and the global and local joint force and force parameters in swimming are estimated. The model of swimming mechanics is realized. The simulation results show that the proposed method is accurate and accurate in estimating the mechanical parameters of swimming movement, and it can effectively guide swimming training.

1. Introduction

Swimming competition is mainly composed of five links: starting, route, turning, sprint and edge technique. As the first step of the whole process, swimming and departure has great significance. With the improvement of the competitive level of swimming in the world and the increasing intensity of the competition, different water sensations have different effects on the swimming performance of the athletes. Only by improving the water sense of the swimmers can they become more relaxed in the process of swimming. In order to get a better result in swimming. In this study, there are two main methods of water sense practice, one is fist grip exercise and the other is using water stroke exercise. If a swimmer has mastered the key points of action, but he lacks a good sense of water, we can use the method of clenching to make athletes tighten their double fists, avoid palms contact with the current, and use their fists to feel the direction and strength of the current in the water. We should pay attention to the need to control the stroke strength of the fist well, not too large[1]. By limiting the number of strokes and using the palm of the hand to magnify the resistance encountered by the athletes during the stroke, the paddling method can enhance the athletes' feeling of water, and facilitate the athletes to adjust the frequency and amplitude of their own stroke. Through the analysis of swimming movement mechanics, it is of great significance in improving the training level and studying the swimming sports mechanics analysis model to improve the swimming technical movement[2].

In order to realize the kinematic analysis of swimming, it is necessary to construct the dynamic model of the body and the body, and to analyze the dynamics of the body's body. From the point of view of modeling theory of lower limb and knee movement chain, the geometric control and behavior control mechanism of lower limb and upper limb movement chain in the course of useful swimming should be analyzed[3]. In reference [4], the kinetic energy decomposition and mechanical model of a moving arm with 7 rotational degrees of freedom are solved by geometric method. First, the CCD algorithm is used to make the inverse motion error between the virtual pose and the current position and pose. The method of combining mechanical structure with inverse kinematics of human body structure is used to decompose the characteristics of lower limbs and knees during swimming, and the global force is analyzed. In this way, it is impossible to estimate the local force mode of each joint of the limb, and the human motion model can not be constructed accurately. The

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lower limbs and knees are decomposed with 6 degrees of freedom, and the dynamic mathematical modeling and mechanics are carried out. The composition of the algorithm is complex and the adaptability is not good[5].

Aiming to solve the above problems, this paper presents a mechanical analysis method of swimming motion based on computer simulation technology[6]. The ARMA model is used to analyze the mechanics of the limb movement of swimming, the Lagrange dynamics model is used to model the characteristics of the mechanics of swimming movement, and the distributed characteristic parameter model of the dynamics of swimming is analyzed in the space of six degrees of freedom. The dynamic distribution space of swimming motion is obtained by using the forward kinematics analysis model, and the inverse kinematics of multiple degrees of freedom is solved by analytic method, and the global and local joint force and force parameters in swimming are estimated. The model of swimming mechanics is realized. Finally, the performance test is carried out through the simulation experiment, which shows the superior performance of this method in improving the ability of swimming mechanics analysis.

2. Structure and parametric model of human sports chain in swimming

2.1. Structure of human sports chain in swimming

In this paper, the Lagrange dynamic model is constructed, and the structure of swimming human body motion chain is analyzed in six degrees of freedom space combined with six degrees of freedom spatial impact dynamics model construction method. The kinetic energy of the sagittal knee impact force in swimming is decomposed and described, and the local mechanical parameters of the knee joint are solved[7]. The global analysis of the mechanical parameters in swimming process is carried out by using the 7-bar driving structure, and the optimal solution vector is obtained. Firstly, the spatial position model of swimming is analyzed, as shown in figure 1.

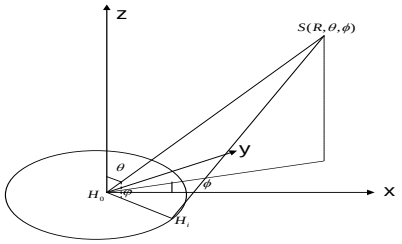

Figure 1. Human body spatial position model during swimming

In the figure, the swimming field is a standard swimming field, the amplitude of the space vector of the human body entering the water, the array spacing of the space position of swimming[8], the elevation angle of the human body entering the water, the azimuth of the waist and the left (right) arm θ, it is correlated with the distance S, The estimated parameters of three rotational degrees of freedom are as follows:

$$\frac{c\tau_i}{r} = \frac{r^2 - c^2\tau_i^2}{2Rr} + \cos\varphi_i \qquad \text{(i=1,2…M)} \qquad (1)$$

Because in swimming, the space position of entering water is a uniform linear array, according to motion planning theory, it can be proved that:

$$\cos(\varphi_i) + \cos(\varphi_{i+M/2}) = 0 \qquad (2)$$

The dynamic decomposition structure model of inverse kinematics of swimming athletes was obtained. In the initialization study of mechanical decomposition, $\sum_{i=1}^{M}\cos\varphi_i$ is obtained. The azimuth distance R of the position and posture of human body in the process of entering and leaving the water can be deduced as follows:

The joint at the palm of the world coordinate system construction, knee joint unit i in the process

of force, the body into the water of the arm movement chain as:

$$
\begin{aligned}
{}^{4}\mathbf{T}_{7} &= \prod_{i=5}^{7} {}^{i-1}\mathbf{T}_{i}(q_i) = \prod_{i=4}^{1} {}^{i-1}\mathbf{T}_{i}^{-1}(q_i) \cdot {}^{0}\mathbf{T}_{4} \\
&= \begin{bmatrix} \mathbf{n}_e & \mathbf{o}_e & \mathbf{a}_e & \mathbf{p}_e \\ 0 & 0 & 0 & 1 \end{bmatrix}
\end{aligned} \tag{3}
$$

In that kinematic chain structure of the swimming exercise human body, the joint can be approximate as a fixed center[9], and the state equation of the motion chain of the human body in the swimming exercise is:

$$m\frac{dV}{dt} = P\cos\alpha - X - mg\sin\theta \tag{4}$$

$$mV\frac{d\theta}{dt} = P\sin\alpha + Y - mg\cos\theta \tag{5}$$

In the formula, m is the mass of the force unit in swimming, P is the moment of momentum of the right foot in the process of entering the water. θ is the rotation vector of the joints of the two limbs. It provides a model basis for kinematic mechanics analysis[10].

2.2. Model analysis of swimming parameters

On the basis of the above model construction and kinematic chain analysis, the kinematic parameter model of swimming is analyzed, and the kinematics of swimming is analyzed in six degrees of freedom, and the joint angle space is obtained by the forward kinematics algorithm. Thus.The homogeneous coordinate transformation matrix of swimming motion can be obtained by the calculation of the previous modulus. Based on the analysis of swimming motion parameter model, the kinetic analysis of motion mechanics can be carried out.

3. Model improvement design and implementation

The ARMA model is used to analyze the mechanics of the limb movement of swimming, the Lagrange dynamics model is used to model the characteristics of the mechanics of swimming movement, and the distributed characteristic parameter model of the dynamics of swimming is analyzed in the space of six degrees of freedom. Using the inverse kinematics analytical model, the total joint structure z_i of swimming under six degrees of freedom is decomposed.

Above all, the distribution characteristic parameter model of swimming motion mechanics is analyzed in six degrees of freedom space, and the dynamic distribution space of swimming motion is obtained by using forward kinematics analysis model, which realizes the mechanical analysis and modeling of swimming movement.

4. Simulation experiment and result analysis

In order to test the application performance of this method in swimming mechanics analysis, the simulation experiment is carried out. The experiment is designed by Matlab 7. After the research object is determined, the experimental results are compared and analyzed by the contrast experiment method. The specific operation is to divide 10 swimmers into control group and experimental group on average, and then to conduct 200m backstroke competition, make good records, and then conduct training for 3 months. In the course of the experiment, the experimental group used the effective backstroke technique to train, while the control group adopted the normal training method. The two groups of swimmers maintained the same training time every day, and the other training contents and intensity remained unchanged. At the end of the experiment period, the two groups of swimmers were given 200m backstroke, and then the results of the two groups were compared, and the results of the two groups were compared with the results of backstroke before the experiment. Finally, the comparative results were observed to find out the gap between the control group and the experimental group, and to judge the effectiveness of backstroke technique.

The results of the analysis show that the results of backstroke in the experimental group are obviously improved, and there is a great time difference between the experimental group and the control group. The average result of the backstroke in the control group is 2.1 s behind the average result of the experimental group, which shows that the effective backstroke technique is effective.

5. Conclusions

In this paper, a method of swimming mechanics analysis based on computer simulation technology is proposed. The ARMA model is used to analyze the mechanics of the limb movement of swimming, the Lagrange dynamics model is used to model the characteristics of the mechanics of swimming movement, and the distributed characteristic parameter model of the dynamics of swimming is analyzed in the space of six degrees of freedom. The dynamic distribution space of swimming motion is obtained by using the forward kinematics analysis model, and the inverse kinematics of multiple degrees of freedom is solved by analytic method, and the global and local joint force and force parameters in swimming are estimated. The model of swimming mechanics is realized. The simulation results show that the proposed method is accurate and accurate in estimating the mechanical parameters of swimming movement, and it can effectively guide swimming training. This method has good application value in mechanics modeling and training instruction of swimming.

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References

[1] GU Q, YUAN L, XIONG Q J, et al., (2011). A comparative study of cost-sensitive learning algorithm based on imbalanced data sets. Microelectronics and Computer, 28(8), pp.146-149.

[2] LI Z X, ZHAO L D., (2008). A SVM classifier for imbalanced datasets based on SMOTEBoost. Systems Engineering, 26(5), pp.116-119.

[3] MAO W T, TIAN Y Y, WANG J W, et al., (2016). Granular extreme learning machine for sequential imbalanced data. Control and Decision, 31(12), pp.2147-2154.

[4] GU Q, YUAN L, NING B, et al., (2012). A noval classification algorithm for imbalanced datasets based on hybrid resampling strategy. Computer Engineering and Science, 34(10), pp.128-134.