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Research on the evolution of movement difficulty of competitive aerobics based on digital image processing

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Abstract. Competitive aerobics is a sports project which combines music, aerobics, difficulty and performance as the whole, and takes health, strength and beauty as its movement characteristics. Competitive aerobics is one of the sports that is dominated by skills, and the technical requirements are higher. Through the analysis of the existing literature, the current research on the difficulty of aerobics is only in the general qualitative description and experience summary. So far, there is no comprehensive analysis of the evolution of the competitive gymnastics articles, in the theoretical aspects of the study which is more general, limited. In this work, the method of digital image processing is used to focus on the evolution of the difficulty of aerobics. Combining the rules of the international competitive aerobics competition in each cycle, this work analyzes the statistical data of the movement difficulty of the aerobics championships, discusses the difficulty of aerobics development and evolution process, from summing up the characteristics of the development of difficult movements,the development trend of difficult movements of competitive aerobics is scientifically predicted.

Key words. Digital image processing,aerobic gymnastics,prediction ,championships.

1. Introduction

Competitive aerobics is a sport that can show continuous, complex, and high-intensity sets of action. The project originated from the traditional aerobics, and the set of movements must show the athlete's flexibility through a continuous combination of actions And the strength of the seven basic pace of the diversity of the operation of the combination of action, combined with the difficulty of action to complete the perfect set of athletic ability. Movement difficulty is the core of the United States and the United States race group competition, is the key to victory in the game. Competitive aerobics are skills-driven hard-to-class group of sports, so the difficulty of action is both aerobics athletes physical and technical performance, but also the referee on the set of actions to score an important factor. Its evolution

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has gone through a process from easy to difficult, from less to more, from plain to novel and complex[1-2].

A certain number of difficulty moves is the basis of winning the game, high-quality difficulty of the movement is the key to win, so the difficulty of movement innovation is particularly important. Innovation is not only the eternal theme of the development of competitive aerobics technology, it is also the theme of the development of difficult action. Since the rise of aerobics in the 1980s, its development and evolution are all related to innovation. The introduction of each new rule, will inevitably lead to the emergence of new actions, but also must have a new difficulty born, so the constant pursuit of difficulty action innovation has become a coach and athletes to strive for the goal, but also to promote coaches and athletes in accordance with the rules of the highest level of difficulty. The number of levels, the level of the design to arrange the difficulty of the action, the difficulty of continuous action innovation, with its novel, unique difficulty moves to the same level of athletes, in the game to win, and thus further promote the development of difficult moves and evolution[3].

In this work, the movement difficulty of competitive aerobics has evolved into a breakthrough, combined with each cycle of the international rules of competitive aerobics. Through the statistics of the video data of the World Aerobics Championship project difficulty movement, discusses the difficulty in competitive aerobics development process, summarizes the characteristics of difficulty movement evolution to the prediction of competitive aerobics development trend of difficulty, in order to provide a theoretical reference for the coaches and athletes[4].

2. The Trend of the Development of Competitive Aerobics Difficult Movements

Based on the video analysis of the difficulty score of the five finals of the Eighth World Aerobics Championships, the difficulty scores of athletes are mostly concentrated between 0.4-0.7 point, accounting for 85% of them. 0.4 points of the movement accounted for 15.62%, 0.5 points of the movement accounted for 18.96%, 0.6 points of the movement accounted for 33.11%, 0.7 points of the movement accounted for 19.17%, while the 0.8 movement only 5.83 %. Although there is no 0.9 points and 1.0 points of action, but the difficulty of movement is getting higher and higher, for example, For example, the six project champion of the French team of Thomas appeared in full rotation, free swivel 900 degrees down vince, to push up other difficult movements. Into the support and other difficult movement; women's single finals also appeared in the support of the two according to Liuxin into no support hanging legs and other difficult movements [5].

Table.1 The 8th Aerobics World Championships The finalists use the difficulty of the score statistics

	0.3	0.4	0.5	0.6	0.7	0.8
Male single	4	12	22	32	16	10
Female single	3	9	23	32	19	10
Mixed doubles	6	15	18	29	14	2
Three people	10	18	15	27	23	3
Six people	9	21	13	30	20	3
Total	32	75	91	150	92	28
Percentage	6.67	15.62	18.96	31.25	19.17	5.83

3. Digital image processing technology

On the basis of the design of the visual perception system of aerobics on-site technical action data, we need to design the algorithm of edge contour feature extraction of aerobics, and establish the static attribute and dynamic attribute in the process of moving through the feature data sensing algorithm. Then, by extracting data information processing and recognition technology from the contour contour feature points, the technical characteristic data containing a lot of noise are decomposed and processed. The feature pattern of the contours of the body contours is constructed by using the method of bright spot model diffraction, and the technical characteristics of the aerobics athletes are searched. The expression of the scattering model of the athlete's motion image is as follows [8]:

$$I(x) = J(x)t(x)\sum_{n=0}^{N-1}\frac{1}{\sqrt{m^n}} + \exp\left\{-\frac{(\theta-\theta_0)^2}{2\sigma_\theta^2}\right\}A(1-t(x)) \tag{1}$$

Where,θ:The direction of the filter;

σ_θ:Standard deviation of Gaussian function;

In order to construct the world coordinate systems A and B, when the coordinate system A and the coordinate system B have the same origin with the same orientation, the aerial movement athletes' multi-contour 3D model is obtained as follows:

$$\frac{\partial u(x,y,t)}{\partial t} = \frac{\sigma}{\rho s}\nabla G(x,y,t) = k\left[\frac{\partial G_x(x,y,t)}{\partial x} + \frac{\partial G_y(x,y,t)}{\partial y}\right] \tag{2}$$

According to the 3D contour model, the motion equation of viewpoint switching is obtained, and the results of edge contour detection are obtained::

$$imag\_err = T_{ij} - W_{ij} = [quarter(R)] * [quarter(Q_i) * W_{ij} + T_i] - W_{ij} \tag{3}$$

Through the above analysis, the body contour contour feature points extraction is realized, which provides an accurate data base for the design of the system..

Based on the above data acquisition and feature extraction, the iconic analysis algorithm of aerobics movement is designed. The traditional method of motion marking analysis adopts motion amplitude detection method, which is not applicable to the sports which show irregular movements in the range of aerobics.. Based on the method of image processing, this work presents a landmark algorithm for motion action based on feature edge feature extraction. The second-order cumulant is used to solve the contours of the three-dimensional model, and the confusion between contour blocks is obtained. The second-order cumulant value of the pixel is:

$$b_{21} = \frac{1}{2}(1-\lambda t)(1-t)^3 + [3+\lambda-2\lambda t(1-t)](t-t^2) + \frac{1}{2}(1-\lambda+\lambda t)t^3 \quad (4)$$

The above equation shows the second second-order lambda function of the multi-contour 3D model. The second-order lambda function is used to binarize the aerobics visual image, and the points in the candidate region of s^2 and c^2 are as long as $A, B, C \geq 0$,then $b_{ni} \geq 0$. The model of the combination of the three-dimensional images of the contours of the contours of the contours is obtained??

$$A = B_{40} + \frac{1-\lambda}{4}B_{41} \quad (5)$$

$$B = \frac{3+\lambda}{4}(B_{41} + B_{43}) + B_{42} \quad (6)$$

$$C = \frac{1-\lambda}{4}B_{43} + B_{44} \quad (7)$$

The gray value of the pixel at the (i, j) position is represented by X_{ij}, and the horizontal displacement of the three-dimensional moving image is estimated as:

$$\begin{aligned} p(x,y,t) &= -\sigma\nabla u(x,y,t) = -\sigma G(x,y,t) \\ &= -\sigma\left[G_x(x,y,t)i + G_y(x,y,t)j\right] \end{aligned} \quad (8)$$

In the above formula, $i$and$j$ are the unit direction vectors. In this work, the spatial neighborhood information is integrated into the landmark motion detection of moving body images, and the contour features of moving body images are extracted to achieve the landmark analysis algorithm improvement of Aerobics movements.

4. Research results and analysis

Bounce technology is one of the core technologies of competitive aerobics, it is one of the most essential features of competitive aerobics and it is also one of the important characteristics to distinguish other projects. The rules stipulate that "technical skill" is a concentrated expression of perfect completion ability. To reflect the perfect completion of the technical skills, bounce technology is the core

technology. The aerobics pace of landing requirements buffer control technique for feet, from the heel on the whole foot or by foot before the whole foot, then quickly knees, hip flexion buffer, followed by the completion of all the action in the moment, while maintaining good posture. The competitive aerobics pace landing buffer control technology is not only to make the movement of the body as much as possible to maintain stability, reduce the movement of the joint momentum, more importantly, this unique pace through the floor buffer control technology is to achieve the body weight rhythm rhythm of the important basic technology. In this work, the digital image processing technology is used to analyze the game of competitive aerobics, and the velocity parameters of hip, knee and ankle joint are analyzed for three typical aerobics athletes in sucking leg, jumping and jumping quantitative analysis is described in Figure 1, Figure 2 and Figure 3.

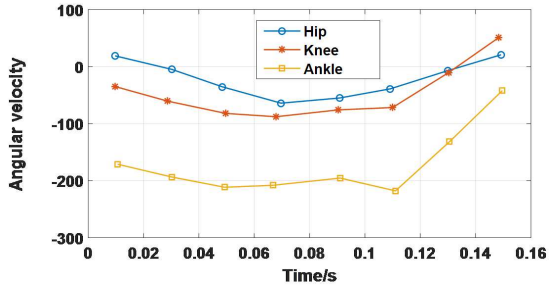

Fig. 1. The curve of the angular velocity of the hip, knee and ankle joint when the leg is jumped

Figure 1 shows the curve of the angular velocity of the hip, knee and ankle joints of the elite competitive aerobics athletes during the leg jump support leg.. As can be seen from the figure, most of the athletes hip joint curve is to accelerate after the first deceleration, only the side of the hip joint angular velocity is first accelerated after the acceleration and has been reduced; knee is first accelerated after the slowdown, and angular velocity down the back, ankle joint and knee changes in the trend is similar. The knee and ankle joint do the concession work first, turn to the restraint work, most of them do the negative work. The force curve of hip, knee and ankle to that of hip and knee and ankle is synchronous relative; ankle joint angular velocity curve of the rise and fall drastically, ankle active buffer is an important issue, should cause enough attention.

Figure 2 shows the curve of the angular velocity of the hip, knee and ankle joint when the competitive aerobics are leg-jumping. Most of the changes in the hip curve accelerate and then slow down. Knee joint is the first to accelerate after the slowdown, ankle and knee changes in the trend is similar to most of the athletes knee joint angular velocity which is the first acceleration and then slow down, and the angular velocity of the first downward, the knee and ankle to do the concession work for the restraint of work, most of the work is done. From the curve shows the results of changes in the knee more changes, and the ankle joint curve changes in the synchronization of the poor, showing hip, knee, ankle joint synchronization is poor, which ankle joint angular velocity curve rise and decline is relatively large. An

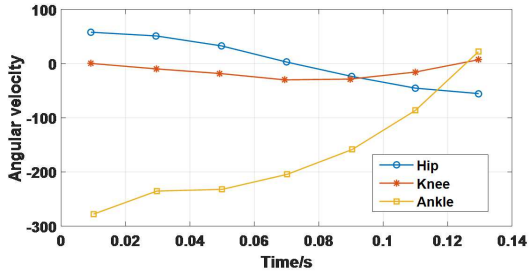

Fig. 2. The angular velocity curve of the hip, knee and ankle joint when the leg is jumped

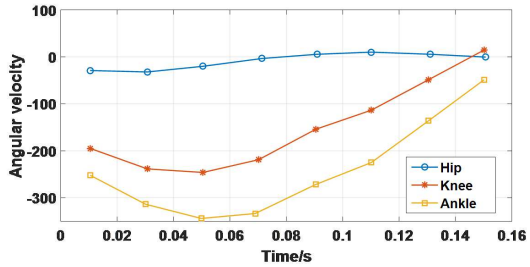

Fig. 3. The angular velocity curve of the hip, knee and ankle joint

active adjustment of the ankle joint is an important technical link that should attract enough attention. Comparing the timing of hip, knee and ankle joint strength, the order of lower extremity force is: hip, knee, ankle joint.

Figure 3 is the curve of the angular velocity of each elite aerobics athlete when kicking, jumping, supporting leg, hip, knee and ankle joint. Hip changes in a variety of ways, there are first to accelerate after the slowdown, there have been accelerated, but also the first deceleration and then accelerated. Most of the athletes' knee joint angular velocity is first accelerated and then decelerated, and the angular velocity direction is first downward and the upward trend of the ankle joint and knee joint is similar. The knee joint and ankle joint do the concession work first, turn to the restraint work, most of them do the negative work.

5. Conclusion

The quantitative analysis of the symbolic movements of aerobics and other exercise states is used to evaluate and describe the quantitative standards of aerobics training and competition level. The traditional method of movement of the iconic analysis method using the motion amplitude detection method, aerobics such movement amplitude irregular differences in the movement of the project is not applicable. Based on the method of digital image processing, this paper proposes a motion symbol analysis algorithm based on the extraction of feature points of contour, and carries out the system design. The spatial neighborhood information is integrated

into the iconic motion detection of the moving body image, and the edge contour feature of the moving body image is extracted to improve the iconic analysis algorithm of the aerobics movement. The experimental results show that the algorithm can effectively and accurately extract the contours of body contours of aerobics, and the probability of motion detection is high, the performance is robust and the superiority is good. The research results of the algorithm have good application value in the field of aerobics.

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