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Research Article

Research on Skiing Sports Planning and Physical Training Optimization Method Based on Computational Intelligence

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Skiing tourism is a kind of sports tourism product with high participation and high stimulation. With the construction of ski resorts, more and more people understand and participate in skiing tourism, and skiing tourism has gradually become one of the most popular leisure sports and tourism projects in winter. Most of the researches on skiing at home and abroad are based on experimental tests, and few of them involve theoretical modeling. At present, there is still a lack of a platform to comprehensively analyze and deal with skiing. To solve the above problems, this paper takes skiing as the research object. Starting with the related mechanical problems of skiing, the biomechanical model of skiing is established at the same time, to analyze the problems of various technical indexes in the process of skiing by mechanical calculation. The research involves the fields of multibody system dynamics, numerical optimization, mechanical modeling, skiing technical indexes, and so on. In the second part of this paper, based on the skiing motion mechanics model, physical mechanics formula, and load distribution function calculation of multirigid-body system, the sports problems in skiing process are studied.

1. Introduction

180 adolescents were trained in Alpine skiing for 5 years to test whether early and sustained organized adolescent sports in childhood and adolescence can predict the frequency of leisure time Alpine skiing at the age of 27. Research shows that the correlation coefficient of men is relatively high, and then, the correlation coefficient of men and women begins to decline. There is a positive correlation between the organized sports activities of adolescents in childhood and adolescence and the frequency of alpine skiing in adolescents' leisure time [1]. This article talks about the origin of cross-country skiing in Northern Europe. Since the first Winter Olympics in 1924, cross-country skiing has been competed in the Winter Olympics and has become the most comprehensive event in the Winter Olympics, with 12 individual events. During the preparations for the 2022 Beijing Winter Olympics, China plans to participate in all events [2]. In wearable sensor technology, users usually infer any qualitative information from data, which makes them confused about their own performance and what to take next. This paper proposes an advanced process of converting sensor data into instant expert feedback in the form of guidance instructions. Based on an example of Alpine skiing, various aspects of process and software design are discussed, which is helpful to solve the previous confusion [3]. This paper briefly reviews the machining theory and puts forward an approximate model to describe skiing sideslip. Sideslip is a characteristic of several movements in alpine skiing. Sideslip involves removing a thin layer of snow, which makes it similar to material processing in manufacturing [4]. This paper discusses how to build skiing landscape into male space. Through the comparison of mountains, remote areas of ski resorts, and advanced terrain, the less risky areas in ski landscape are interpreted as "gender-neutral" or female space. Through skiing, participants construct the meaning of gender and location, giving the sport a male version of privilege [5]. In this paper, the mathematical statistics method is used, and the method is explained in detail through an example, which solves the representativeness, validity, and reliability

of the construction of the evaluation index system of military physical training [6]. In order to solve the problem of patient transfer between bed and wheelchair, in this paper, we propose a novel framework to produce comfortable personal transfer movement. Through the physical interaction between human and robot, we find comfortable motion from user feedback (scalar value) and use a data-efficient black box optimization method, Bayesian optimization, which is used to quickly search for the optimal nursing motion. The experimental results show that the dual-arm human body transfer assistant robot can effectively optimize the comfort care motion controller of each user in the upper body lifting state [7]. By means of experiment and questionnaire investigation, this paper discusses the effect of physical fitness optimization training for 96 national defense students. The results show that the adaptive conditions of physical fitness optimization training are good and the training practice is reasonable [8]. This paper introduces the information of teaching cross-country skiing to people with intellectual disabilities, which makes the teaching of sports skills personalized and combined with other curriculum fields. Teaching is designed by volunteers, and information includes tips for good teachers, skill assessment, and specific skill processing [9]. Firstly, this paper introduces the importance of ski tourism and then analyzes the sports perception of ski tourists in Taiyuan by using various scientific methods, so as to get the main motivation of ski tourists to participate in ski tourism and know that the quality requirements of relevant employees need to be improved. Managers should pay attention to ski tourism projects, make full use of sports resources, and do a good job in maintaining the sustainable development of ski tourism in Taiyuan [10]. This paper first expounds the problems faced by the planning and construction of ski towns, then mentions the government's emphasis on the construction of characteristic towns, and then lists several successful cases of characteristic towns, trying to provide reference for the planning, construction, and sustainable development of ski towns from various aspects [11]. This book traces the history of skiing as a recreational and competitive activity in the United States, from its origin to today. In the mid-19th century, residents of mining communities along the Sierra and Rocky Mountains border used skis for practical purposes, including mail and supply transportation and hunting. But SK was first organized by Norwegian immigrants from the Midwest [12]. One of the pioneer areas of skiing is Tyrol (Austria). At school, most students take skiing courses. Such a large group of students also caused a large number of skiing injuries. Through the analysis and analysis of the patterns and conditions of skiing injuries, it is concluded that several main skiing events are skiing, skating and snowboarding, sledding, and cross-country skiing. Fractures are the majority in skiing, followed by contusions and sprains [13]. From the point of view of computational intelligence, this chapter discusses three key problems in the application of Complex Adaptive Network Logistics System (CACPLS) based on Computational Stock Market Model (CSMM) in the future supply network. Then, through the analysis of the problem, the method used in three cases to study and draw conclusions [14]. Described herein is a physical fitness training apparatus and method, including the function of the apparatus and the function of the person and muscle group, which can provide relatively constant or variable strength to various parts of the body and can also provide a resistance training module [15].

2. About the Optimization of Physical Training

2.1. Concept of Optimal Design of Physical Training. Optimization is the process of selecting and implementing the best plan on the basis of science. Things are always changing. Therefore, optimization is an ideal state or the ultimate goal, while optimization cares about the process of pursuit and is a means of continuous improvement. It can be seen that the design covers two core basic contents. First of all, design is the process of expressing an idea through reasonable planning and careful planning in various ways. Second, the result of the design is finally expressed in the form of vision, which is a kind of picture performance activity and a kind of artistic work. To sum up, the optimization design of physical training refers to the process of focusing on effectively improving the physical quality of trainees through physical training and scientifically formulating a set of practical and effective training programs in advance from the objective reality.

2.2. Principles of Optimal Design of Physical Training. The principle followed by the optimization design of physical training is the basis that must be adopted when optimizing the design, which is the precondition of optimization and the root of the design. From the above optimization design concept, to optimize the design of physical training program, we must abide by the following principles: first, the objectivity of conditions, second, the purpose of design, and third, the scientific basis.

2.2.1. Objectivity of a Condition. Lenin emphasized that "things do not depend on our consciousness or our feelings, and they exist outside us." This theory affirms the objectivity and independence of cognitive objects, which can be understood as design is only an objective reflection. Therefore, the design must be based on certain materials and theories, instead of building a car behind closed doors; otherwise, the designed scheme will only be a castle in the air, and it will always fall down one day. The general design should proceed from reality, and the optimized design should study the reality in depth, so as to better grasp the design direction, steps, and results. The optimal design of physical training should follow the principle of objectivity of conditions and proceed from reality.

2.2.2. Purpose of Design. "Setting" means assuming and assuming, while "planning" means calculating, planning, choosing, and planning, all of which occur for certain purposes. Purpose provides direction and basis for design. Only when there is a purpose can it be called design and optimization design. The purpose is to design goals and solve problems. The purpose of physical training is to develop and improve one's own strength, so all the plans, methods, and ways of physical training are designed to achieve this fundamental purpose.

2.2.3. Scientific Nature of the Basis. The so-called scientific nature is to conform to the inherent essential laws of things. Dialectical materialism theory says that the laws of nature are objective and true and do not take human will as the main body. People-oriented training is the basic physical quality training, so training must follow people's own laws. Man is the product of nature and a special creature in nature. As a creature, man has many commonalities, such as talking and jumping, but at the same time, he has many personalities, such as human appearance and character. Therefore, the optimization design of training is people-oriented, and it is also based on people's commonness and individual differences and designs a series of training programs.

2.3. Ways to Optimize the Design of Physical Training. "Approach" is the route and channel. The way to optimize the design of sports training is to realize the training route and channel. Design approach is the main carrier of a series of sports training activities, and it is also the main part of the whole sports training activities.

3. Skiing Mechanics Model Based on Multirigid-Body System

3.1. Snowboard-Snow Model. Where *oxyz* is the inertial reference frame, r_i' is the vector of point *I* on the ski relative to the center of the ski. Formulas (1) and ((2)) are

$$r_i = r_c + Ar_i', \tag{1}$$

$$v_i = v_c + w \times r_i'. \tag{2}$$

f_i^s, f_i^c, f_i^f is the immersion force, impact force, and friction force acting on the point by snow, and the resultant force is as shown in

$$f_i = f_i^s + f_i^c + f_i^f. \tag{3}$$

The formula is the interaction between point*I*on skis and snow.

3.1.1. Snowboard-Snow Elastic Immersion Force. Snow is a nonlinear substance, and the contact force is not proportional to the immersion amount. Contact force is related to contact history.

Federolf can ignore the nonlinear relation and its fitting formula is

$$p\text{load} = \begin{cases} ax + b, & x > 0, \\ 0, & x \le 0, \end{cases} \tag{4}$$

$$P\text{unload} = \begin{cases} c(x\text{-}x_{\max}) + p_{\max}, & x_{\max} \ge x \ge x_0, \\ 0, & x \le x_0, \end{cases} \tag{5}$$

where *x* is immersion depth, *a*, *b*, and *c* are characteristic constant parameters describing snow, and $x_0, x_{\max}, p_{\max}$ is unloading parameter depending on loading process.

When applying the above formula directly, it will encounter difficulties such as determining snow parameters and selecting calculation formulas. Because even for snow at the same point, pressure before and after will change the characteristic parameters of snow. In application, the above formula will cause sudden change near zero, which makes it difficult to solve numerically. To avoid this problem, the formula is modified as in

$$\rho = \begin{cases} ax + b, & x > \varepsilon_0, \\ \zeta x^{\delta}, & x \le \varepsilon_0. \end{cases} \tag{6}$$

According to the continuity calculation, there is always an elastic immersion force between the snowboard and the snow, regardless of whether the snowboard is stationary or moving relative to the snow, as shown in

$$f_i^s = pA_i\rho, \tag{7}$$

where Rho is the snow density and *A* is the area of the contact point.

3.1.2. Snowboard-Snow Impact. When the skiing board is still, the submerged force plays an important supporting role, and the acting force of snow on skiing can be calculated by formula. However, when skiing moves at a fixed angle relative to snow, the skiing board can push the snow to the plateau. If the relative motion is very strong, thunder will not fly. The energy of these separated snow must come from the work done by the force of Qingcao board. This force is impact force, and its mechanism is different from immersion force.

According to the momentum theorem, the change of momentum before and after a certain point on a snowboard is equal to the impact force as shown in

$$f_i^c = -\frac{\triangle m_i v_i}{\triangle t} = -pA_i|v_i|\left(v_i' - v_i\right), \tag{8}$$

where *m* is the mass of snow at point *i*, *p* is the density of snow, *A* is the area of point *I* on skis, and v_i and v_i' are the snow velocities before and after impact, respectively. The speed of snow before and after impact is the key to calculate the impact force. *T* is the time difference before and after the momentum change of skis, and *F* is the impact force.

p_i is the unit vector of point *i* perpendicular to the contact surface *ab*, and p_i is the unit impact vector in the opposite direction to v_i. Then, there is

$$p_{ab} = (p_i \times p_v) \times p_i. \tag{9}$$

As a vector on the contact surface, decompose p_v into

$$p_v = p_v^1 + p_v^2. \tag{10}$$

There are

$$p_v^2 = (p_v \bullet p_i)p_i, \tag{11}$$

$$p_v^1 = p_v - p_v^2 = p_v - (p_v \bullet p_i)p_i. \tag{12}$$

Component p_v^1 is parallel to the contact surface and does not change before and after because it is not impacted. Component p_v^2 is perpendicular to the contact surface, and the direction of $p_{v'}^1$ after impact is opposite to that of $p_{v'}^2$ before impact, which is related to the loss of impact energy. $p_{v'}$ is the velocity per unit velocity p_v after impact as shown in

$$p_{v'} = p_{v'}^1 + p_{v'}^2. \tag{13}$$

Formula (14) was obtained from Newton collision model.

$$p_{v'}^2 = -kp_v^2, \tag{14}$$

where K is the recovery coefficient and is a constant, and the velocity per unit velocity after impact is

$$p_{v'} = p_{v'}^1 + p_{v'}^2 = p_v^1 - kp_v^2 = p_v - (1+k)(p_v \bullet p_i)p_i. \tag{15}$$

Therefore, the impact force at point I can be

$$f_i^c = -pA_i|v_i|^2(p_{v'} - p_v) = pA_i|v_i|^2(1+k)(p_v \bullet p_i)p_i. \tag{16}$$

If p_v^2 and p_i are in opposite directions, it means that skis and snow do not affect each other.

Some previous studies ignored this impact force, while others regarded it as damping force. Although the damping force is also related to the relative motion speed, it is different from the impact force in that its direction is opposite to the relative motion speed. From the above deduction, it can be seen that the impact force is related to the relative speed. However, the direction of the impact force is perpendicular to the contact surface. Therefore, the damping force and the impact force are different in direction.

3.1.3. Snowboard-Snow Friction. Friction is common between skis and snow. The dynamic friction coefficient is between 0.01 and 0.3 or 0.05 and 0.45. Friction between snowboard and snow is affected by several factors: speed, contact area, snow properties (snow temperature, hardness, and amount of liquid water), and snowboard characteristics (stiffness, bottom material, bottom roughness, and temperature conductivity). Friction is considered in many literatures. However, their approach is too simple. They think that the direction of friction is along the long axis of skis. This treatment is not accurate.

Classical Coulomb friction can be used to describe the friction between two objects. The friction between skis and snow can be expressed as

$$f_i^f = \mu|f_i^s + f_i^c|f_i^e. \tag{17}$$

Coulomb's law means that Coulomb's friction force is proportional to the positive pressure acting on the friction surface and has nothing to do with the contact area of the outer surface.

Where μ is the friction coefficient, $Uf + f1$ is the resultant force of diffuse force and impact force, perpendicular to the contact surface, and fi is the direction of friction force and the projection direction of impact velocity on the contact surface, which is

$$f_i^e = \frac{p_v^1}{|p_v^1|} = \frac{p_v - (p_v \bullet p_i)p_i}{|p_v - (p_v \bullet p_i)p_i|}. \tag{18}$$

In order to avoid the instability of numerical calculation caused by the sudden change of friction force near the zero point of velocity, the friction coefficient at the zero point of velocity is smoothed as shown in

$$\mu \begin{cases} \mu\left|\sin\left(\dfrac{\pi v_i^{ab}}{2v^*}\right)\right|, & \left|v_i^{ab}\right| < v^*, \\ \mu, & \text{else}, \end{cases} \tag{19}$$

where V is a tiny quantity. Integrate the contact part along the whole ski, and the result is the total contact force. Even in the simplest cases, where skis are rectangular and snow is flat, calculations are difficult. On the one hand, the snow terrain is irregular, and not all snowboard parts can contact with the snow. On the other hand, it is necessary to distinguish the velocity direction of the contact point in the calculation of impact force, which makes it difficult to express the integral function and integral region.

In order to avoid the above difficulties, the skis are dispersed into small units. This discrete method makes the calculation of contact force relatively simple. The resultant force of all discrete points on skis is

$$\begin{cases} F = \sum f_i, \\ M = \sum\left(A_i r_i' \times f_i\right). \end{cases} \tag{20}$$

This is the total interaction between skis and snow.

3.2. Load Distribution Function. Ignoring the flexibility of skis, the stress distribution of skis calculated according to the above formula will be different from the actual situation. For example, when a skier stands still on a flat snow and balances, the immersion amount X is the same at all points of the ski, and the immersion force calculated according to the above formula is also the same. In fact, the actual force distribution is not uniform. Because of the different stiffness of the front and back parts along the long axis of the snowboard, the immersion amount should be different and the corresponding immersion force is also different. In this paper, the load distribution function is proposed to approximate the flexibility of skis. Suppose that the flexible load distribution function of snowboard is

$$K = k(x, y, z). \tag{21}$$

The contact force between the snowboard and the snow can be expressed as

$$K = f\left(h_x, h_y, h_z, \theta_x, \theta_y, \theta_z\right). \quad (22)$$

The force is then multiplied by the load distribution function to approximate the deformed force, as in

$$F = K \cdot F = k(x, y, z) \cdot f\left(h_x, h_y, h_z, \theta_x, \theta_y, \theta_z\right). \quad (23)$$

For the convenience of calculation, it is assumed that the stiffness is symmetrical around 0 point, and the stiffness is approximately fitted. The fitting formula is as follows

$$E_1 = \frac{c_1}{c_3 x^2 + 0.5} + c_2, -\frac{1}{2} \leq x \leq \frac{1}{2}. \quad (24)$$

Normalized stiffness distribution function as

$$k(x, y, z) = \frac{E_1}{s_{\max}}. \quad (25)$$

In a word, taking skis as a rigid body has six degrees of freedom. It can be described by the following parameters: snow density ρ, snow pressure constant a, b, ε_0, recovery coefficient K, friction coefficient μ, snowboard geometric parameters, and stiffness distribution maximum stiffness $s_{\max}$, $s_{\min}$ to describe the interaction force between snowboard and snow, which not only considers the geometric characteristics of snowboard but also reflects the influence of snowboard flexibility on the interaction force to a certain extent.

4. Statistical Results and Analysis of Technical Performance Index Data

4.1. Index Analysis of Video Samples with Serious Errors

4.1.1. Serious Error Rate. Figure 1 shows that in the participating videos of snowboarding U-field competition in 2010, 2014, and 2018 Winter Olympics, the total error rates of male athletes in each Winter Olympics are 53.41%, 47.52%, and 45.16%, respectively, and the total error rate is 48.58%. The total error rate of women in each Winter Olympics is 46.23%, 51.52%, and 43.21%, and the average total error rate is 47.20%. It can be seen that the high serious error rate is one of the characteristics of snowboarding U-shaped field competition.

4.1.2. Link Where Serious Mistakes Occur. Table 1 shows that in the last three Winter Olympics snowboarding U-shaped field competitions, male and female athletes mainly had serious technical problems such as falling down, stalling, and physical contact with snow surface, and there were serious mistakes in this link. Secondly, serious mistakes occurred in the taxiing stage accounted for 88.10%-100% of the total error samples, but the number of serious mistakes occurred in this link only accounted for 2.86%-11.90% of the total error samples. No serious mistakes were observed in takeoff and air stagnation.

4.1.3. Types and Causes of Serious Errors. Figures 2 and 3 show that the main types of serious mistakes of male and female athletes are "fall or stall caused by insufficient snowboard rotation angle after landing", accounting for 60.58% of the total mistakes of male athletes and 65.92% of the total mistakes of female athletes, respectively. It can be seen that the samples of male and female athletes who made serious mistakes made mistakes, although they were all in the landing stage. However, the main cause of mistakes is the stagnant link. Whether the air flip amplitude is too large or the air flip is insufficient, the air action completion quality is not high. Correspondingly, it will affect the adjustment of athletes' body and skis when landing. When athletes cannot land in a correct attitude, the overturning moment produced by the reaction force of snow surface on the centroid of human body at the moment of landing will destroy the dynamic balance of athletes when landing, thus causing athletes to topple. The ordinates in Figures 2 and 3 both represent the percentage of athletes' error types. Through the analysis of the percentage of error types, the types and reasons of athletes' serious errors can be summarized.

4.1.4. The Effect of Mistakes on Competition Results. The intergroup t-test (Table 2) on the competition results of male and female athletes in the "major error group" sample and the "no major error group" sample shows that there is a significant difference in the competition results between groups (0.01), and the competitive performance of the non-major error group sample is higher than that of the serious error group.

4.2. Technical Performance Index Analysis of Video Samples without Serious Errors

4.2.1. Number of Air Movements. Table 3 shows that, in the last three Winter Olympics, the complete set of competition movements of male athletes usually includes 5-6 air movements. Among them, in the 2010 Winter Olympics, the number of video samples including five air movements accounted for 87.8% of the total samples, while in the 2014 and 2018 Winter Olympics, the number of video samples including five air movements accounted for 34.0% and 39.2% of the total samples, respectively, and the number of samples completing six air movements accounted for 60.4% and 60.8% of the total samples, respectively. The whole set of female athletes' movements usually consists of 5-7 air movements, among which the number of female athletes' air movements in 2010 Winter Olympics is mainly 5, and the number of samples completing 5 air movements accounts for 63.2% of the total samples, and the number of samples completing 6 air movements accounts for 35.1% of the total samples. However, in the 2014 and 2018 Winter Olympics, the number of female athletes' movements was mainly 6, of which the proportion was 47.9% in 2014 and 58.7% in 2018, while the number of samples who completed 5 air movements accounted for the total number or the number of samples who completed 7 air movements decreased, respectively.

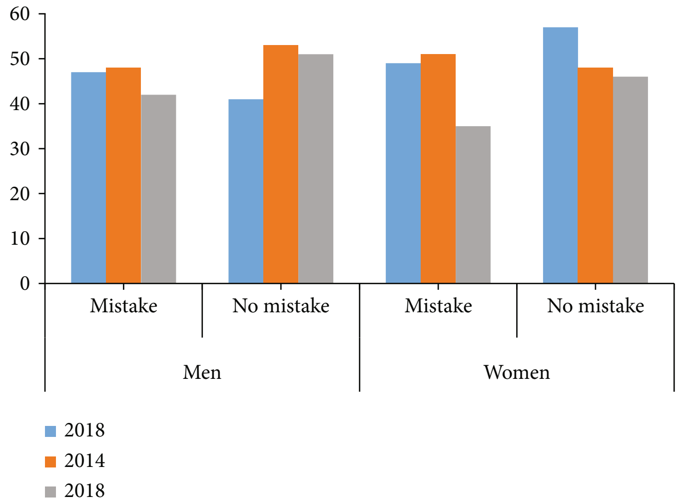

Figure 1: Comparison of men's and women's mistakes in 2014-2018 Winter Olympics.

Table 1: Link of athletes' mistakes.

Error occurrence link	Men 2010	Men 2014	Men 2018	Women 2010	Women 2014	Women 2018
Sliding link	0	5	0	5	0	1
	0%	10.40%	0%	11.90%		2.86%
Landing link	46	43	42	44	51	34
	100%	89.60%	100%	88.10%	100%	97.14%
Other stages	0	0	0	0	0	0
	0%	0%	0%	0%	0%	0%
Total	47	48	42	49	51	35

Correlation test shows that there is no significant correlation between the results of male athletes and the number of air movements ($r = -0.16 \sim 0.08$, $P < 0.05$). The results of female athletes and the number of air movements showed a significant negative correlation ($r = -0.28 \sim -0.45$, $P < 0.05$). From the aspect of technical performance, this shows that for female athletes, the more the number of air movements completed cannot improve their sports performance but will affect the referee's evaluation of athletes' overall performance because of the short time of air stagnation or the low difficulty of air movements.

4.2.2. Average Stagnation Time. Table 4 shows that the average stagnation time of male athletes is between 1.54 s and 2.13 s, and that of female athletes is between 1.13 s and 1.83 s in the last three Winter Olympics snowboarding U-shaped field competitions. The data in Table 4 show that the average stagnation time of male athletes in skiing is longer than that of female athletes, and the correlation with competition performance is also low.

4.2.3. Average Flip Angle, Combined Maximum Flip Angle, and Maximum Continuous Flip Angle. Tables 5, 6, and 7, respectively, show the correlation between the average flip angle, the comprehensive maximum flip angle, and the maximum continuous flip angle and the competition results. These three indexes examine the relationship between athletes' technical performance indexes and competition results from three angles: average movement difficulty, comprehensive maximum difficulty, and maximum continuous difficulty.

The data showed that the correlation between the comprehensive maximum flipping angle index and the results of male athletes was moderate or strong ($r = 0.58 - 0.81$, $P < 0.01$), and the correlation between the comprehensive maximum flipping angle index and the results of female athletes was also moderate or strong ($r = 0.53 - 0.70$, $P < 0.01$). Maximum continuous flip angle has moderate or strong correlation with male athletes' performance ($r = 0.54 \sim 0.74$, $P < 0.01$) and also has moderate or strong correlation with female athletes' performance ($r = 0.51 \sim 0.58$, $P < 0.01$). The above results show that the average difficulty of movement, the comprehensiveness of movement, and the difficulty of movement cohesion are closely related to the competition results.

4.2.4. Nonperpendicular Axis Angle%. Table 8 shows all the valid data of the correlation between the nonvertical axis angle% index of male and female snowboarding U-shaped field athletes in 2010-2018 Winter Olympics and their competition results. The inspection results show that there are some gender differences in the correlation between the nonvertical axis angle% index and the competition results of male and female athletes, which are mainly manifested in

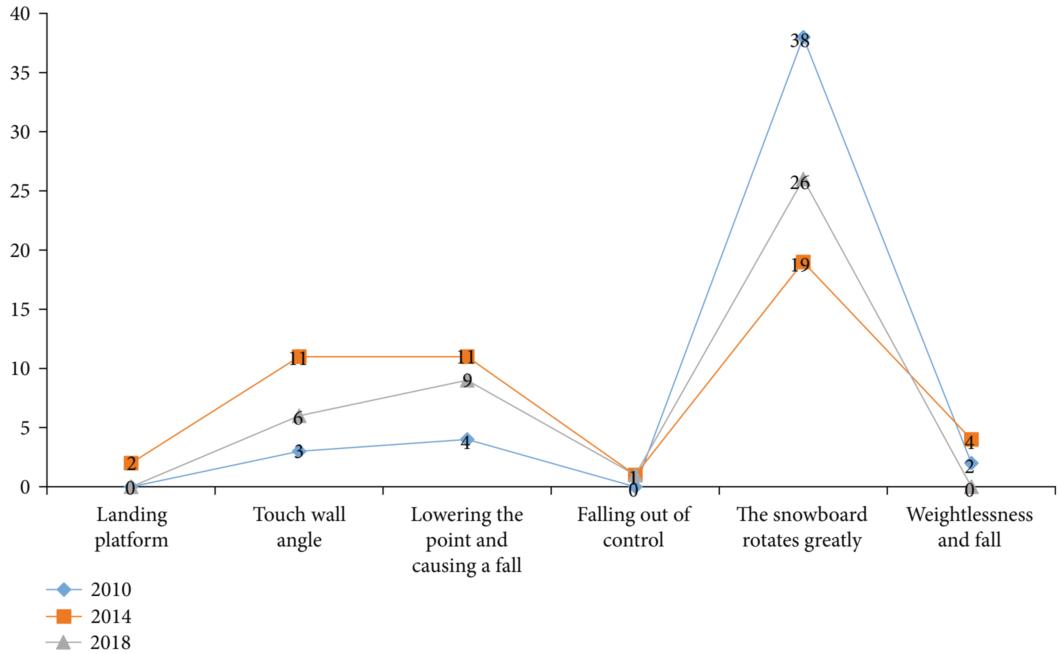

Figure 2: Types of male athletes' mistakes.

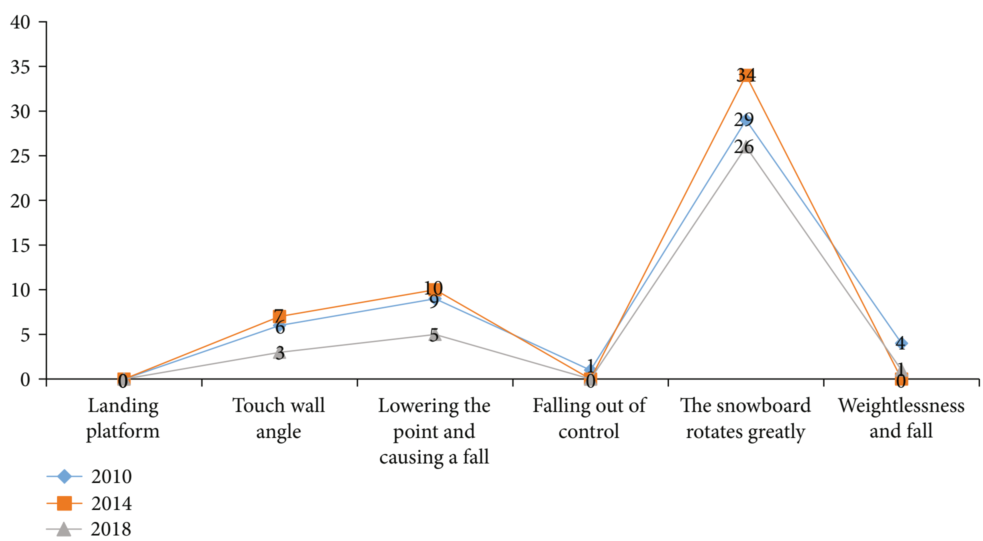

Figure 3: Types of female athletes' mistakes.

the strong correlation (2010: $r = 0.58$, $P < 0.01$), moderate correlation (2014: $r = 0.44$, $P < 0.01$), and weak correlation (2018: $r = 0.30$, $P < 0.05$) between the index and the competition results of male athletes, but the correlation between the index and the competition results of female athletes is not significant (2010: $r = -0.11$, $P > 0.05$); 2014: $r = -0.10$, $P > 0.05$; 2018: $r = 0.01$, $P > 0.05$). Because "nonvertical axis angle%" represents the ratio of the turnover angle and the total turnover angle of somersault air movements and compound turnover movements around the horizontal axis or sagittal axis of human body, it is preliminarily inferred that this may be related to the number and difficulty of athletes' completion of such movements.

4.2.5. Inward Rotation Angle% Indicator. In Table 9, the test results show that there is little or no significant correlation between the index of inward rotation angle% and competition results. The correlation between male and female athletes' diversity index and their achievements in 2018 Winter Olympics is weak (male: $r = 0.32$, P 0.05; female: $r = 0.33$, $P < 0.05$), while there was no significant correlation between male athletes' diversity index and competition performance in 2010 and 2014 Winter Olympics ($r = -0.15 \sim 0.11$, $P > 0.05$). This result shows that the index of inward rotation angle% may have an impact on competition performance under some conditions, but the degree of this impact is limited. Mean value is the quantity

Table 2: Comparison of the results between male and female athletes with major mistakes and those without major mistakes.

Group			Minimum grade	Highest achievement	Average achievement	P
Men	2010	There are major mistakes ($n = 47$)	2.5	35.7	15.61 ± 7.18	<0.01
		No major mistakes ($n = 41$)	25	48.8	36.07 ± 6.54	
	2014	There are major mistakes ($n = 48$)	4.5	70.75	32.68 ± 14.22	<0.01
		No major mistakes ($n = 53$)	49	95.75	76.70 ± 12.30	
	2018	There are major mistakes ($n = 42$)	4.5	81.75	33.15 ± 17.99	<0.01
		No major mistakes ($n = 51$)	52.25	98.5	78.98 ± 13.01	
Women	2010	There are major mistakes ($n = 49$)	2.7	29.8	15.61 ± 6.72	<0.01
		No major mistakes ($n = 57$)	23	45.8	35.06 ± 5.74	
	2014	There are major mistakes ($n = 51$)	14	61.75	36.65 ± 11.83	<0.01
		No major mistakes ($n = 48$)	45.75	95.5	75.42 ± 13.54	
	2018	There are major mistakes ($n = 35$)	6.5	49	24.29 ± 12.98	<0.01
		No major mistakes ($n = 46$)	34	98.25	67.68 ± 14.57	

Table 3: The number of air movements of male and female athletes in the last three Winter Olympics.

Group		Number of air movements				Correlation with competition results ®
		4 (%)	5 (%)	6 (%)	7 (%)	
Men	2010 ($n = 41$)	1 (2.4)	36 (87.8)	4 (9.8%)		0.08
	2014 ($n = 53$)		18 (34.0%)	32 (60.4%)	3 (5.7%)	0.04
	2018 ($n = 51$)		20 (39.2%)	31 (60.8%)		-0.16
Women	2010 ($n = 57$)		36 (63.2%)	20 (35.1%)	1 (1.8%)	-0.28
	2014 ($n = 48$)		3 (6.3%)	23 (47.9%)	22 (45.8%)	-0.38
	2018 ($n = 46$)		5 (10.9%)	27 (58.7%)	14 (30.4%)	-0.45

Table 4: Correlation between athletes' average time and competition results.

Group		Average stagnation time (unit: S)			Correlation with competition results ®
		Minimum value	Maximum value	Mean ± standard deviation	
Men	2010 ($n = 41$)	1.56	2.07	1.86 ± 0.10	0.66
	2014 ($n = 53$)	1.54	2.11	1.84 ± 0.10	0.64
	2018 ($n = 51$)	1.71	2.13	1.92 ± 0.10	0.76
Women	2010 ($n = 57$)	1.22	1.77	1.52 ± 0.12	0.71
	2014 ($n = 48$)	1.13	1.83	1.51 ± 0.18	0.8
	2018 ($n = 46$)	1.17	1.81	1.55 ± 0.13	0.82

Table 5: Correlation between average flip angle index and performance of athletes.

Group		Average flip angle (unit: °)			Correlation with competition results ®
		Minimum value	Maximum value	Mean ± standard deviation	
Men	2010 ($n = 41$)	420.00	864.00	745.17 ± 83.87	0.51
	2014 ($n = 53$)	488.79	874.54	656.35 ± 92.54	0.65
	2018 ($n = 51$)	630.00	1188.00	902.30 ± 134.87	0.45
Women	2010 ($n = 57$)	324.00	684.00	478.77 ± 83.74	0.43
	2014 ($n = 48$)	283.00	630.00	459.46 ± 79.44	0.68
	2018 ($n = 46$)	360.00	750.00	535.06 ± 88.85	0.77

Table 6: Correlation between comprehensive maximum flip angle index and performance of athletes.

Group		Comprehensive maximum flip angle (unit: °) Minimum value	Maximum value	Mean ± standard deviation	Correlation with competition results ®
	2010 ($n = 41$)	1980.00	3420.00	2800.97 ± 362.35	0.67
Men	2014 ($n = 53$)	1440.00	3780.00	2803.77 ± 396.10	0.81
	2018 ($n = 51$)	2160.00	4320.00	3240 ± 519.20	0.58
	2010 ($n = 57$)	1080.00	2340.00	1762.11 ± 353.08	0.53
Women	2014 ($n = 48$)	1080.00	2340.00	1830 ± 306.94	0.60
	2018 ($n = 46$)	1440.00	2700.00	2015.22 ± 267.31	0.70

Table 7: Correlation between athletes' maximum continuous flip angle index and competition results.

Group		Maximum contact flip angle (unit: °) Minimum value	Maximum value	Mean ± standard deviation	Correlation with competition results ®
	2010 ($n = 41$)	1440.00	2160.00	1949.27 ± 234.35	0.58
Men	2014 ($n = 53$)	1440.00	2520.00	2007.17 ± 227.13	0.74
	2018 ($n = 51$)	1800.00	2880.00	2195.29 ± 241.55	0.54
	2010 ($n = 57$)	1080.00	1800.00	1315.84 ± 183.68	0.51
Women	2014 ($n = 48$)	1080.00	1800.00	1312.50 ± 213.17	0.58
	2018 ($n = 46$)	1080.00	2160.00	1440.00 ± 242.98	0.58

Table 8: Correlation between nonvertical axis angle% index and athletes' performance.

Group		Nonvertical axis angle% Minimum value	Maximum value	Mean ± standard deviation	Correlation with competition results ®
	2010 ($n = 41$)	0	0.61	0.19 ± 0.16	0.56
Men	2014 ($n = 53$)	0	0.69	0.23 ± 0.15	0.44
	2018 ($n = 51$)	0	0.61	0.19 ± 0.16	0.30
	2010 ($n = 57$)	0	0.33	0.04 ± 0.09	-0.11
Women	2014 ($n = 48$)	0	0.21	0.05 ± 0.07	-0.10
	2018 ($n = 46$)	0	0.38	0.09 ± 0.10	0.01

Table 9: Correlation between athletes' internal rotation angle% index and competition results.

Group		Inward rotation angle% Minimum value	Maximum value	Mean ± standard deviation	Correlation with competition results ®
	2010 ($n = 41$)	0.05	0.53	0.25 ± 0.09	0.11
Men	2014 ($n = 53$)	0.15	0.39	0.24 ± 0.07	0.06
	2018 ($n = 51$)	0.05	0.53	0.25 ± 0.09	0.32
	2010 ($n = 57$)	0	0.64	0.32 ± 0.14	-0.15
Women	2014 ($n = 48$)	0.18	0.94	0.34 ± 0.14	0.07
	2018 ($n = 46$)	0.13	0.75	0.28 ± 0.17	0.33

of trends in a set of data sets, which refers to the sum of all data in a set of data divided by the number of this set of data. Standard deviation is the most commonly used quantitative form to reflect the dispersion degree of a group of data, and it is also an important index to express the accuracy.

4.2.6. Reverse Foot Angle%. In Table 10, the correlation test shows that there are great differences in the correlation between the antifoot angle% index and competition results of different groups of athletes. Among them, there is a significant weak correlation between male athletes' antifoot

Table 10: Correlation between athletes' antifoot angle index and competition results.

Group		Reverse distance angle% Minimum value	Maximum value	Mean ± standard deviation	Correlation with competition results ®
Men	2010 ($n = 41$)	0.19	0.5	0.27 ± 0.07	0.19
	2014 ($n = 53$)	0	0.35	0.22 ± 0.06	0.34
	2018 ($n = 51$)	0.12	0.65	0.28 ± 0.14	0.31
Women	2010 ($n = 57$)	0	0.57	0.21 ± 0.12	0.44
	2014 ($n = 48$)	0	0.31	0.18 ± 0.07	0.25
	2018 ($n = 46$)	0	0.33	0.20 ± 0.06	0.33

Table 11: Composition of diversification indicators.

Group		Diversification Types of grasping board methods	Types of overturning shafts	Type of flipping direction	Style and action types
Men	2010 ($n = 41$)	3.19 ± 0.71	2.07 ± 0.69	3.09 ± 0.30	0.80 ± 0.56
	2014 ($n = 53$)	3.77 ± 0.80	2.70 ± 0.87	3.19 ± 0.44	1.00 ± 0.65
	2018 ($n = 51$)	3.76 ± 0.79	2.94 ± 1.04	3.45 ± 0.67	0.69 ± 0.68
Women	2010 ($n = 57$)	2.63 ± 0.64	1.26 ± 0.58	3.04 ± 0.50	0.96 ± 0.78
	2014 ($n = 48$)	3.25 ± 0.81	1.37 ± 0.53	3.18 ± 0.49	0.63 ± 0.64
	2018 ($n = 46$)	3.57 ± 0.75	1.89 ± 0.80	3.07 ± 0.33	1.06 ± 0.92

Table 12: Correlation between athletes' diversification index and performance.

Group		Diversification Minimum value	Maximum value	Mean ± standard deviation	Correlation with competition results ®
Men	2010 ($n = 41$)	6.00	12.00	9.17 ± 1.45	0.58
	2014 ($n = 53$)	6.00	16.00	10.66 ± 1.93	0.09
	2018 ($n = 51$)	7.00	15.00	10.84 ± 1.87	0.61
Women	2010 ($n = 57$)	6.00	11.00	7.89 ± 1.30	0.17
	2014 ($n = 48$)	6.00	12.00	8.43 ± 1.36	-0.05
	2018 ($n = 46$)	6.00	12.00	9.59 ± 1.57	0.40

angle% index and competition results in 2014 and 2018 Winter Olympics ($r = 0.31 \sim 0.34$, $P < 0.01$), but there is no significant correlation between this index and competition results in 2010 Winter Olympics. Similarly, there is a weak correlation between this index and competition results of female athletes in 2010 Winter Olympics and 2018 Winter Olympics ($r = 0.33 \sim 0.44$, $P < 0.05$), but there is no significant correlation between this index and competition results in 2014 Winter Olympics ($r = 0.25$, $P > 0.05$). This result shows that the number and difficulty of the air movements performed by the antifoot angle% index have limited influence on the competition results.

4.2.7. Diversification. Tables 11 and 12 show the composition of diversity indicators of male and female athletes, respectively, and the correlation between diversity indicators and the performance of snowboarding U-shaped field events in 2010-2018 Winter Olympics.

The correlation test shows that the correlation between diversification indicators and competition results is quite different among Winter Olympics competitions from all walks of life. Among them, there is a significant strong correlation between male athletes' competition diversity indicators in 2010 Winter Olympics and 2018 Winter Olympics and competition results ($r = 0.58 \sim 0.61$, $P < 0.01$), while the correlation between competition diversity indicators and competition results in 2014 Winter Olympics is not significant ($r = 0.09$, $P > 0.05$). In addition, there is a weak correlation between the diversity index and the competition results of female athletes only in the 2018 Winter Olympics ($r = 0.40$, $P < 0.05$), while there is no significant correlation between the diversity index and the competition results in the 2010 and 2014 Winter Olympics ($r = -0.05 \sim 0.17$, $P > 0.05$). This result shows that the diversification index will have a significant substantial impact on the competition results under certain conditions, and it is preliminarily inferred that this specific condition may be related to the innovation of technical movements.

4.2.8. Completion Effect. Table 13 shows some data on the correlation between the completion effect index and the

Table 13: Correlation between athletes' completion effect index and performance.

Group		Completion effect Minimum value	Maximum value	Mean ± standard deviation	Correlation with competition results ®
Men	2010 ($n = 41$)	6.00	9.50	7.91 ± 0.93	0.85
	2014 ($n = 53$)	6.00	9.50	7.85 ± 0.99	0.89
	2018 ($n = 51$)	5.00	9.50	7.85 ± 1.11	0.73
Women	2010 ($n = 57$)	5.50	9.00	7.67 ± 0.85	0.80
	2014 ($n = 48$)	6.00	9.50	7.86 ± 0.97	0.89
	2018 ($n = 46$)	4.00	9.00	7.26 ± 1.14	0.73

competition performance of male and female snowboarding U-shaped field events in 2010-2018 Winter Olympics. The correlation test showed that there was a strong correlation between the completion effect index and the competition results of male and female athletes ($r = 0.73 \sim 0.89$, $P < 0.01$).

The results show that there is a significant covariant relationship between the completion effect index and athletes' competition results, and athletes' completion effect index is a technical performance index that plays a direct and important role in athletes' competition results; that is, the completion quality can greatly affect athletes' competition results.

5. Conclusion

The skiing sports mechanics model compiled in this paper provides a new research tool for the research and analysis of skiing sports planning. It studies skiing sports from the aspects of mechanics, numerical optimization, and technical index comparison and theoretically solves some previous technical problems. Modern competitive sports are changing with each passing day. Competitive sports show a vigorous development momentum. With the continuous development of science and technology, many basic disciplines, such as physiology, biomechanics, and motor skills, which construct the theoretical system of physical training, have developed unprecedentedly. Therefore, people's cognition of "physical training" is getting deeper, physical training means are more advanced, and monitoring means are more scientific, which makes people turn from the initial "physical training view based on physical quality improvement" to "physical training view focusing on competitive performance." The important basis of sports technical achievements is the supporting factors of athletes' physical quality, psychology, intelligence, and experience. External constraints such as venue conditions and competition rules have limited effects on athletes' technical performance. Adjustment factors, such as coaches' adjustment of athletes' competitive state and competition tactics, play a regulatory role in athletes' technical performance. In the future research, we will take skiers as the research object, establish biomechanical simulation model for analysis, and then use multirigid mechanical formula for calculation to study skiing problems.

Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declared that they have no conflicts of interest regarding this work.

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