

## *Retraction*

# **Retracted: Research on Balance Control of Freestyle Skiing Aerial Skills Based on Ant Colony Algorithm**

### **Security and Communication Networks**

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This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

### **References**

- [1] W. Jun, W. Song, and Z. Li, "Research on Balance Control of Freestyle Skiing Aerial Skills Based on Ant Colony Algorithm," *Security and Communication Networks*, vol. 2021, Article ID 4503358, 10 pages, 2021.

## Research Article

# Research on Balance Control of Freestyle Skiing Aerial Skills Based on Ant Colony Algorithm

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Aiming at solving the problem of poor performance of airborne freestyle skiing balance, this paper presents the research of airborne freestyle skiing balance control based on ant colony algorithm. On the basis of defining the trajectory division of the airborne balance of freestyle skiing and the track of the center of gravity of the human body, a sensor is used to collect the data of the airborne balance of freestyle skiing, and the moving average, denoising, and normalizing processes are done. The training label of the ant colony algorithm is made by the analog signal matrix, the implementation foreground of the key posture frame of freestyle skiing is extracted, the disturbed area in the key posture frame is removed by the clustering algorithm, and the key posture area of freestyle skiing is obtained. The incremental clustering of the data of the key posture area of freestyle skiing is conducted, the incremental posture data mining model of freestyle skiing is established, the mining parameters are input into the mining model, and the incremental data mining is realized by the ant colony algorithm to complete the research on the control of the airborne balance of freestyle skiing. The results show that the proposed method has good reliability, good convergence, and strong response ability.

## 1. Introduction

The gradual rise of winter sports will further accelerate the development of international ice and snow events and the improvement of competitive results. However, air skill is a high-risk event, a perfect combination of somersault and skiing. The sport requires “stable, high, accurate, and beautiful.” This is a sport with strong technicality, strong appreciation, and strong artistic quality [1]. Athletes are required to complete skiing, take-off, take-off, take-off, somersault, and turn in a very short period of time, and finally stand smoothly on the 38° landing slope and delimit. The athletes are required to have strong balance control ability because each technical link can lead to action failure or even cause injury. A poor balance control ability of the athletes will cause them to deviate from the jumping platform in the stage of skiing assistance. The inability to reach the best launching angle in the stage of taking off will cause insufficiency of the height and distance of the take-off as well as insufficiency of the somersault. The instability of the

turning body and the large lateral drift of the movements in the stage of air movement and the failure of the landing movement such as the left- and right-side slip and the back touching the snow in the stage of landing will cause serious injury to the knee joint or waist [2].

In recent years, more and more researchers have paid attention to the balance control ability of different populations. Balance control, also known as posture stability, is the ability to control the relationship between the body's center of gravity and the support surface. It is mainly affected by vision, proprioception, vestibular function, and muscle strength of each link. In reference [3], gender differences in balance control in classic international cross-country skiing competitions are presented to compare the speed, skill selection, and time patterns of world-class male and female cross-country skiers and to explore the combined impact of gender and speed on subskill selection. In reference [4], it is suggested that freestyle skiing should have a sense of balance and control, which highlights the social dimension of adventure by examining the values of freestyle skiing culture.

Studies have shown that the mechanism of balance control involves sensory input, central integration, and motor control. The stability and directionality require complex interactions between the musculoskeletal system and the nervous system. Musculoskeletal components include joint ROM, spinal flexibility, muscular properties, and biomechanical relationships at the body stage. They can be divided into two types: static maintenance of fixed posture and dynamic adjustment and maintenance of posture control. The dynamic state is divided into two types: automatic state (the ability to regain the stable state by performing various autonomous movements without an external force) and other dynamic state (the ability to recover the stable state when disturbed by an external force). In the technical link of aerial skill project, when the direction of ground reaction force is constant, static balance control plays a leading role; when the direction of supporting reaction force changes, dynamic balance plays a leading role. Athletes need to have high static and dynamic balance control ability. In the skiing stage, athletes are required to have good static balance to maintain a fixed posture, achieve greater speed, and enter the transition area and the take-off platform in a precise direction. When the speed of reaching the transition area is too large or too small, athletes also need to have high automatic balance ability to adjust. Balance control of freestyle skiing aerial skills is important in airborne freestyle skiing balance. In other words, the airborne freestyle skiing balance has a number of effects that can be effectively addressed by balance control of freestyle skiing. It also has an important impact on security and communication networks.

At the take-off stage of the platform, athletes are required to maintain a static fixed posture to achieve rigid braking of the whole body and take off with a certain position angle (the angle between the body and the jumping head of the platform) to achieve the height and distance of the air movement. A large position angle will cause the height deficiency and the speed of the somersault to be larger, which will eventually lead to landing backstroke, and a small position angle will cause the distance deficiency and the speed of the somersault to be smaller, which will lead to landing forward roll; forward roll is also an important factor causing injury. Therefore, a research on the balance control of airborne freestyle skiing skills based on ant colony algorithm is proposed. The airborne somersault is required to maintain the static stability of the body. In the instant standing phase before landing, the static balance of the fixed limb posture is mainly maintained, while in the high-speed gliding phase after landing, the static and dynamic balance is required. Therefore, the static and dynamic balance control ability of the athlete is an important factor affecting the performance.

The research contributions of this article include the following:

- (1) Aiming at solving the problem of poor performance of airborne freestyle skiing balance, this paper presents the research of airborne freestyle skiing balance control based on ant colony algorithm
- (2) On the basis of defining the trajectory division of the airborne balance of freestyle skiing and the track of

the center of gravity of the human body, a sensor is used to collect the data of the airborne balance of freestyle skiing, and the moving average, denoising, and normalizing processes are done.

- (3) The results show that the proposed method has good reliability, good convergence, and strong response ability

The remainder of this paper is organized as follows. Section 2 introduces the freestyle skiing skill movement data acquisition and preprocessing based on ant colony algorithm. Section 3 discusses the freestyle skiing airborne skill balance key attitude data incremental control algorithm and database design of management information system. Section 4 discusses experiment and analysis. Section 5 presents the conclusions of the study.

## 2. Freestyle Skiing Skill Movement Data Acquisition and Preprocessing Based on Ant Colony Algorithm

*2.1. Instruction and Collection of Aerial Skill in Freestyle Skiing.* Freestyle skiing is a high-speed slalom on snow where skiers ski downhill a mountain at a high speed using tools such as poles and skis and can ski at will [5]. The key to freestyle skiing is the control of balance in the air, which requires the athlete to turn around on the prescribed track in the shortest time. Usually, for the same flag gate number, athletes should circle the flag gate and slide fast on the same line. The closer the athlete's center of gravity moves along the line, the better the performance [6].

Before analyzing the freestyle slewing technique, we first determine the relationship between the course of the skis and the track of the athlete's center of gravity, as shown in Figure 1.

This trajectory plotting method accords with the actual situation (Figure 2). As can be seen from Figure 2, this project mainly interprets the "S" curve of a continuous turn by the human body before turning back to left and right.

The core of freestyle skiing is the slewing technique. Usually in a turning, arc is divided into the preparation stage, the beginning into the arc stage, the rotation stage, and the completion of the turning stage. The movements of these four stages are technically interrelated [7]. First, the height of the body's center of gravity goes from low to high and then to low again, with the lowest posture at the time of pole extension and the highest point at the moment of passing through the fall line. Second, the center of gravity first moves forward gradually from the beginning stage to the gliding stage and to the middle stage and then moves back a little from the middle position to the completion of the turn. Third, the second half of the completion stage is the beginning of the next turn transformation and can also continue to slide up again, and there is a sharp turn around the hill, and finally, the gliding stops [8]. In alpine slalom skiing, the area before and after the intersection of the track of the skis and the track of the center of gravity is set as the "exchange area," which is the area for the preparation of the next slalom and the completion stage of the previous slalom.

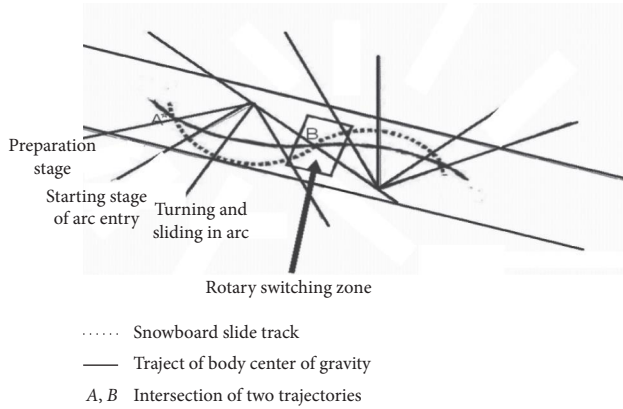


FIGURE 1: Trajectory partition.

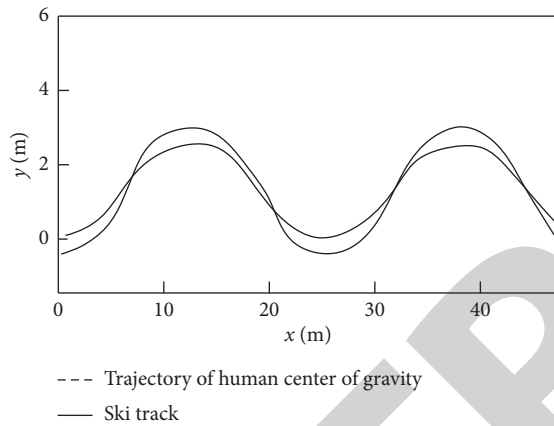


FIGURE 2: Snowboard/body track.

The setting of “exchange zone” is more convenient to discuss and understand the skiing technology, which is also the core of the slewing skiing technology.

2.2. *Collection and Storage of Freestyle Skiing Skills.* Rotation movement has a certain dynamic and consciousness and reflects the clear role of the whole body. Different rotation movements show different directions, which mainly include the following characteristics: (1) dynamic continuity: in this paper, a series of continuous movements are taken as experimental data and continuous transformation occurs under the change of time and space. (2) User dependence, even for the same kind of rotation action, presents different results under the expression of different people and will show specific performance in the speed of action and the range of rotation, resulting in certain differences in the collected data [9]. (3) There is variability in the integrity. Due to the different personal habits of skiers, for a standard action, some people can complete it well and some people can complete part of it or exceed the standard, which leads to the lack of data or a long time consumption.

Motion recognition usually includes visual recognition, sensor-based recognition, and image-based recognition. In

the search mechanism based on ant colony algorithm, the whole action recognition system can be regarded as a network composed of many ant nests and the paths connecting them. Each ant nest is a peer node in the action recognition network, which stores a certain amount of action recognition file resources for all nodes in the network to access. In addition to providing external document service, each node can also receive local user’s document query request, forward the request to the network, and return the query results to the local user. Each nest needs to maintain three tables: the local resource storage table, the URL buffer table, and the pheromone table. The local resource storage table is responsible for the maintenance of local resources; it can provide external resource information query. The URL buffer table is responsible for caching the recently accessed resource addresses, and for frequently accessed resources, the URL of the resource can be obtained directly from the table. The LRU algorithm can be used to replace and update the buffer table. The first recognition method is to use video or image storage and the information obtained by the input to the computer, and after the implementation of segmentation of the background, the effective information is extracted. This approach limits the scope of user activity, and peripherals need to be videotaped within the limits specified. Videos and pictures themselves also have a high degree of dependence on the background. The user performs corresponding actions in a good light environment and needs to match the camera equipment to complete the imaging angle, but its anti-interference ability is not strong and cannot satisfy the customer’s good experience. In addition, the quality of camera device has a serious impact on the acquisition of video or picture information recognition rate, due to its higher hardware requirements, so that the cost is greatly increased. At present, the relevant microelectronics technology has become increasingly mature, the sensor sensitivity is also increasing in daily life, the electronic equipment has played a great role, which gives users the freedom of space, and access to acceleration information cannot be bound by the site. The sensor-based recognition method does not need to obtain the detailed color and shape of the action, which greatly reduces the disturbance of the angle and illumination and makes the collected data more authentic.

Based on the ant colony algorithm, this paper collects the aerial acrobatic movements and applies them in the outdoor experiment. Ten subjects completed two different levels of gyro movements, mainly small gyro movements and large gyro movements. Each movement was repeated 30 times, and 600 gyro data were collected, in the existing experimental environment, through the PC end link-integrated Bluetooth chip to complete data transmission, from Bluetooth to the PC, storage format for txt, as shown in Figure 3.

Among them, X, Y, and Z provide the motion acceleration information in the X, Y, and Z axes, and each line represents the specific rotation action at a certain time. “{X = 132, Y = 172, Z = 162}” is the value of the acceleration produced by a time action in the process of entering the arc. The values of the acceleration are 132 in the X direction, 172 in the Y direction, and 162 in the Z direction.

$\{X = 132, Y = 172, Z = 162\}$   
 $\{X = 132, Y = 166, Z = 159\}$   
 $\{X = 132, Y = 166, Z = 159\}$   
 $\{X = 131, Y = 167, Z = 153\}$   
 $\{X = 132, Y = 169, Z = 154\}$   
 $\{X = 134, Y = 167, Z = 157\}$   
 $\{X = 134, Y = 167, Z = 157\}$   
 $\{X = 136, Y = 165, Z = 156\}$   
 $\{X = 136, Y = 163, Z = 151\}$   
 $\{X = 134, Y = 162, Z = 145\}$   
 $\{X = 134, Y = 162, Z = 145\}$

FIGURE 3: Data storage form.

**2.3. Air Skill Movement Pretreatment.** The collected information is related to the movement characteristics in space, indicating the acceleration values of each movement in the  $X$ ,  $Y$ , and  $Z$  axes. The detailed motion coordinate system is shown in Figure 4.

Because of the different personal habits of skiers, the same movement occurs at different speeds. In addition, different arm spreads and heights make the same action different in initial position and range of completion; however, for the same person, different levels of proficiency may occur due to time differences, which may also generate more biased data information [10]. For the interference of temperature, environment, and equipment itself, the noise will be found in the collected information. In the waveform matched with the original data of the rotary action, the jumping point will suddenly appear in part of the time period. This phenomenon may be related to the behavior habit of the experimenter at that time, and the relative noise at that time will cause the acceleration value to fluctuate greatly.

Therefore, in the beginning of identifying acceleration information collected by MEMS, the data information is first preprocessed to minimize the impact of noise and improve the identification effect [11]. In this paper, the original acceleration information is processed by denoising, normalization, and moving average.

**2.3.1. Moving Average.** Because of the different personal habits of the experimenter, there are different accelerations in the same action, and the initial values of the same action are still different in the information collected by the sensor, which has a great impact on the subsequent action recognition. Therefore, it is necessary to shift the average of the initial acceleration to the coordinate origin, so as to ensure the same initial acceleration signal.

**2.3.2. Noise Elimination.** Because of the influence of some psychological factors and environmental factors, the collected data information will appear with a lot of noise, which will interfere with the actual action signal. On the basis of this, it is necessary to denoise the information before identifying the rotary movement, so the adjusted data information will be smoother and helpful to the follow-up work. In this paper, the data information is decomposed into two layers, which is carried out under the wavelet “db 8.”



FIGURE 4: Freestyle skiing rotation coordinate system.

Based on the wavelet decomposition structure, the vector of the reconstructed coefficient is calculated by approximate zero-filling method, so as to reduce the interference of noise and promote the authenticity, reliability, and smoothness of the data information.

**2.3.3. Normalization.** The fluctuation of acceleration is directly affected by the initial velocity of the movement. The faster the rotation of the action transformation, the greater the amplitude of the acceleration waveform obtained, and there will be a higher peak acceleration. Conversely, if the transformation of the rotation is slow, the acceleration waveform will not fluctuate significantly. Therefore, the normalized acceleration information needs to be adjusted after the noise filtering of db 8 wavelet and moving mean, so as to reduce the influence of different action sizes [12].

**2.4. Air Skill Movement Extraction.** The signal based on the sensor is a set of continuous information, which includes three stages in the process of completing the action: the preparation stage, the movement stage, and the end of the movement stage. The acceleration signal value of the preparatory stage is zero, and the information data of the movement process stage and the end stage are meaningless. Only the value of the rotation stage is the valid value [13].

Ant colony algorithm can segment the initial data and show different motion information for different actions. However, it is impossible to detect the stage with obvious changes, and the acceleration is zero. In order to solve this problem, a method is established by adding a threshold model to facilitate the distinction between the two. The algorithm is used to automatically extract effective motion data. The specific steps are as follows.

*Step 1.* Determine your processing goals. Segmenting the waveform of data signals in all directions leads to incomplete segmented signals, which is mainly because the acceleration values in  $X$ ,  $Y$ , and  $Z$  axes are obtained by sensors, respectively. For example, when there is no obvious change on the  $X$  and  $Y$  axes, the  $Z$  axis has obvious acceleration floating, which means that the movement is out of the upward direction. If the state of rest or motion is judged according to the same threshold, the signals retained by the same

movement in the three-axis acceleration have different lengths, which will affect the later work. In addition, although there is a continuous change of position and direction in space, the state of motion is identified by the value of acceleration, so the value of acceleration in a single direction has no practical significance. In this paper, the change in the value of acceleration is measured in each direction of the existence of the sum of the square of the acceleration, that is,

$$R = A_x + A_y + A_z. \quad (1)$$

In the above equation,  $A_x$ ,  $A_y$ , and  $A_z$ , respectively, represent the acceleration in the direction of three orthogonal coordinate axes and  $R$  is the sum of them. The value of  $R$  is the basis for judging whether the action is in motion or static state.

*Step 2.* Optimize the data: although the experimenters do the same action, there is still a difference in intensity between them, which results in different amplitudes of the waveforms of the same action acceleration. At the same time, because the square deals with the data, the difference between the data is greater, and the signal needs to be normalized. The data should be kept within the range of [0, 1], and the data with a lower amplitude than 1 should be optimized. The sum of the squared accelerations should be optimized by setting the magnification threshold  $A$ .

*Step 3.* Line fitting action acceleration signal: in order to divide the data into different units, it is necessary to load part of the square of the optimized acceleration to the buffer area, and the least square method is used to fit the two adjacent points on the data. After the division of the elements, the error values between the two connected elements shall be calculated and the set thresholds and error values shall be compared. If the error is smaller than the value specified by the thresholds, then a combination of the two elements shall be made. If the error is not within the threshold range, then a combination shall not be made.

*Step 4.* Cut signal: after the straight-line fitting action signal, these signals can be found obviously in the region of preparation stage, rotation stage, and completion stage. Among them, the straight-line fluctuations in the beginning and the end of the preparation phase and the completion phase are smaller, but the straight-line fluctuations in the experimental stage are larger. In order to judge the motion and static motion, this paper sets a threshold value according to the characteristics of each stage; the specific process is as shown in the following equation:

$$S_{\text{slope}} = G_{df} + H_{jk} - D_{gh}. \quad (2)$$

In the above equation, the slope threshold value set by the system is represented by  $S_{\text{slope}}$ , the residual threshold value is represented by  $G_{df}$ , the slope of the line in each stage is represented by  $H_{jk}$ , and the residual value of the line is represented by  $D_{gh}$ . Through this process, the useful signals

of the rotary motion can be retained and the useless signals of the completion and preparation phases can be eliminated.

### 3. Freestyle Skiing Airborne Skill Balance Key Attitude Data Incremental Control Algorithm

*3.1. Airborne Freestyle Skiing Skills Balance Key Attitude Area Acquisition.* Based on the ant colony algorithm, the key attitude frame of freestyle skiing aerial balance is extracted, the interference region in the key attitude frame of freestyle skiing aerial balance is removed by ant colony algorithm, and the key attitude region is obtained [14]. The specific process is shown in Figure 5.

First, we need to extract the foreground of the key attitude frame based on ant colony algorithm, that is, segment the key attitude frame of the airborne freestyle skiing [15]. The specific method is to mark the key attitude areas in the air balance of freestyle skiing skills, mark the athletes and sports equipment in red and green, respectively, and mark the background area in blue; then process the key attitude frames in the air balance of freestyle skiing skills, mark the background area as 0, and mark the athletes and sports equipment as 1 as the simulation signals of the ant colony algorithm; and use the analog signal matrix to prepare the training labels of the ant colony algorithm as follows:

$$P = \begin{Bmatrix} 0 & 1 & 1 & 0 & 1 & 1 \\ 1 & 1 & 0 & 1 & 1 & 0 \\ 0 & 1 & 1 & 0 & 1 & 1 \\ 1 & 1 & 0 & 1 & 1 & 0 \end{Bmatrix}, \quad (3)$$

where  $s$  represents the training label of ant colony algorithm.

The ant colony algorithm is trained on the Balance Key Posture Frame data set of Pascal, a freestyle skiing aerial technology, through the training tags, and the finished caffemodel is obtained. The initialization parameters of the balance key posture frame of the freestyle skiing aerial technique are used to adjust the image of the balance key posture frame of the freestyle skiing aerial technique, thus obtaining the foreground extraction parameters of the balance key posture frame of the freestyle skiing aerial technique [16]. When adjusting the image, the input parameter of the first layer of AlexNet was set to 2, corresponding to the athlete and sports equipment area and background area in the key posture frame of freestyle skiing aerial balance [17]. The caffemodel is iterated numerous times until a smaller range of loss is obtained, which can be used to achieve the best results in the region segmentation of the key posture frame in freestyle skiing. First, the binary image after region segmentation is rough segmented.  $L_{xy}$  value of all points in the image is set to 0, and the image is traversed by pixels, starting from the upper left point of the image. The specific pixel traversal process is shown in the following equation:

$$L_{xy} = I_{\text{max}} + 1 + P_{xy}. \quad (4)$$

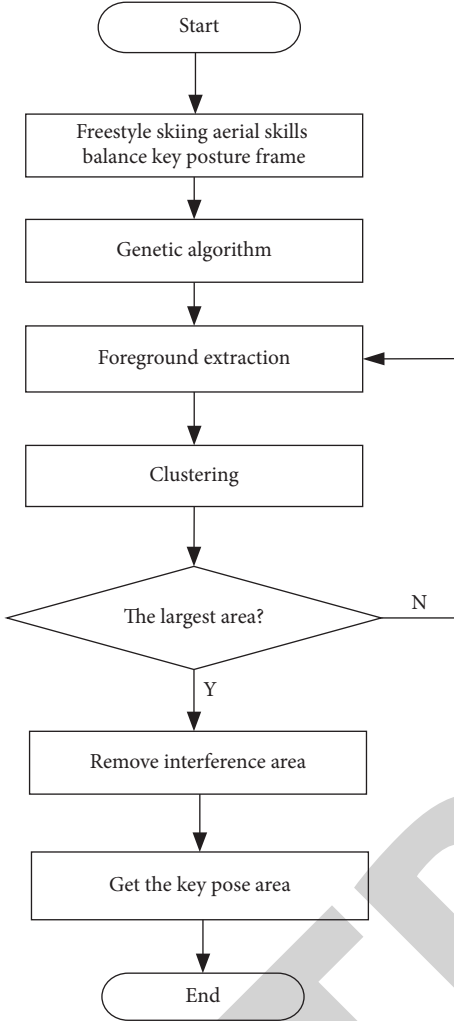


FIGURE 5: Key attitude area capture process.

In the above equation,  $L_{xy}$  represents the current point label with an initial value of 0;  $P_{xy}$  represents the set of tags above zero in the neighborhood of  $(x, y)$ ; and  $L_{\max}$  represents the maximum value of label number of each pixel in the image. Then, the coarse segmentation of the image is adjusted to remove the interference area in the key pose frame of freestyle skiing aerial skill balance, so that the tag value of the image does not change, and the key pose area of freestyle skiing aerial skill balance is obtained.

**3.2. Keywords Freestyle Skiing Aerial Skill Balanced Critical Attitude Data Incremental Clustering.** Through the SOFM network, the data of key posture area of freestyle skiing aerial skill balance are clustered incrementally. First, the SOFM network is trained, and the trained SOFM network is used for incremental clustering of data: the weights of SOFM network are initialized, a random number with a smaller value is given as its initial value, and the training samples are input. The initial value of time is set to 0 to calculate the distance between the ownership vector and the mode:

$$D_i = (R_{ij} - F)^2, \quad (5)$$

where  $D_i$  represents the distance between the ownership vector and pattern  $F$ . The cell coordinates of the minimum distance are recorded as  $R_{ij}$ .

The time interval is regarded as the basic unit of incremental clustering, and the cluster is built with the cluster dataset as the center. The cluster center is set as the core point, and the threshold value is set. When the distance between the two clusters is smaller than the threshold value, the two clusters are merged. After several times of merging, when the data of the key posture area of freestyle skiing aerial skill balance meet the requirements of clustering accuracy, the incremental clustering of key attitude data of aerial skill balance in freestyle skiing is realized.

**3.3. Freestyle Skiing Air Skills Balance Key Attitude Data Incremental Control.** Based on the incremental clustering results of key posture data of freestyle skiing aerial skill balance, an incremental control model of key posture data of freestyle skiing aerial skill balance is established and data coalescing operation is carried out. The incremental control parameters of key posture data of freestyle skiing aerial skill balance are obtained by using coalescing paradigm, and the control parameters are input into the control model. Ant colony algorithm is used to realize the incremental control of data.

The main structure of the model for incremental control of video key attitude data is shown in Figure 6.

Based on the incremental control model of airborne balance critical attitude data of freestyle skiing, the incremental clustering results of the data are used to obtain the conjunctive normal form of airborne balance critical attitude data of freestyle skiing:

$$L_{cv} = M_n \times D_i. \quad (6)$$

In the above formula,  $L_{cv}$  represents the conjunctive normal form of key posture data of freestyle skiing aerial skill balance and  $M_n$  represents the disjunctive logic expression of key attitude data of free skiing air skill balance. The incremental control parameters of key attitude data of freestyle skiing aerial skill balance are obtained by using conjunctive normal form:

$$\lambda = \frac{L^2}{2} \sum_{i=0} L_{ij}, \quad (7)$$

$$P_{KL} = \sum_{cv=1}^n L_{cv}.$$

The control parameters are input into the incremental control model of key attitude data of freestyle skiing aerial balance, and the incremental control of key attitude data of freestyle skiing aerial balance is realized by using ant colony algorithm.

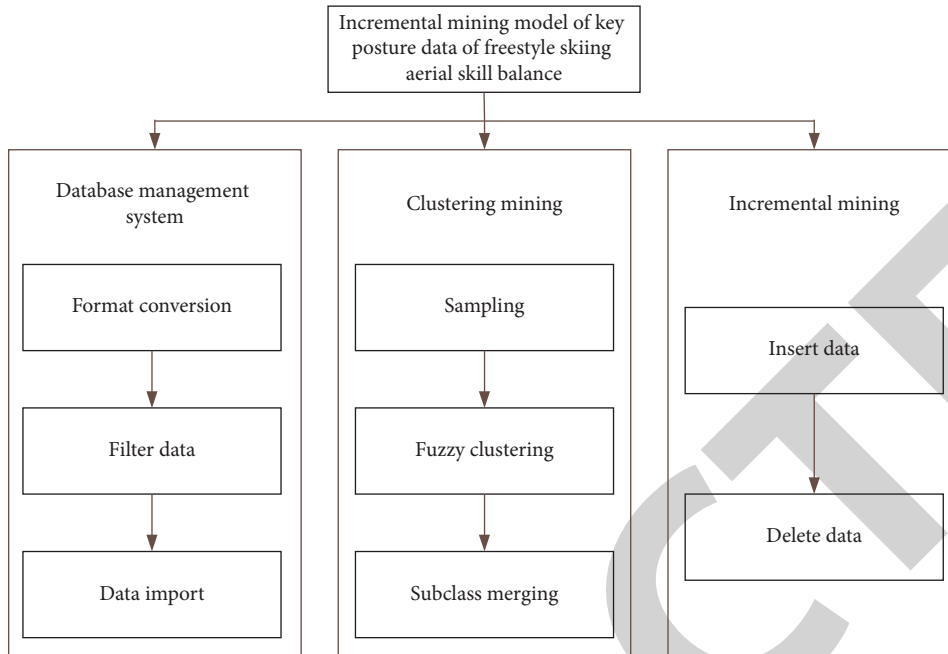


FIGURE 6: Freestyle skiing aerial balance key attitude data incremental control model.

#### 4. Analysis of Experimental Results

On the basis of the research of the airborne skiing skill balance control method based on ant colony algorithm, the experiment is carried out. Using Matlab software to carry out simulation research, the balance control analysis model of freestyle skiing air skill is written in a computer, which is connected with the power transmission Internet of Things through the analysis model to capture the information transmitted within the Internet of Things. The simulation parameters of the Internet of Things are set as shown in Table 1.

Enter the above parameters into the computer and set up the network topology in the Power Transmission Internet as shown in Figure 7.

The main hardware of ATP includes transmission node, intelligent gateway, and sensor, which are connected by wireless signal. The hardware is tested by three analysis models, and the collected data are drawn into image. Using the database as the data management engine for the quantitative evaluation of ice and snow sports tourism resources, the equipment catalog table and equipment attribute table of the freestyle skiing air skill balance control model are established, the DMA0\_START\_ADDR register is configured, and the program load module is used to load the algorithm for the quantitative evaluation of freestyle skiing air skill balance, to get the system structure diagram, as shown in Figure 8.

According to the above system structure design, the balance control test of freestyle skiing aerial skill is carried out, the length of buffer data is set to 16 bits, the length of data sample is 1024, and the test set DMA0\_X\_MODIFY is 2. In order to verify the effectiveness of this method, this paper compares the time cost of the quantitative evaluation

TABLE 1: Parameters of internet of things.

Serial number	Project	Parameter
1	Areal area	100 m × 100 m
2	Number of zone nodes	100
3	Initial energy of node	0.25 J
4	Sensor device location	(50, 50)
5	Circuit unit consumption	15 pJ/(bit·m <sup>2</sup> )
6	Unit loss of node convergence	2.5 nJ/bit
7	Packet length	2000 bit
8	Algorithm iterations	500
9	Experimental period	1000

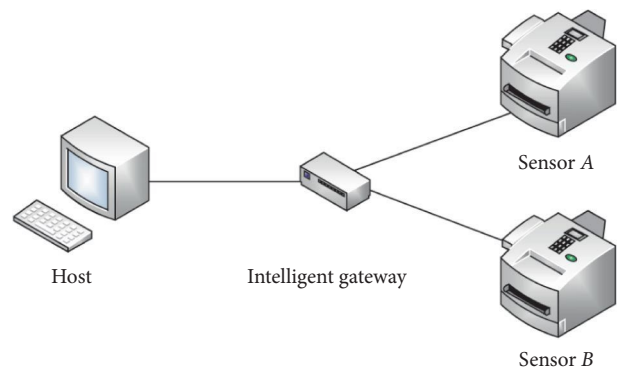


FIGURE 7: Internet of Things network topology.

of the balance control of freestyle skiing aerial skills between this method and the methods in [3] and [4], and the results are shown in Figure 9.

Analysis of Figure 9 shows that the time spent in the quantitative evaluation of the aerial balance control of freestyle skiing by this method is shorter than that by the



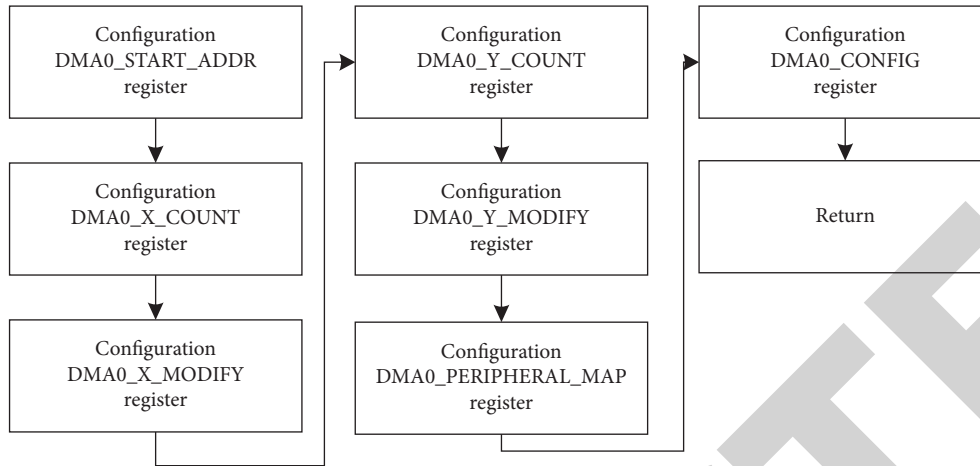


FIGURE 8: System architecture implementation diagram.

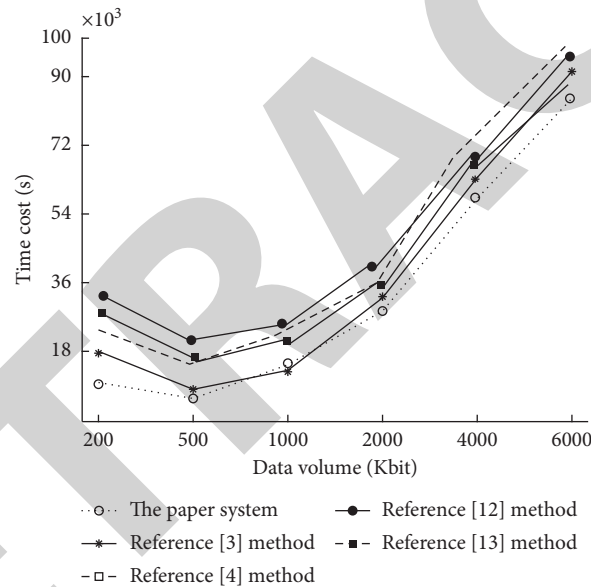


FIGURE 9: Comparison results of time cost for the quantitative evaluation of aerial balance control in freestyle skiing.

TABLE 2: Different methods of freestyle skiing air balance packets control total.

Time (ms)	Method of this paper (kb)	Methods of reference [3] (kb)	Methods of reference [4] (kb)	Methods of reference [3] (kb)	Methods of reference [3] (kb)
10	<b>136236</b>	94142	115265	105682	116235
20	<b>129262</b>	96415	102145	85462	96352
30	<b>245142</b>	126625	186259	176842	145259
40	<b>126852</b>	85085	103956	106328	115326
50	<b>234632</b>	145256	174745	179634	186249
60	<b>121142</b>	106196	115856	98634	115692
70	<b>252178</b>	179652	168958	163521	152362
80	<b>161852</b>	102375	129458	145326	137564
90	<b>132645</b>	96352	106765	143265	114236
100	<b>214745</b>	167459	172325	176239	147689

The value in bold indicate the research result of this method.

methods of references [3] and [4], indicating that the response ability of this method is better. In order to further verify the effectiveness of this method, this paper compares the total control volume of the data packets for the quantitative evaluation of the airborne balance control of freestyle skiing techniques of this method with that of the methods of references [3] and [4]. The results are shown in Table 2.

The total number of airborne balance control packets for different methods of freestyle skiing over a 100 ms period is shown in Table 2. The method in this paper can control 175468.6 kb data per 10 ms on average, while the methods of references [3] and [4] can only control 119955.7 kb and 119955.773.2 kb, respectively. The method in this paper is obviously superior to the methods of references [3] and [4], with 55512.9 kb and 37895.4 kb, respectively. Therefore, this paper designs a balance control method of freestyle skiing airborne skill based on ant colony algorithm, which can control more data in unit time and has better performance.

## 5. Conclusion and Prospect

**5.1. Conclusion.** The balance control ability of the human body is the adaptive control and adjustment of the body posture and movement by the central nervous system, which integrates the sensory system (vision and tactile sense, proprioception, vestibule system). It reflects the human body under the static control and stability and dynamic control, regulation, and coordination capabilities. Balance stability reflects the body's ability to maintain its original balance and resist toppling. The stability of human body balance and posture control has an important impact on human body movement and fall prevention. Balance control is the control of the position of the body in space to achieve stability and direction. It is the performance of interaction between individual, task, and environment. The results show that the airborne skiing skill balance control method based on ant colony algorithm is reliable, astringent, and responsive.

### 5.2. Prospects

- (1) It is difficult to control the interference conditions at the same level due to the restriction of the experiment conditions
- (2) Due to the project characteristics and the number of national team, the sample size is relatively small
- (3) In terms of disturbance conditions to somatosensory perception, there is still a certain gap with the actual environmental conditions, such as the stiffness, damping, elastic coefficient, and other conditions between the balance disk of somatosensory perception and the 60 cm thick snow mass on the actual landing slope
- (4) Athletes use various postures to control balance in actual sports, but this paper only uses standing posture, and the future research needs to be improved

In the future, the incremental clustering of the data of the key posture area of freestyle skiing should be conducted, the

incremental posture data mining model of freestyle skiing should be established, the mining parameters are input into the mining model, and the incremental data mining should be realized by the ant colony algorithm to complete the research on the control of the airborne balance of freestyle skiing.

## Data Availability

Data are available on request from the corresponding author.

## Conflicts of Interest

The authors declare that they have no conflicts of interest.

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