Research Article

Research on the Possibility of Smart Wearable Devices in Ice and Snow Sports Based on Wireless Network

Zhongle Liu

Jilin Agricultural Science and Technology University, Jilin, 132101 Jilin, China

Correspondence should be addressed to Zhongle Liu; liuzhongle@jlnku.edu.cn

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Ice and snow sports are very popular fashion sports in the world. The development of ice and snow sports in China is affected by factors such as climate and natural environment, industrial development, consumption concept, and ice and snow culture. With the advent of the intelligent era, technology has developed rapidly, and the emergence of smart wearable devices has been widely used. The article is based on the recognition of ice and snow movement status, combined with wearable technology, signal processing technology, wireless communication technology, using acceleration sensors, biosensors, Bluetooth modules, smartphones, and back-end servers to build a "wearable health monitoring based on recognition of the status of human ice and snow movement system." Through the daily wear test, on the basis of real-time recognition of the human body motion state, the system issues alarms for dangerous fall actions and abnormal physiological signals in different motion states and can use energy management strategies to save system energy according to the user status, which proves reliability of wearable health monitoring architecture based on human motion state recognition. The paper firstly reviews the related works and literatures of ice and snow sports and smart wearable equipment at home and abroad through literature search and web search and uses questionnaire survey, logic analysis, and interview method to study the development of ice and snow sports. It is feasible to go to the snow and ice. Among them, the proportion of people who think it is expensive is the highest, reaching 65%.

1. Introduction

With the increasingly fierce competition in the smart wearable industry, the phenomenon of homogeneous products is becoming more and more serious, and all kinds of smart hardware with only a single function have begun to seek cooperation with other smart hardware. Intelligent wearable devices have been rapidly applied in sports. The wearable testing system can not only quantify the process of ice and snow sports but also help participants to obtain real-time information of the process of sports and improve the accuracy of coaches’ decision-making. But at present, the coaches and scientific researchers in our country focus mainly in sports development in present situation analysis, sports tactics and training methods, cultivation of reserve talented person, sports injury, etc., and for wearable test system, research has just started in the snow and ice projects; the paper will be born in motion from the application of wearable research situation and existing problems in test system and development countermeasures and other aspects to elaborate on the necessity and urgency of wearable testing system research. Taking the development strategy of mass ice and snow sports as the research object, the article analyzes the development of mass ice and snow sports and the realistic path for comprehensive promotion of mass ice and snow sports by means of on-the-spot investigation and logical argumentation. Through research, it is found that Chinese scholars’ research on ice and snow sports mainly focuses on six main fields of speed skating, short track speed skating, figure skating, skiing, and ice hockey curling. Speed skating generally refers to speed skating. Speed skating is an ice-racing sport that is performed on ice with a skate as a tool. It belongs to ice skating in the international classification of sports. Among them, speed skating research is the most extensive, involving a wide range of research, and the research has a certain depth; the research on short track speed skating training is relatively more, the research on teaching and the public is relatively weak, and the
comparative study between China and foreign countries is concerned; the analysis of the event is a hot spot in the research of figure skating. The research on rules is valued; the research in the skiing field tends to be studied in the skating and skiing industry, and the research on competitive skiing is relatively deep, focusing on the participation of youth groups in ice and snow sports, stimulating the maximum vitality of social forces, exploring the training mechanism of ice and snow professionals, and clarifying the career development prospects and promotion channels of professionals. The research on ice hockey is lagging, the development is slow, the research on curling is relatively weak, and the research is relatively narrow. In the field of intelligent equipment technology for ice and snow sports, China’s relevant scientific research is almost in a blank state. How to apply smart wearable devices to the ice and snow sports, so that athletes get better training results to help China achieve better results in the 2022 Winter Olympics, has become a top priority.

With the advent of the intelligent era, the rapid development of science and technology and the emergence of smart wearable devices have been widely used, mainly in many fields, such as leisure, entertainment, and medical. Wearable smart devices are mainly represented by iPhone watch, Xiaomi bracelet, Huawei smart glasses, Google Glass, etc. The application of smart wearable devices in running is particularly hot. In the past, people needed to use treadmills to observe data such as the number of steps taken and calories consumed during running. Now, smart wearable devices have completely revolutionized the functions of treadmills. Compared with traditional treadmills, smart wearable devices are lightweight, small in size, and convenient to carry, and the data is also fully reflected on the device. Since smart wearable devices can be used in running sports, it is also feasible to apply them to ice and snow sports. The purpose of the research is how to combine the two organically to add new strength to the development of ice and snow sports. Smart wearable devices are portable electronic devices that can be worn directly as accessories. Wearable device further includes an operation unit, and the operation unit is configured to receive the target operation instruction sent by the instruction sending unit and execute the target operation instruction. That is, the target operation instruction can be executed through the wearable device, and other devices are not required to execute the target operation instruction.

They can sense, record, and analyze vital signs with software support, greatly improving the quality of our lives. With the development of the Internet of Things and the mobile Internet, smart wearable devices are closely integrated with various application software and become a new trend. Intelligent wearable devices are mainly used in many fields, such as leisure, entertainment, and medical care. The application of smart wearable devices in running sports is particularly hot. In the past, people need to observe the number of steps and calories burned during running through treadmills. Now, smart wearable devices completely revolutionize the functions of treadmills. Compared to traditional treadmills, smart wearable devices are lightweight, small, and easy to carry, and the data is also fully reflected on the device. Since smart wearable devices can be applied to running sports, it is also feasible to apply to ice and snow sports.

With the deepening of research, great progress has been made in the application of smart wearable devices in different fields. It also provides experience for the feasibility of smart wearables for applications in snow sports. The characteristics of sensors include miniaturization, digitization, intelligence, multifunction, systematization, and networking. It is the first link to realize automatic detection and automatic control. In 2017, Lei et al. [1] conducted research on the application of smart wearable devices in the field of fire protection. Based on the multifunctional visual helmets that have been widely used by firefighting forces at home and abroad, they have added intelligent modules. The toxic gas detection sensor and alarm module, the flammable gas detection sensor, and the alarm module are added, the helmet display device is added, and the helmet subprocessor is added to realize the intelligence of the helmet. Based on the existing smart bracelet, the three-axis accelerometer is used to complete the bracelet accelerometer, and the skin electrical response sensor is used to monitor the level of motion. The heart rate monitoring is performed by using a bioimpedance sensor, the data is more accurate, the cost is low, and the application prospect is wider. Accurate positioning is achieved by combining Beidou positioning, GPS positioning, and inertial navigation positioning and by adding a barometric pressure sensor, a wireless communication module, and a smart air caller processor to a common air respirator and engaging with a smart helmet.

Finally, through the use of various wearable intelligent devices, better monitoring the real-time status of firefighters in various trainings, improving the training performance of firefighters also provides better safety for firefighters in the mission. In 2018, Panpan and Shen [2] designed a research based on smart wearable devices in children’s apparel applications and acquired and analyzed the environmental, functional, comfort, and aesthetics of children’s smart wearable devices. On the basis of ensuring the performance of children’s safety clothing, select a representative smart wearable device to carry out experiments; optimize the design by the shape, size, quality, etc. of the device, including smart wearable devices, integrated circuit boards, lines, sensors, interfaces, etc.; experiment with wearing smart wearable equipment; and choose the best solution to make smart wearables and children’s clothing perfectly combined. Under the premise of ensuring children’s wearing comfort, the smart components can be disassembled, and the clothes can be washed and harmless to the environment, summarizing reasonable and scientific research theories. The control of the wearable device is realized through the dielectric constant signal generated by the change of the muscle of the corresponding position of the wearable device when each unit of the wearable device detects the gesture change. Moreover, since the dielectric constant of muscle tissue is not easily affected by the environment, the wearable device can be used under any conditions.

A sensor is a detection device that can sense the measured information and can transform the sensed information into electrical signals or other required forms of...
information output according to certain rules, so as to meet the requirements of information transmission, processing, storage and display, recording, and control requirements. Through literature retrieval, network retrieval, and other methods, we have consulted domestic and foreign ice and snow sports and smart wearable devices and other related works and documents and used questionnaire survey, logical analysis, and interview methods to study the development of ice and snow sports; interviews on ice and snow sports senior coaches of the company issued questionnaires to the first-line or second-line athletes participating in ice and snow sports on the use of smart wearable products in actual training to understand their understanding of smart wearable products. This research discusses on how to apply smart wearable devices in ice and snow sports training which are discussed, and finally, a solution to the problems in the application of smart wearable devices in ice and snow sports training is proposed.

2. Method

2.1. First, Increase Scientific Research Investment and Improve the Scientific Research Level of Ice and Snow Sports. The development of ice and snow sports is inseparable from the support of scientific and technological strength. On the one hand, it is necessary to carry out scientific research on the sports itself and the quality of athletes. On the other hand, research on high-tech equipment is also necessary. In the Vancouver Winter Olympics, many countries have integrated advanced scientific and technological strength into their national athletes’ equipment. Speed skating is not a strength in the UK, but the British short track speed skating team has a lot of brains on skate design. Designers use cutting-edge computer software, often used to design jets and submarines, on design skates to find the best curvature of the skate aluminum bracket. The Canadian team’s speed skating sportswear uses a special rubber material in the thighs. The rubber is ten times more elastic than ordinary fibers and can minimize the athlete’s physical exertion. It can be seen that the current ice and snow sports competition is not only the competition of physical strength and skill, but the competition of scientific and technological strength cannot be ignored. Therefore, it is very necessary to increase the investment of relevant scientific research and comprehensively improve the scientific research level of China’s ice and snow sports [3, 4]. As the technology of smart wearable products in a single field becomes more and more mature, products in different fields and functional demands will complement each other in terms of functions according to the actual needs of users, thereby bringing about a smart experience that is more in line with user needs, and the development direction will become increasingly clear and diversified.

2.2. Second, Accelerate the Development of Smart Wearable Devices. Shopping behavior is added. Under the big data environment, the main characteristics of the network platform are satisfying the individual needs of consumers, highly standardizing the safety of consumers’ shopping information, and paying more attention to the shopping experience of consumers. There are three problems facing the development of smart wearable devices: First, smart wearable device systems are diverse, which is not conducive to operation, and it is difficult to form scale effects [5]. Second, smart wearable devices do not have good network services. Third, smart wearable products are highly homogenized, similar in function, and poor in functional service development. Therefore, in the future, smart wearable devices will be particularly developed in the following aspects. (1) United internet. With the popularity of smart clothing and smart homes, smart wearable devices and the Internet are more important. Combining the Internet with wearable smart clothing is a favorable means of occupying the market [6, 7]. In the future development, smart wearable devices can develop wireless transmission technology, combine with mobile terminals, establish a unified platform service, and realize real-time data transmission, analysis, and feedback, which is conducive to the monitoring of physical health. (2) Fashion development. Today, smart wearable devices not only meet functional requirements but also meet the appearance requirements. Design has become an important factor in smart wearable products. Some big companies such as Google, Microsoft, and Intel have seen the market prospects of smart wearable products, but they lack the fashion sense in the appearance of the products. Therefore, through cooperation with large companies in the fashion industry, they produce products that are more in line with market demand. (3) Accurate information. The accuracy of smart wearable devices is a concern [8–10]. With the advancement of sensing technology, the data collected by smart wearable devices is more accurate and reliable and then transmitted to mobile terminals through sophisticated wireless transmission technology, which can provide consumers with targeted data through big data analysis and feedback service.

2.3. Third, Accelerate the Application of Smart Wearable Devices in Various Fields. The birth of smart watches has become a hallmark of the 21st century technology. Unlike traditional watches, today’s society has become a symbol of decoration, fashion, identity, and status. In recent years, with the rapid development of electronic technology, smart watches have become the focus of everyone. Because of the smart watch, the watch has a built-in intelligent system, a smart phone system, and a network connection to achieve multiple functions. The realization of these functions has caused a major change in the watch that only looked at the time, resulting in more effective use for people [11]. Use one: check the daily needs of weather, time and alarm clock, stopwatch, and so on. Use two: instant call, connect the mobile phone through the network, is an important function to expand the smart watch. Use 3: remote control camera, with the continuous advancement of technology, the current smart phone camera function has become more and more
powerful, but in addition to the upgrade of software and hardware, there is no more innovative and interesting camera experience, and the smart watch is connected to the phone. You can freely position the phone and take photos at various angles [12–14]. Use 4: a smart watch that cares for health, motion detection, built-in motion monitoring, and sleep management functions can record the user’s day’s action data and use the watch’s processing chip to accurately analyze the fat burning situation and health index, providing data reference for the fitness person.

The application of smart wearable devices in the clothing field has caused a boom in smart clothing. With the development of science and technology, modern clothing is a combination of technology, art, and high technology. While satisfying the basic functions of clothing, it also needs to meet the requirements of consumers for aesthetics and health [15]. Smart clothing is a high-tech product that combines clothing, hats, shoes, and belts with clothing products and technology. DuPont has introduced the latest generation of stretchable electronic ink and film technology for smart apparel, while launching a new brand, DuPont Intexar Smart Apparel Technology. Intexar transforms plain fabrics into active, networked smart apparel that provides critical biometric measurements, including heart rate, respiration rate, athletic coordination, and muscle tone. Intexar has excellent stretchability and comfort and can be easily applied to apparel. Msignal showcases two products: one for high-end fitness sports underwear and the other for comfortable, style-inspired underwear, both with advanced sensing technology to record ECG, breathing, and physical activity in real time.

The application of smart wearable devices in the medical field has led to the rise of medical wearable devices. Today, medical wearable devices are booming. Medical wearable devices connect doctors, patients, and the cloud into one and apply them to medical clinics to accurately and effectively understand patients and collect data for disease prevention and treatment [16–18]. Arrhythmia can lead to diseases such as myocardial infarction and heart failure. Shenzhen Oudemont Technology Co., Ltd. has released a product that automatically diagnoses ECG through AI technology—Xunzhi H1 ECG belt, Xunzhi H1 ECG belt with dynamic heart. The function of electric monitoring and analysis collects the user’s single-lead ECG signal, combined with the cloud automatic diagnosis model to identify the arrhythmia event; AI ECG automatic diagnosis algorithm can more effectively identify and judge the arrhythmia event; the effect has even exceeded the human expert; effectively preventing and avoiding damage or even death due to heart problems is of great significance to modern human medicine [19, 20].

2.5. Fifth, Bioelectrode-Based Health Data Acquisition Technology. The bioelectrode is a sensor that can effectively convert the ion potential generated by the electrochemical activity of the living body into the electronic potential of the measuring system. It is widely used in modern clinical detection and biomedical measurement.

With the continuous monitoring of physical signs and physiological parameters, such as ECG ECG, EEG EEG, EMG EMG, electrooculogram EOG, gastric electrical activity GEA, nerve potential and electrical impedance imaging EIT, etc., the most important application is ECG ECG [23]. Bioelectrodes can be divided into two categories according to the manufacturing process: wet electrode and dry electrode. Wet electrodes are often used in clinical monitoring for the measurement of electrocardiograms. The most common type of wet electrode is a silver/silver chloride (Ag/AgCl) electrode. The Ag/AgCl electrode is usually composed of an electrode core, an Ag/AgCl layer, a conductive gel, and a nonwoven fabric and relies on a conductive gel between the sensor and the patient’s skin to enhance the sensor’s ability to sense body electrical signals. However, the wet electrode has the following problems in long-term monitoring: (1) The conductive gel is dry during long-term monitoring, which leads to a decrease in the quality of the electrical signal. (2) The conductive gel will irritate the patient’s skin and cause discomfort to the patient. (3) The electrode will be generated...
when the body is displaced. The displacement thus affects the accuracy of the measurement. In addition, since the wet electrode must be used in conjunction with a conductive gel and the preparation process is limited, it is difficult to apply to a wearable device.

The presence of dry electrodes is intended to address these issues and is common in wearable systems and long-term monitoring equipment. One of the most common dry electrodes is the microneedle dry electrode, which is primarily used for EEG monitoring. The microneedle dry electrode adopts the way that the needle electrode directly penetrates the stratum corneum of the skin, thereby avoiding the influence of the high impedance property of the stratum corneum on the brain electrical signal acquisition. Compared with the Ag/AgCl electrode, the microneedle electrode does not need to be coated with conductive gel on the skin, has a smaller impedance, and is more suitable for long-term monitoring.

3. Data Sources

3.1. Research Objects and Methods

3.1.1. Research Object. A total of 30 senior coaches with ice and snow sports and 167 first- or second-line athletes involved in the ice and snow sports were surveyed, including 118 first-line athletes and 49 second-line athletes.

3.1.2. Research Methods

(1) Document Search Method. Read articles about snow sports and smart wearables by searching Chinese journal full-text databases, sports core journals, and online access.

(2) Questionnaire and Interview Method. This interview is mainly aimed at investigating the use of smart wearable products by senior ice and snow sports coaches. Combined with the actual training situation, a questionnaire survey is conducted on first-line or second-line athletes participating in ice and snow sports to understand their understanding of smart wear.

(3) Mathematical Statistics. The original data is stored by Excel, and a database is built. The advanced SPSS software is used to perform mathematical and statistical analysis on data and data.

(4) ECG Method. The method is to extract the heart rate from the ECG signal. In order to measure the ECG signal, it needs to be on the surface of the human body. Place the signal and reference electrodes in the same position, usually on either side of the chest or left and right hands. Positions. The electrode is connected to the positive and negative electrodes of the electrocardiograph galvanometer through the lead wire, from the lead electrocardiogram. Get the heart rate value.

(5) Photoelectric Volume Method. A human motion state recognition algorithm based on a single three-axis acceleration sensor is proposed. According to the characteristics of short-term persistence of human daily activities, the motion state can be divided into stable state and unstable state. The three-axis acceleration vector value is converted into acceleration amplitude variation, which eliminates the wearing correlation of sensor coordinate system, and uses the Kalman filter to identify the stable or unstable state in real time. At the same time, the adaptive threshold method is used to identify the snow and ice movement in the steady state.

The research proposes a recognition algorithm based on a single three-axis accelerometer for dangerous fall actions (a relatively period of time unable to recover from activities). By extracting overweight intensity, continuous weightlessness time, tilt angle, and continuous resting time as characteristic values, the wearing correlation of the sensor coordinate system is eliminated and the calculation complexity is reduced; the gravity reference value of the sensor is dynamically adjusted according to the motion state to improve the measurement accuracy. The experimental results show that the recognition accuracy of the algorithm is better than the first-order support vector machine algorithm and the recognition algorithm based on multiaxial threshold.

In order to solve the energy consumption problem of the system under the condition of continuous perception by mobile terminals, an event model is established: the human body’s continuous static state under normal conditions is used as the system’s dormancy trigger event. The trigger mechanism adaptively adjusts the system work cycle according to the body’s own state.

The method uses different light absorbance when the blood volume changes and converts the light signal into an electrical signal. The heart rate was measured.

(6) Pressure Method. This is the oldest method of heart rate measurement. The pulse of Chinese medicine is to apply pressure to the artery. The heart rate was measured. The method usually uses a pressure sensor to detect the pulse signal of the pulse beat and then transform the pressure signal into a heart rate.

4. Results and Analysis

4.1. The Application of Smart Wearable Products to Actual Training. The paper investigates which people can use smart equipment in 2013, as shown in Figure 1:

As shown in Figure 1, according to the survey results, smart wearable devices can be used not only for senior ice and snow athletes but also for ordinary snow and ice athletes because they can be directly worn on the body or can be integrated into the clothing and have special functions, providing good training effect.

The paper investigates which people can use smart equipment in 2013, as shown in Figure 2:

As shown in Figure 2, it shows that it is feasible for smart wearable devices to be applied to ice and snow sports. The country needs to promote the application of smart devices in the field of ice and snow and the development of phase printing products.
A survey of whether 100 athletes wore smart equipment in 2015 is shown in Table 1:

A survey of whether 100 athletes wore smart equipment in 2016 is shown in Table 2:

A survey of whether 100 athletes wore smart equipment in 2017 is shown in Table 3:

As shown in Tables 1, 2, and 3, the comparison of the past three years shows that more and more athletes are beginning to wear smart equipment.

4.2. Athletes’ Survey on the Application of Smart Equipment to Ice and Snow Sports as Shown in Figure 3. As shown in Figure 3, according to the survey, the recognition of smart wearable devices applied to ice and snow sports is 77%, among which the first-line athletes’ recognition is 72.88% and the second-line athletes’ approval is 93.88%. According to the survey results, most snow and ice athletes have great expectations for the use of smart devices in ice and snow sports. Therefore, it is feasible to apply smart devices to ice
and snow sports, and it has great prospects, as shown in Figure 4:

As shown, it can be seen from Figure 4 that more and more people are interested in smart wear, up to 70%. According to the survey results, most snow and ice athletes have great expectations for the use of smart devices in ice and snow sports. Therefore, it is feasible to apply smart devices to ice and snow sports, and it has great prospects.

The paper investigates the reasons why 6 groups of people choose smart equipment, as shown in Table 4:

As shown in Table 4, among the 6 groups of people, the number of people who think that smart equipment is safer is the largest, with 51% the highest. The lowest also reached 32%; the proportion of people who think it is more labor-saving is the least, at 3%, so we know that most people choose smart equipment because it is safer.

Then, the reasons for not choosing smart equipment were investigated, as shown in Table 5:

As shown in Table 5, the reasons for not choosing smart equipment are that it is more expensive, that it is unnecessary, that it is inconvenient, and that it is not known. Among them, the proportion of people who think it is expensive is the highest, reaching 65%.

The article investigates the wearable equipment of athletes, as shown in Figure 5:

As shown in Figure 5, with the continuous development of wearable technology, wireless sensor networks, and energy harvesting equipment, human activity assessment based on sports energy still has many research significance and research value issues that need to be resolved in the fields of health monitoring, disease prevention, and teledicine.

The article investigates the wearable devices of second-level athletes, as shown in Figure 6:

As shown in Figure 6, more and more people wear smart devices.

4.3. Neural Network Algorithm. The representative model of ImageNet combination in recent years is shown in Figure 7:

As shown in Figure 7, at present, the theoretical research of convolutional neural network is not perfect. People used to think that the convolution was very large. The larger the kernel, the larger the acceptance area. The network model can get more information from the graph. If the convolution kernel is large, the calculation will increase sharply, but the depth will not increase. Model and calculation performance will also decrease.

The deeper the number of layers, the greater the gradient, as shown in Figure 8:

As shown in Figure 8, it is therefore difficult to perform background attribute training on shallow networks. The lower the network performance, the worse the performance.

The correlation between the characteristic channels is modeled, and the corresponding weights of each channel are obtained. The original characteristics are multiplied by the ratio of the channel weights to complete the weight distribution of the characteristic channels, as shown in Figure 9:

As shown in Figure 9, in this way, the parameters can be reduced while increasing the network depth, and the network performance can be improved.

The topological structure of the 3-layer BP network is shown in Figure 10:

As shown in Figure 10, the theory proves that the 3-layer BP network can complete the mapping from input to output.

The output formula of the hidden layer node is as follows:

$$Z_i = F \left( \sum_{i=1}^{n} b_x + 1 \right).$$

As shown in Figure 5, with the continuous development of wearable technology, wireless sensor networks, and energy harvesting equipment, human activity assessment based on sports energy still has many research significance and research value issues that need to be resolved in the fields of health monitoring, disease prevention, and teledicine.

The output formula of the output layer node is as follows:

$$s_i = f \left( \sum_{i=1}^{n} z_i + d \right).$$

The error formula for the v-th sample is obtained as follows:

$$s_i = f \left( \sum_{i=1}^{n} z_i + d \right).$$

Table 1: A survey of whether 100 athletes wore smart equipment in 2015.

| Survey object | First-line athlete | Second-line athlete |
|---------------|-------------------|---------------------|
| 1             | 15                | 10                  |
| 2             | 14                | 7                   |
| 3             | 21                | 12                  |
| 4             | 23                | 16                  |
| 5             | 14                | 10                  |

Table 2: A survey of whether 100 athletes wore smart equipment in 2016.

| Survey object | First-line athlete | Second-line athlete |
|---------------|-------------------|---------------------|
| 1             | 18                | 15                  |
| 2             | 21                | 17                  |
| 3             | 24                | 19                  |
| 4             | 25                | 21                  |
| 5             | 29                | 20                  |

Table 3: A survey of whether 100 athletes wore smart equipment in 2015.

| Survey object | First-line athlete | Second-line athlete |
|---------------|-------------------|---------------------|
| 1             | 32                | 39                  |
| 2             | 35                | 29                  |
| 3             | 36                | 23                  |
| 4             | 41                | 37                  |
| 5             | 45                | 36                  |
For $p$ samples, the global error formula is as follows:

$$P = \frac{1}{2} \sum_{i=1}^{p} \left( t_i - y_i \right)^2.$$  \hspace{1cm} (4)

$P$ is the corresponding probability.

According to the gradient descent method,

$$W_{jk} = -\mu \delta e.$$  \hspace{1cm} (5)

$\mu$ is the rate of decrease.
$\mu$ is the learning rate. Define the error signal formula as follows:

$$
\partial y_j = -\frac{\partial E_V}{\partial S_j}, \quad (6)
$$

where,

$$
\frac{\partial E_V}{\partial S_j} = -\sum_{j=1}^{N} (a_t^v - b_t^v)^{-1}. \quad (7)
$$

$a, b$ is the corresponding parameter value. Formula (8) can be obtained:

$$
\partial y_j = \sum_{j=1}^{m} (a_t^v - b_t^v) f(s_j). \quad (8)
$$

Formula (9) from the chain theorem—$\partial_{ij}$ is as follows:

$$
-\partial_{ij} = -\sum_{j=1}^{m} (a_t^v - b_t^v)^{+} \times z_k. \quad (9)
$$

Therefore, the weight adjustment in formula (10) of each neuron in the output layer can be obtained:

$$
\Delta Q_{jk} = \sum_{j=1}^{m} \eta (a_t^v - b_t^v) f(s_j). \quad (10)
$$

$\Delta Q_{jk}$ is the corresponding weight. The hidden layer weight $\Delta v_{ki}$ change is defined as follows:

$$
\Delta v_{ki} = -\eta \frac{\partial e}{\partial v_{ik}}. \quad (11)
$$

Table 5: Questionnaire on the reasons for not choosing smart equipment.

| Object | More expensive | No need | Inconvenient | Do not know |
|--------|----------------|---------|--------------|-------------|
| 1      | 46%            | 11%     | 17%          | 23%         |
| 2      | 54%            | 12%     | 13%          | 25%         |
| 3      | 56%            | 13%     | 12%          | 27%         |
| 4      | 65%            | 15%     | 54%          | 28%         |
| 5      | 54%            | 11%     | 18%          | 22%         |
| 6      | 52%            | 18%     | 11%          | 29%         |

Figure 5: The use of smart equipment by first-level athletes.
Define the error signal as follows:

\[
\frac{\partial z_k}{\partial s_k} = -\frac{\partial e_k}{\partial s_k} \cdot \frac{\partial z_k}{\partial s_k}.
\]  

(12)

\(\frac{\partial z_k}{\partial s_k}\) is the error signal.

The first term is

\[
\frac{\partial z_k}{\partial s_k} = -\sum_{j=1}^{m} (a_j^* - b_j^*) \frac{\partial b_k}{\partial a_k}.
\]  

(13)

Formula (14) is derived from the chain theorem:

\[
\frac{\partial z_k}{\partial s_k} = \frac{\partial b_k}{\partial a_k} \cdot b_j^* = f(s_j).
\]  

(14)

The second term is

\[
\frac{\partial z_k}{\partial s_k} = f(s_k).
\]  

(15)

**Figure 6:** The use of smart equipment by second-level athletes.

**Figure 7:** Convolutional layer usage.
So we can get

\[ \frac{\partial z_k}{\partial s_k} = -\frac{\partial z_k}{\partial a_i}. \] (16)

The formula for each neuron in the hidden layer $\Delta V_{IK}$ can be obtained as follows:

\[ \Delta V_{IK} = \sum_{j=1}^{m} \eta (a_i^j - b_j^i) f(s_k) a_i. \] (17)

The convolutional layer is the feature extraction layer. The characteristics of this network layer are local recognition, parameter sharing, and multiple convolution kernels.

The concept of locality is triggered by the biological nervous system, as shown in Figure 11:

As shown in Figure 11, the neurons of each layer share a series of parameters, and the local receptive field parameters corresponding to each neuron can be regarded as a method for extracting features regardless of location.

The function of the pooling layer is to perform summary calculations on the feature map output by the convolutional layer, as shown in Figure 12:

As shown in Figure 12, the maximum sampling refers to selecting the maximum value of each subregion as the sampling result, and random sampling allocates probability according to the pixel size and performs subsampling according to the probability.

The function of the fully connected layer is to synthesize the features extracted by the convolutional layer for classification or regression research. For

\[ H_\theta(a) = \sum_{j=1}^{K} e^j, \] (18)

$K$ is the number of layers.
where,

$$J_\theta = -\frac{1}{m} \sum_{i=1}^{m} s_i = j.$$  \hfill (19)

For large negative numbers and large positive numbers, they map to 0 and 1, respectively. The function form is

$$\phi(A) = \frac{1}{1 + e^{-a}}.$$  \hfill (20)

For large negative numbers and large positive numbers, they map to 0 and 1, respectively. The function form $\phi(b)$ is

$$\phi(b) = \frac{1 - e^{-2a}}{1 + e^{-2a}}.$$  \hfill (21)

The tanh function curve is shown in Figure 13:

As shown in Figure 13, this has played an important role in suppressing network overadaptation and is widely used in deep networks.

The function diagram of its variant is shown in Figure 14:

As shown in Figure 14, ReLu function calculation is simple, the derivative function is constant, and the computer calculation is very fast.

Due to the use of nonlinear activation functions, multiple convolutional layers make the network more nonlinear and improve the generalization ability of the network, as shown in Figure 15:

As shown in this strategy (Figure 15), the amount of parameters can be greatly reduced.

The basic components of the residual network model are shown in Figure 16:

As shown in Figure 16, in the background attribute process, the shallow network parameters cannot be updated, and the network depth cannot be further deepened.

4.4. Data Acquisition Principle

4.4.1. Principle of Pulse Wave and Photoelectric Volume Method. The pulse is the arterial pulse. During each cardiac cycle, the ventricles experience an alternating contraction and relaxation.

The periodic expansion of the vascular vasculature and the pulsation of the return position are called pulse, and the pulse is caused by the contraction of the heart contraction, so the pulse is completely consistent with the heart rate under normal conditions [24]. The pulse wave is formed by
the heart’s pulsation spreading along the arterial blood vessels and blood flow. The pulse waveform contains a large amount of physiological and pathological information of the human body system. The typical pulse waveform is shown in Figure 17:

As shown in Figure 17, a pulse wave cycle consists of a main wave (A), a tidal wave (B), and a heavy wave (C), where C is heavy beat wave trough. The photoelectric sensor can be used to acquire the pulse wave signal of the test subject, thereby obtaining the pulse wave cycle information. In general, the pulse rate is the same as the heart rate value. Photoelectric sensors operate on Lambert-Beer’s law. According to the Lambert-Beer law, when the monochromatic light passes vertically through a uniform non-scattering light absorbing material, the absorption rate and concentration of the light absorbing material to a certain monochromatic light will increase. In proportion to [25], the formula for this relationship is expressed as follows:

\[ I = I_0 e^{-\varepsilon CL} \]  

Among them, \( I \) is the intensity of the emitted light, \( I_0 \) is the incident light intensity, \( \varepsilon \) is the medium light absorption coefficient, \( C \) is the solution concentration, and \( L \) is the optical path length. When a certain wavelength of light is irradiated onto the surface of human skin, the light measured by the absorption and reflection of the human tissue will reflect the structural characteristics of the irradiated part to some extent [26].

Photoplethysmography is a noninvasive method for detecting changes in blood volume using photoelectric means [27]. When a certain wavelength of light beam is irradiated onto the body surface, the absorption of light by the skin, muscle, tissue, water, etc. is kept constant, but under the action of the heart, the absorption of light by the blood exhibits pulse and periodic changes [28]. When the heart contracts, the blood volume of the human body becomes larger, the amount of light absorbed increases correspondingly, and the intensity of the detected light becomes smaller. Conversely, when the heart is dilated, the blood volume of the human body becomes smaller and absorbs light. The amount is reduced, and the intensity of the detected light becomes larger [29]. By converting a signal of the detected change in light intensity into an electrical signal, a change in blood volume can be obtained, thereby obtaining a heart rate.

Depending on how the light is received, the photoelectric sensor can be divided into two types: transmissive and reflective. The radiation type photoelectric sensor is to place the light source and the receiving device on the same side of the human body tissue; the transmissive photoelectric sensor is to place the light source and the receiving device on both sides of the human tissue. A common transmissive photoelectric sensor device is a finger-clip sensor device. Such a device can squeeze the user’s fingers for a long time, giving the user a sense of discomfort, so the use of reflective photoelectric sensors for measurement is more convenient and comfortable. When measuring heart rate, a reflective photoelectric sensor with a green LED as the incident light source is generally selected.

4.4.2. Blood Pressure Collection. Blood pressure is usually referred to as arterial blood pressure and is an important physiological indicator reflecting cardiovascular function. In the blood pressure during each cardiac cycle, the maximum pressure reached is systolic blood pressure and the
minimum is diastolic blood pressure. The average pressure in a complete cardiac cycle is the mean arterial pressure. There are four main methods for blood pressure measurement: (1) determining the blood pressure value by vibration measurement, (2) determining the blood pressure value by the radial artery pulse amplitude, (3) determining the arterial blood pressure value by changing the blood volume per stroke, and (4) passing the pulse wave. The conduction velocity determines the blood pressure value. The first method is the most common method of measuring blood pressure in daily life. The local pressure of the inflatable cuff is used to detect the vibration generated when the blood collides with the blood vessel wall, and then, the blood pressure value is calculated; the second method of blood pressure is measured by a pressure sensor at the surface of the body surface; the third method is to measure blood pressure using a photoelectric sensor, the principle of which is similar to the principle of measuring heart rate and blood oxygen. The fourth method mainly uses the two pulse wave parameters of pulse wave velocity and pulse wave transit time to determine the blood pressure value. This method is commonly used in wearable devices, pulse wave velocity and pulse wave transit time, between them. The relationship is as follows [30]:

$$PWV = \frac{L}{PWTT}.$$  \hspace{1cm} (23)

Among them, $L$ is the measurement of the body surface distance of the arterial segment; $PWV$ is the pulse wave conduction velocity; $PWTT$ is the pulse wave conduction time. Within a certain range, the pulse wave transit time is linear with the arterial blood pressure, and the relationship between them can be expressed as follows:

$$Bp = a + b \times PWTT.$$  \hspace{1cm} (24)

Among them, $Bp$ is the arterial blood pressure value and $a, b$ is the undetermined coefficient.

On the basis of formula (3), the regression equation analysis can be used to obtain the determined value of the sum, and the measurement equation of diastolic blood pressure can be established, and the diastolic blood pressure, systolic blood pressure, and mean arterial blood can be calculated.

## 5. Conclusion

In recent years, the level of competition in China's ice and snow sports has been continuously improved, but there is still a big gap compared with the strong snow and ice sports countries. Based on the development of China's ice and snow sports, Beijing and Zhangjiakou jointly hosted the 2022 Winter Olympics, which is developing vigorously. Ice and snow sports should also apply existing technology to the real world. Ice and snow sports are a kind of extreme sports. All indicators of athletes need to be monitored in real time. Intelligent wearable devices can solve this problem well. In particular, when performing skill training, comprehensive data monitoring is needed. With this data, the coaches can better arrange the training plan. The dielectric constant signal detection unit is used to detect the first dielectric constant signal of each position of the detection area, the first dielectric constant signal of each position of the detection area changes with the gesture change, and each position of the detection area includes detection muscle and fat and/or blood vessels in the area. Only scientific training can effectively improve the level of China's ice and snow sports. Smart wearable devices are an important direction for the development of sports in the future. Its main function is to build a bridge between sports and the Internet, so as to help coaches capture and process various types of athletes' information and improve coaches' decision-making. The application of smart wearable devices in ice and snow sports can better understand the various data indicators of athletes during training, so that coaches can objectively obtain real-time training data of athletes and arrange training load measurement and training according to the actual situation of training. Therefore, the application of smart wearable devices to ice and snow sports is feasible. The organization of mass ice and snow sports activities and venues and facilities should establish a safety warning mechanism for dangerous information, introduce and improve modern information technology and network media platforms, and overcome the characteristics of information asymmetry, slow information transmission, and complex information in the process of multi-information fusion.

### Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

### Conflicts of Interest

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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