Scalable Computing: Practice and Experience, ISSN 1895-1767, http://www.scpe.org
© 2025 SCPE. Volume 26, Issues 5, pp. 2078–2086, DOI 10.12694/scpe.v26i5.4949

INTELLIGENT ALGORITHMS FOR COLLEGE PHYSICAL EDUCATION ATHLETE TRAINING USING COMPUTER BIG DATA TECHNOLOGY

HANYANG CUI*AND XINYU YANG†

Abstract. In order to solve the problems of long training content mastery time, poor training effect, and high cost in traditional training systems, the author proposes the use of computer big data technology in the research of intelligent algorithms for athlete training in university physical education. The author begins by gathering sports data from athletes, then utilizes a virtual reality perception interaction model to feed the data into the virtual environment generation unit. Data fusion is performed under the supervision of the simulation management module. Finally, combined with the motion behavior interpretation in the database and image card of the sports simulation training data unit, simulation 3D modeling is carried out in the 3D model processor according to user settings. The experimental results demonstrated that athletes trained with this system (the third group) had a markedly better understanding of the training content compared to those trained with the other two systems (the first and second groups) after the first week, achieving a mastery rate of 73.875%. As the duration of the training increased, all groups showed improved mastery of the content. This system enhances athletes' training effectiveness while also reducing training costs, offering significant practical application value.

Key words: Virtual Reality Technology, Athletes, Simulation training, Sports data

1. Introduction. In recent years, the continuous development and advancement of computer technology have led to its widespread application across various aspects of production and daily life. It has become a crucial tool in supporting both work and productivity, offering numerous conveniences that enhance the quality of life and increase efficiency in various fields [1]. The continuous upgrading and innovation of computer technology have significantly improved the level of computer applications, gradually transforming from simple computer system applications to composite business systems that are widely used [2]. Computer technology has a long-standing history of application in sports competitions. Integrating it into sports training and events can enhance the efficiency of athletes' training and improve the fairness and precision of competitions. Based on this targeted analysis, the application of computer technology in sports training and competitions promotes the optimization of computer technology applications, which is of great significance for sports training and competitions, and also plays an important role in improving the quality of college students [3,4].

Sports training is a long-term and tedious activity, in which the application of computers can enhance the fun and diversity of training [5]. Computers have the characteristics of real-time, novelty, sharing, and random input, and have high repeatability, which can ensure that athletes can focus on training or competition for a long time and promote their performance improvement [6]. When teenagers engage in sports learning and exercise, they are influenced by factors such as their age and physical and mental development patterns, resulting in a higher probability of interest transfer and change, which can seriously affect the effectiveness of sports training [7]. Reasonably applying computer related technologies to sports training and teaching can ensure that students' nervous system excitability is fully stimulated, promote a more relaxed and interesting learning and training atmosphere, help enhance students' interest and focus, and thus promote their better mastery of sports related skills, which can help transform the boring problems existing in traditional teaching.

Modern information technology and multimedia technology have unique and outstanding functions, especially in terms of diversity and fun, which are of great significance. They can stimulate students' interest in learning, enhance their focus, promote learning effectiveness, and help solve problems that ordinary teaching

*College of Education, Polytechnic University of the Philippines, Manila 1000, Philippines (Corresponding author, cuihanyang 1122@163.com)
†School of Physical Education, Emilio Aguinaldo Collage, Manila 1000, Philippines.

methods cannot solve. From the current situation of competitive sports, to some extent, competition in competitive sports belongs to technological competition, and computers are a key factor affecting competition. The application of computer technology in sports training and competitions can play an important role. If advanced computer technology cannot be effectively applied to assist and support in the current sports field, the training level will not be significantly improved, and athletes will have difficulty breaking through. The author aims to explore the combined application of computer big data technology and intelligent algorithms in athlete training in university physical education.

2. Literature Review. Training simulation, also known as simulation training, refers to the use of modern scientific and technological methods to construct virtual scenes or implement training under certain special conditions. It is characterized by a high level of realism, strong focus, enhanced safety, and improved training efficiency.

Simulation training is a key approach in athlete preparation, typically involving scenarios like real-life simulations, obstacle navigation, and athlete condition modeling. This method is used to enhance athletes' adaptability and responsiveness, with the goal of helping them adjust quickly to competition environments, maintain peak performance during events, and achieve better results [8]. Xiao, S. et al. plan to integrate rock climbing training with the traditional university sports curriculum, utilizing collaborative teaching methods to innovate and enhance the university sports system. By conducting a rock climbing teaching experiment with students at School A, and analyzing the data through literature review, surveys, and statistical analysis, they aim to evaluate the practical impact of incorporating physical rock climbing into college physical education programs [9]. Die, H. et al. optimized sports management based on clustering algorithms in the context of big data. They implemented all the functions of the algorithm using the popular Java language and demonstrated the correctness of the fuzzy clustering algorithm with some small examples [10]. Fu, C. et al. focus on developing a system for athlete selection and physical fitness evaluation using big data technology. The system is built around evaluation indicators, weight assignments for these indicators, and specific evaluation criteria. Following data mining principles, it incorporates the Apriori and FP algorithms, using physical data indexing and algorithmic frameworks to guide the process, the minimum support degree of association rules is determined to establish an association model between stereo energy testing level and individuals [11].

As an advanced product of modern Internet technology, virtual reality technology creates a virtual environment for users by constructing immersive virtual worlds. Building on this, the use of virtual reality in athlete simulation training has emerged as a key future trend in the development of simulation training systems for athletes. Therefore, designing computer big data technology in the research of intelligent algorithms for athlete training in university physical education enables diversified development of athlete virtual training.

3. Method.

3.1. Overall System Structure Design. The athlete simulation training system based on virtual reality technology consists of three parts: a motion simulation training input unit, a virtual environment generation unit, and a motion simulation training output unit. The detailed structure is illustrated in Figure 3.1. The input unit for sports simulation training consists of a position and direction sensing module, a conversion module, a data glove module, and a glove input control module, which primarily handle the collection of athlete motion data [12]. The virtual environment generation unit comprises a simulation management module, a user application module, a 3D model processing module, and a computer, which together handle the creation and management of the virtual environment. This unit serves as the central component of the athlete simulation training system utilizing virtual reality technology. The output unit, primarily consisting of an effects generator and a signal converter, is responsible for delivering the virtual training outcomes and facilitating interaction with users.

3.2. Virtual Reality Perception Interaction Model. The athlete simulation training system based on virtual reality technology can simulate the scenes during the athlete training process and record the athlete training movements and related data input by the motion simulation input unit. Through the analysis of the movement movements and related data, it can identify whether the athlete's movements during the training process meet the set standards, and also provide prompts for the athlete's movements that do not meet the standards during the training process, thereby improving the quality of athlete training [13,14]. To effectively

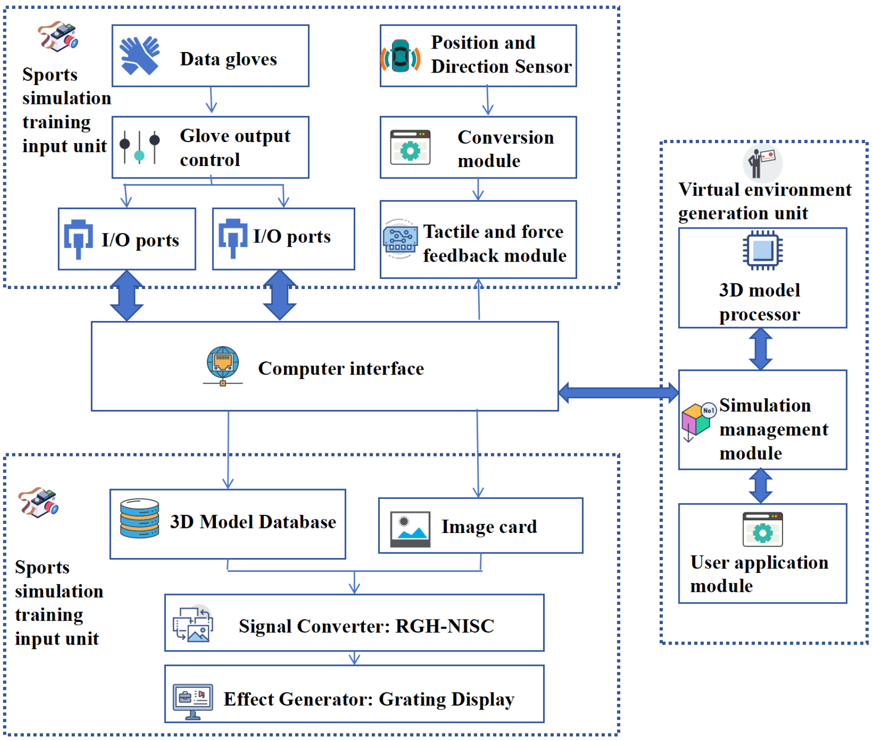

Fig. 3.1: Structure diagram of athlete simulation training system based on virtual reality technology

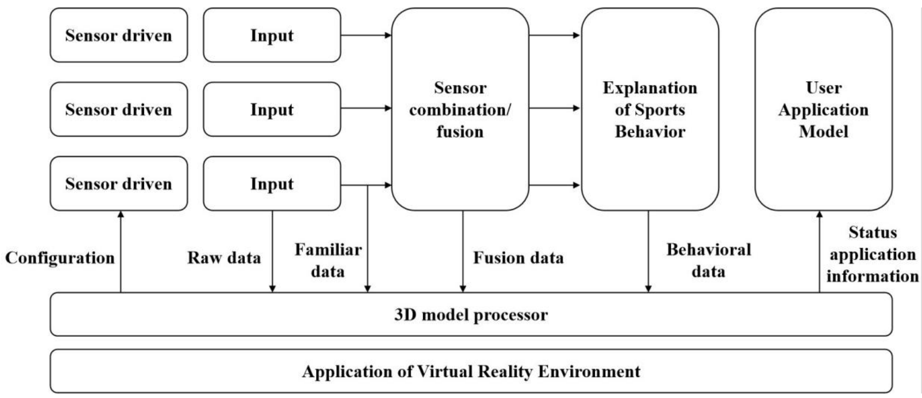

Fig. 3.2: Virtual Reality Perception Interaction Model

support data input and output functions, the athlete virtual training system must integrate with virtual reality technology. This integration ensures that athlete training movements are simulated with high fidelity, providing a realistic and dependable virtual environment for real-time sports training. Figure 3.2 illustrates the virtual reality perception interaction model within the simulation management module of the virtual environment generation unit.

The Simulated Management Module in the Virtual Environment Generating Unit is a 3-D Model Processor, which integrates the raw data of athlete sports training simulation collected by various sensors in the sports

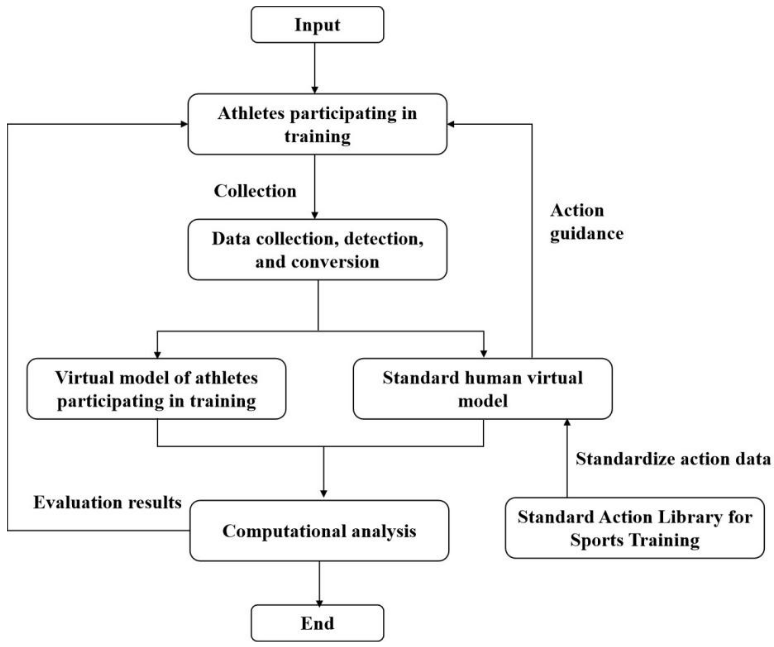

Fig. 3.3: System software operation process

simulation training input unit [15]. Combined with the interpretation of sports behavior, it simulates 3D modeling in the 3D model processor according to user settings, and finally displays the state application information on the display.

3.3. Three dimensional reconstruction of virtual athletes and construction of a standardized action library for sports. Design a virtual athlete 3D reconstruction software in an athlete simulation training system using the built-in scripting language Maxscript in 3D Studio MAX. The software aims to guide trained athletes in real-time and track the posture of their training parts. Throughout the athlete simulation training, virtual athletes are controlled according to standards to demonstrate training movements in real time. Concurrently, the user application module utilizes these virtual athletes to illustrate the movement trajectories of the participating athletes' training activities [16].

As a widely used 3D production software, 3D Studio MAX software includes various functions such as modeling, rendering, and animation roaming. In the 3D model processing module, the system calls internal programs to construct standard virtual humans based on standardized movements, and sets the time and angle of joint movements for a certain part to display guided standardized movements to participating athletes. The system collects data through functions such as Read Value to implement 3D reconstruction of intermediate document content, constructs a 3D virtual human of athletes participating in training, and real-time collects and reproduces the posture of the training parts of athletes participating in training in the real environment. In the design process using 3DStudio MAX software, a timer clock is added with a time interval of 20ms, which means that the intermediate document content is collected every 20ms to ensure that the sampling frequency of the same action position and direction tracker is the same, and to achieve the goal of real-time training of the posture of the trained parts of the athletes in the real environment. Athletes engaged in sports training follow real-time instructions based on standardized movements of virtual figures. The system uses a dialog box interface to offer feedback on their virtual training performance. Figure 3.3 depicts the software operation workflow of the athlete virtual training system [17,18].

To support athletes and coaches in tailoring training to various athletic scenarios and accessing specific training standards, it is essential to develop a virtual human sports movement library during the creation of a virtual reality-based athlete simulation training system. This library primarily consists of two components:

1. An athlete training record consisting of the names, ages, genders, training movements, and performance evaluations of athletes participating in sports training;
2. Including standardized movements for exercise training, such as movement number, type, position, and angle.

3.4. Simulation Application of Virtual Reality Technology. The advent of virtual reality technology has led to substantial advancements in athlete simulation training. Through technical analysis, the interactions between various positive feedback modules in virtual reality-based athlete simulation training are characterized by the following formula:

$$\frac{d \times L_{ev}}{t} = R_{\alpha} \tag{3.1}$$

In the formula, d and L_{ev} represent the time parameters of the simulation and the parameters of the virtual simulation, respectively; t and Ra indicate the number of simulated objects and the initial value of the simulation.

Optimize equation 3.1 using the differential equation shown in equation 3.2:

$$L_{ev} = L_{ev0} \cdot exp(c_0 \cdot t) \tag{3.2}$$

In the formula, L_{er0} and c_0 respectively represent the key parameters and scaling constants of the virtual simulation parameters.

In equation 3.2, the system state variables display dynamic variations, which can be used to compute relevant parameters for motion training simulations, providing crucial data for these simulations [19]. To meet the needs of virtual training simulations for athletes, the maximum value of feature roots max can be determined, as outlined in the following formula:

$$C = \frac{\lambda_{max} - n}{n - 1} \tag{3.3}$$

In the formula, C denotes the comparison matrix, and n represents the number of matrices used in the virtual simulation. Leveraging current experience with virtual training simulations, the comparison matrix helps quickly derive critical data related to virtual reality technology, leading to more precise data processing standards.

To meet the simulation needs of the athlete virtual training system, the consistency verification procedure must be applied to handle the simulation comparison matrix. The formula for this data verification process is given by:

$$C \cdot R = \frac{C \cdot I}{R \cdot I} \tag{3.4}$$

In the consistent verification, R and I. are the values of the matrix and the matrix parameters, respectively.

In virtual reality technology, the above process can be used to directly import important data of various sports training numbers, including athlete training plans and interdisciplinary results, during the recognition process of sports training data. Given these conditions, it is possible to determine the single-layer weight vector for sports training simulation. The details of this process are outlined in equation 3.5:

$$\overline{W_j} = \begin{bmatrix} W_1 \\ \vdots \\ W_N \end{bmatrix} j \tag{3.5}$$

In the weight vector identification process detailed in equation 3.5, $\overline{W}$ denotes the weight level, and j represents the parameter values of the single-layer fully connected weights. Following this weight vector identification requirement, the coach can utilize the system to assess the weight vector parameters for each layer. The formula for this evaluation process is as follows:

$$W_1 = \sum_{j=1}^{m} a_j b_{ij} \tag{3.6}$$

Table 4.1: Data Collection Error

	Lift your left arm up		Bending of waist	
sportsman number	Athlete's movements	System display action	Athlete's movements	System display action
12	45°00′	44°78′	32°45′	32°57′
19	44°21′	44°08′	30°06′	29°74′
26	41°44′	41°48′	42°27′	42°28′
38	17°46′	17°50′	24°22′	24°15′
54	57°70′	57°71′	53°24′	53°17′
60	70°03′	70°05′	42°01′	41°88′
66	45°78′	44°78′	63°03′	63°15′
71	96°26′	96°18′	19°06′	19°07′
77	80°25′	80°40′	77°36′	77°21′
89	74°04′	73°87′	15°25′	15°38′
105	22°60′	22°65′	95°30′	94°86′
113	19°30′	19°27′	82°00′	81°84′

$$W_2 = \sum_{j=1}^{m} a_j b_{2j} \tag{3.7}$$

$$W_3 = \sum_{j=1}^{m} a_j b_{nj} \tag{3.8}$$

In the formula, W signifies the actual vector values, while a and b denote the results from consistency tests and root analysis, respectively. By leveraging virtual reality technology, the performance of athlete simulation training systems can be optimized. This allows for the use of various simulation recognition and weight partitioning techniques to enhance the effectiveness of athlete training simulations.

3.5. Experimental verification. The experiment seeks to assess the real-world effectiveness of the athlete simulation training system developed using virtual reality technology. For this purpose, athletes from a specific school were chosen as subjects, with 120 participants from various sports training programs utilizing the system for their simulation training [20].

4. Results and Discussion. The author employs position and direction sensors to gather data on athlete movements. The error rates in data collection for this system are detailed in Table 4.1. Analysis of Table 4.1 reveals that the motion errors are generally limited to within 0° 20', demonstrating that the system effectively captures athletes' training data with high accuracy. This precision enhances the overall effectiveness of the sports training provided by the system.

To evaluate the training effectiveness for athletes, the mastery of training content was chosen as the benchmark. Out of 120 athletes with similar age and fitness levels, 15 were randomly assigned into three groups of five. The first group trained using a traditional artificial neural network-based system, the second group used a mechanical motion device-based system, and the third group utilized the newly designed system for comparison. Each group underwent eight weeks of training, and their progress was monitored and recorded weekly. The results, depicted in Figure 4.1, show that athletes using the new system (third group) demonstrated a notably better understanding of the training content after just one week, achieving a mastery rate of 73.75%. Over the eight weeks, all groups improved their content mastery, but the third group reached approximately 95% mastery by the end, compared to less than 80% for the other two groups. This indicates that the new system is more effective for athlete training and is better suited for enhancing training outcomes.

Table 4.2 presents the costs incurred by each group of athletes over the eight-week training period. During the first week, the cost of using the new system was reduced by 4000 yuan and 2000 yuan compared to the

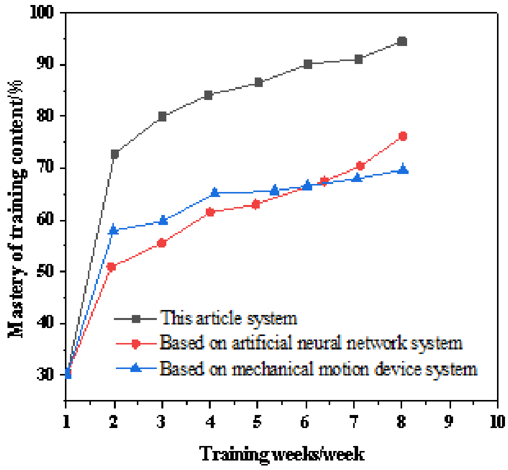

Fig. 4.1: Comparison results of mastery of training content

Table 4.2: Comparison Results of Training Costs (10000 yuan)

Training weeks/week	Traditional training system based on artificial neural network	Training system based on mechanical motion device	The system
1	1.3	1.1	0.8
2	1.5	2.3	0.8
3	1.7	3.5	0.8
4	2.1	4.7	0.8
5	2.1	6.1	0.8
6	2.3	7.1	0.8
7	2.5	8.3	0.8
8	2.7	9.5	0.8

traditional artificial neural network-based system and the mechanical motion device-based system, respectively. As the training continued, the cost of using the new system remained steady at 8000 yuan throughout the eight weeks. In contrast, the costs for the traditional and mechanical motion systems increased by 0.1 million yuan and 11,000 yuan per week, respectively. By the end of the eight weeks, the costs for the traditional and mechanical systems had risen to 27,000 yuan and 95,000 yuan, respectively. This demonstrates that the new system is more cost-effective and better suited for practical use in sports training.

Figure 4.2 illustrates the system's response speed during the comparative training effect test experiment. Analysis of this figure reveals that the response speed of the observation data calculation of the system basically meets the real-time requirements of virtual reality technology simulation analysis, which proves that the response speed of the system is guaranteed.

5. Conclusion. The author proposes that computer big data technology is an important component of future sports simulation applications in the field of intelligent algorithm research for athlete training in university physical education, as well as the design and development of athlete training simulation systems. The author's design leverages virtual reality technology to create an athlete simulation training system, with the goal of enhancing training effectiveness and lowering the costs associated with sports training. Due to time constraints, the performance testing content of the system is not comprehensive, and there are still certain defects within

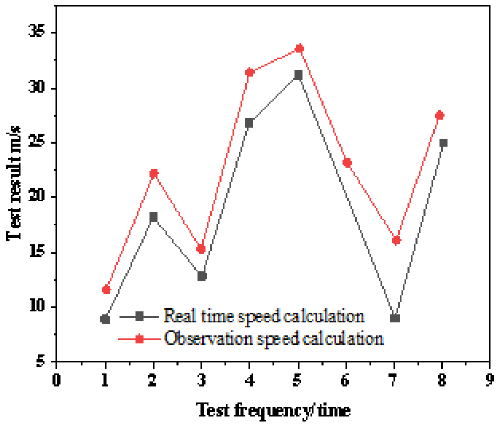

Fig. 4.2: System response speed test results

the system. These defects will be gradually optimized and resolved during the long-term testing process in the future.

REFERENCES

[1] Wu, M., Wang, R., & Wu, L. S. (2023). Invisible experience to real-time assessment in elite tennis athlete training: sport-specific movement classification based on wearable mems sensor data. Proceedings of the Institution of Mechanical Engineers, Part P. Journal of Sports Engineering and Technology, 237(4), 271-282.

[2] Zhang, Y., & Wei, W. (2023). Sports training correction based on 3d virtual image model. Mobile Networks and Applications, 28(5), 1687-1698.

[3] Luo, C., & Yang, H. (2024). Athlete training load monitoring using sensor-based technology and motion image analysis. Revista internacional de medicina y ciencias de la actividad fica y del deporte, 24(94), 322-339.

[4] Dan, J., Zheng, Y., & Hu, J. (2022). Research on sports training model based on intelligent data aggregation processing in internet of things. Cluster Computing, 25(1), 727-734.

[5] Zhang, Z., & Huang, X. (2024). Effectiveness assessment for the application of virtual reality technology in physical fitness training of engineering students. Revista internacional de medicina y ciencias de la actividad fica y del deporte, 24(94), 465-481.

[6] Luo, C., & Yang, H. (2024). Athlete training load monitoring using sensor-based technology and motion image analysis. Revista internacional de medicina y ciencias de la actividad fica y del deporte, 24(94), 322-339.

[7] Cheng, Y., Lu, H., & Guan, H. C. (2022). Monitoring simulation of athlete dynamic injury based on nosql database and localization algorithm. Mobile information systems, 2022(Pt.31), 1-10.

[8] Fang, L. (2024). The deployment of smart sharing stadium based on 5g and mobile edge computing. Wireless Networks, 30(5), 4121-4131.

[9] Xiao, S., Huang, H., & Wang, W. (2024). Research on the innovation system of physical climbing in college physical education under big data technology. Applied Mathematics and Nonlinear Sciences, 9(1).

[10] Die, H., & Lianhong, L. (2022). Research on the optimization of the physical education teaching mode based on cluster analysis under the background of big data. Scientific programming, 2022(Pt.11), 6340526.1-6340526.9.

[11] Fu, C. (2022). Physical fitness evaluation system for athlete selection based on big data technology. Int. J. Embed. Syst., 15, 249-258.

[12] Ma, Q., & Huo, P. (2022). Simulation analysis of sports training process optimisation based on motion biomechanical analysis. International Journal of Nanotechnology, 19(6/11), 999-1015.

[13] Jayanthi, N., Schley, S., Cumming, S. P., Myer, G. D., Saffel, H., & Hartwig, T., et al. (2022). Developmental training model for the sport specialized youth athlete: a dynamic strategy for individualizing load-response during maturation:. Sports Health: A Multidisciplinary Approach, 14(1), 142-153.

[14] Beaumont, P. L., Hoek, D. V. D., Holland, J., & Garrett, J. (2023). A scoping review of the physiological profiles of motorsport drivers: implications for athlete training. Strength and Conditioning Journal, 46(3), 257-278.

[15] Sansone, P., Rago, V., & Kellmann, M. A. P. E. (2023). Relationship between athlete-reported outcome measures and subsequent match performance in team sports: a systematic review. Journal of strength and conditioning research,

37(11), 2302-2313.
[16] Liu, Y., & Jing, H. (2022). A sports video behavior recognition using local spatiotemporal patterns. Mobile information systems, 2022(Pt.10), 1-10.
[17] Kechi, A. D., Lars, D., & John, K. (2023). Coaches' perceptions of factors driving training adaptation: an international survey. Sports medicine, 53(12), 2505-2512.
[18] Wu, M., Wang, R., & Wu, L. S. (2023). Invisible experience to real-time assessment in elite tennis athlete training: sport-specific movement classification based on wearable mems sensor data. Proceedings of the Institution of Mechanical Engineers, Part P. Journal of Sports Engineering and Technology, 237(4), 271-282.
[19] Zhang, Y., & Wei, W. (2023). Sports training correction based on 3d virtual image model. Mobile Networks and Applications, 28(5), 1687-1698.
[20] Zhu, C. (2022). Design of athlete's running information capture system in space-time domain based on virtual reality. Scientific programming, 2022(Pt.4), 1-10.

Edited by: Hailong Li
Special issue on: Deep Learning in Healthcare
Received: Sep 16, 2024
Accepted: Oct 21, 2024