

Research on the Development of Sports in the Age of Artificial Intelligence

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Abstract: In recent years, artificial intelligence technology has developed rapidly and is no longer limited to the interdisciplinary integration of information and traditional engineering majors. There have also been relatively successful application achievements in fields such as humanities and social sciences, and of course, in the field of sports is no exception. The integration of sports and artificial intelligence disciplines usually refers to the use of technologies related to artificial intelligence as a means, reflected in the perception, induction, analysis, and decision-making process of sports data. The final goal is to reveal the laws of human movement, evaluate the effectiveness of sports performance, and develop equipment to assist in sports training, in order to enhance the scientific and healthy nature of sports. This article takes the integration of artificial intelligence and sports as the starting point, and introduces the application cases of artificial intelligence related technologies in the field of sports through literature review, logical analysis, and other methods. Introduced the current situation of professional talent cultivation and industry exchanges in China. Finally, a summary and suggestions were provided.

Keywords: Artificial intelligence; Sport; Interdisciplinary integration; Technology application

1. Introduction

Life lies in motion, and motion requires science. Physical exercise can prevent diseases, pleasure the body and mind, and is a positive, effective, and economical way to maintain physical health. Every country attaches great importance to sports education and industrial development. In the era of artificial intelligence, many emerging technologies belong to the interdisciplinary category. The development of a single discipline can no longer meet the social demand for talent and the changes in industries. The interdisciplinary integration and development will be a future trend^[1]. In the era of artificial intelligence, the promoting role of various technologies in the field of sports cannot be ignored.

General Administration of Sport of China announced the 14th Five Year Plan for sports development and put forward some effective suggestions. We need fully leverage the role of core elements such as technology, capital, talent, and data in the innovative development of the sports industry. Support the innovative application of big data, blockchain, Internet of Things, cloud computing, artificial intelligence and other new technologies in the sports field, create intelligent fitness scenes, and accelerate the development of related products. Artificial intelligence refers to a new technological science that simulates, extends, and extends the theories, methods, technologies, and application systems of human intelligence through research and development, enabling machines to perform tasks that humans require intelligence to complete^[2,3]. This article mainly summarizes the current application status of sports artificial intelligence technology in various fields of sports, in order to provide reference and reference for sports technology workers to further explore and study the theory, technology, and application of sports artificial intelligence.

2. Various Technologies of AI in Sports

2.1. Big Data in Sports

Big data technology is a new generation of information technology and service industry that collects, stores and analyzes data in a large number, scattered sources and diverse formats to discover new knowledge, create new value and improve new capabilities. Big data is a massive, high growth rate and diversified information asset that requires a new processing model to have stronger decision-making

power, insight and discovery, and process optimization capabilities [4,5]. IBM company researchers proposed five characteristics of big data, namely, variety, velocity, volume, veracity and value.

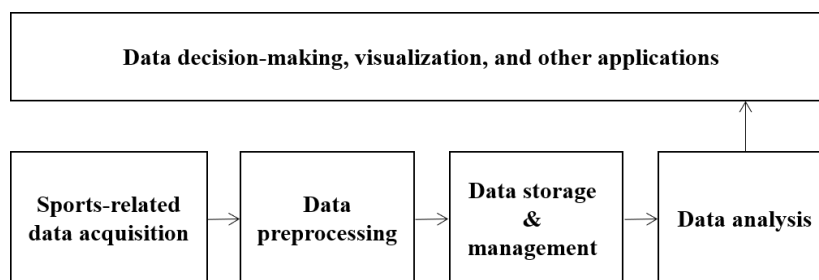


Figure 1: Big data processing flowchart.

In addition to finance, communication, retail, medical care, tourism, government management, etc., big data technology can be used in many fields of sports, such as, storage of historical data, prediction of competition or behavioral trajectory, sports analytics. A classic sports big data processing flow is shown in Figure 1. In addition to traditional structured data, there are also unstructured forms such as image information, network logs, sounds, animations, and athlete sports videos. Taking the basketball game as an example, the application of big data in all aspects is analyzed. In terms of game data, including score data, official lineup and player distribution of both sides, real-time technical statistics, goals scored by both sides, player substitutions, red and yellow cards, and other major events. In terms of data analysis, it includes a list of relevant scores for completed matches, relevant scores for completed matches of a certain team in the past two years, the total number of goals and single or even numbers of a certain team, the ranking of a certain team, and the upcoming schedule of a certain team. In terms of database data, provide point data and rankings obtained by each team in a certain league, as well as information on all rounds, match times, matches, and other aspects of the league. The database provides accurate match information for the designated team in the past 15 to 30 games, including past matches, time, team, results, etc. In addition, personal information of the designated player, including their name, race, age, and height are also provided. In terms of data products and advanced applications, a team of sports experts collects and deeply analyzes competition related intelligence, integrates their own industry experience and professional insights, and provides users with comprehensive competition analysis. Based on real-time on-site data, we provide users with a high-quality viewing experience through simplified text and vivid visualization modes. Collaborating with foreign on-site collection teams, after obtaining first-hand source data, it is transformed into multiple languages including Chinese in real-time through a standardized translation system, and output to various partners. Obviously, there has the characteristics of automation, speed, standardization, and wide coverage.

There are many other applications of Big data. In terms of physical education teaching, through data collection in teaching activities, big data technology can evaluate teaching activities. Based on the big data, we can build a personalized sports training model and analyze the rules in sports training and competitions.

2.2. Robotics in Sports

With the development of artificial intelligence robot technology, all kinds of robots are gradually moving forward to help people carry out sports, such as assisting people in daily exercise and training competitions, competing with people in the same field, and evaluating and assisting in the treatment of Sports injury.

The world's first ski robot competition was held to commemorate the 2018 Winter Olympic Games in PyeongChang, Korea [6]. The game needs a humanoid robot performing a ski giant slalom game, a direct moving or curve turning motion, a ski flag detection task, etc. Before the 2022 Beijing Winter Olympics, in China, the first "National Robot Competition Ice and Snow All-Star Challenge" was held in Badaling Ski Resort [7]. Figure 2a shows the skiing robot that increases the fun of skiing and helps promote skiing sport to more people.

Figure 2b is a table tennis sparring-partner robot that is transformed through a KUKA Agilus robot [8]. The robot is a mechanical arm of an industrial robot and the cameras are mounted on the ceiling. To detect the tennis ball, the robot needs to fuse multiple features and achieves the 3D ball positions. Then, the robot should predict the ball's trajectory and control the racket to hit the ball. Through table tennis robots, ordinary people can also engage in combat training with professional coaches.

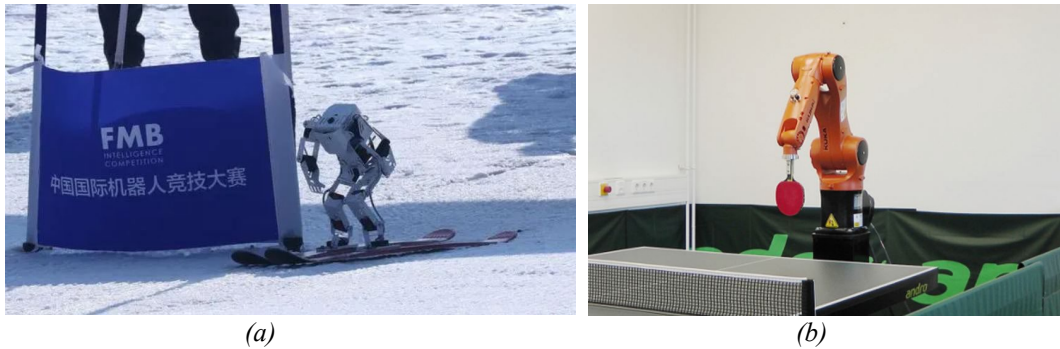


Figure 2: Robots in sports. (a) Skiing robot. (b) Table tennis robot.

There are other robotic applications in sports. Rehabilitation training robots can assist athletes in recovering from injuries such as ankles ^[9]. AI robot improves the quality and efficiency of sports news production and free journalists from routine work ^[10].

2.3. Internet+ in Sports

Different from traditional offline sports forms, introducing internet technology in the field of sports will increase many possibilities. As shown in table 1, the per capita facilities of the national sports venue are very few. Traditional sports have significant industry pain points, such as inadequate offline sports experience and information asymmetry between venues and athletes. Through internet technology, we can broadcast live sports events to remote audiences or sports enthusiasts ^[11]. The teaching content of good coaches or sports teachers can be presented to more people or students in remote areas ^[12].

Through mobile app software, some sports and events can be participated in online, especially during the COVID-19 epidemic ^[13]. In China, the 2023 National Fitness Online Games is successfully held and ongoing. The sport includes multiple events, such as, Brisk walking, Karate, Marathon, Bridge, Figure skating, square dance, hiking, football, renju, digital racing, Radio calisthenics, etc. In addition, the internet+ technology provides the sports venues cloud booking, remote learning fitness classes, and online purchase of sports equipment.

Table 1: Main data of national sports venue (Year 2022, China).

Indicator Name	Sub indicators	Unit of account	Numerical value
Comprehensive indicators	Per capita area of sport venue	Square meter	2.62
	Number of sport venue	Ten thousand	422.68
Basic project site	Athletic field	Ten thousand	19.74
	Swimming site	Ten thousand	3.60
Ball sports venues	Football	Ten thousand	13.59
	Basketball	Ten thousand	110.28
	Volleyball	Ten thousand	10.12
	Table tennis	Ten thousand	93.53
	Badminton	Ten thousand	24.61
Ice and snow sports venues	Skating	piece	1576
	Skiing	piece	876
Sports and fitness venues	National fitness path	Ten thousand	98.02
	Gymnasium	Ten thousand	14.29
	Fitness trail	Piece per Km	12.78/31.42

2.4. Computer Vision in Sports

Computer Vision refers to the technology that allows machines to simulate the process of human vision through visual information such as digital images or videos, in order to achieve the understanding, recognition, classification, tracking, reconstruction, and other purposes of objects. It is a branch in the field of artificial intelligence, involving multiple fields such as image processing, pattern recognition, machine learning, deep learning, etc.

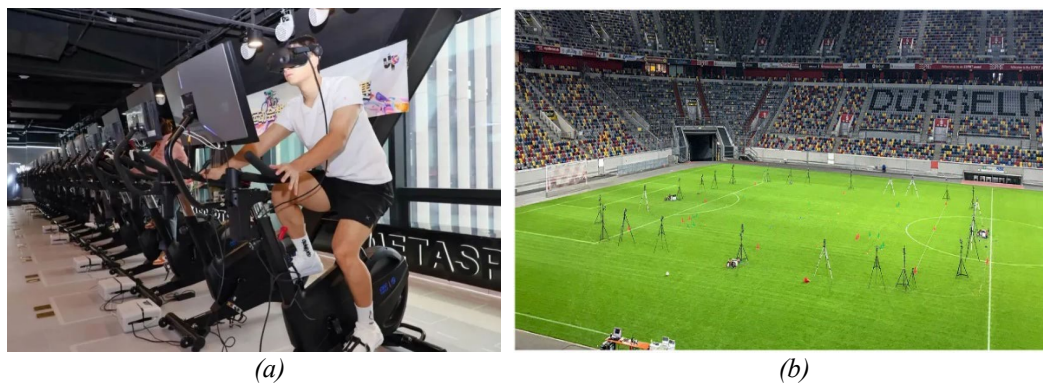


Figure 3: Computer vision in sports. (a) VR in sport. (b) Optical tracking system

As shown in figure 3a, using the virtual reality (VR) techniques, immersive teaching in physical education and VR sports experience can be realized^[14,15]. Compared to traditional forms of sports, VR sports are safer and more scientific. Taking VR riding behavior as an example, traditional cycling is limited by factors such as the venue, making it difficult to ensure safety. VR riding is based on the integration of VR technology and traditional cycling, which can truly simulate the cycling experience. Multidimensional sensors are used to record and calculate data such as cycling strength, posture, speed, heart rate, and calorie consumption, making cycling more scientific. At the same time, different themed scenes change with the distance traveled, experiencing the shocking experience brought by immersive sports vision.

Through the networking and collaboration of multiple cameras, an optical tracking system can be realized to achieve more sport tasks. The optical 3D Motion capture system can collect motion data in real time, synchronize with 3D force measuring platform, 3D force measuring running platform, surface electromyography, plantar pressure measuring instrument and other equipment, and collect Kinematics data such as walking and running. It is applicable to the construction of hospital gait analysis laboratory, clinical gait analysis, amputation rehabilitation, lower limb motion research, cerebral palsy research, motion control and neuroscience, Exoskeleton robot research, etc. Collecting positional data in official football matches, world top leagues such as Bundesliga, La Liga, and Premier League rely on optical tracking systems. The systems provide the only non-invasive solution that can simultaneously track players and balls without the physical intervention of technical equipment. It can be used to derive performance indicators, which are now considered an important component of load monitoring and tactical analysis^[16], as shown in figure 3b.

Computer vision also can be used as AI referee^[17], which utilizes artificial intelligence to assist in sentencing. The Qatar World Cup officially introduced the semi-automatic offside recognition technology (SAOT) for the first time, which utilizes artificial intelligence to assist in refereeing, also known as AI referees, and is an upgrade to the traditional video assistant referee (VAR) technology. SAOT played a role in the opening 3 minutes of the World Cup, and a goal scored by an Ecuadorian player was deemed offside by him. Unlike VAR's previous minutes of work, the AI referee's judgment time can be as low as 25 seconds. The working principle of SAOT is that the 12 cameras in the venue track the ball and the points on the body of 29 players at different positions. This camera will transmit 50 times of information per second. The official ball AlRihla is equipped with an Inertial measurement unit (IMU) motion sensor, which can send 500 times of position data per second, and ultimately achieve faster and more accurate offside determination.

In addition to the above applications, face recognition can be used for check-in work in sports competitions. The diving assistant training system supports the extraction of key bone point information, body posture, motion track and position information from the video, and the use of algorithms for Iterative reconstruction to record the details of takeoff height, rotation, air posture, etc.^[18].

2.5. Others in Sports

In addition to the aforementioned artificial intelligence-related technologies, there are also some other applications in the field of sports, such as cloud computing [19], the Internet of Things, machine learning, or deep learning network^[20]. The Internet of Things in sports can obtain the player's data at any time anywhere. Based on these data, the intelligent system can analyze the various physical indicators and parameters of the player^[21].

3. Talent Training and Exchange

No matter what industry, the prerequisite for good development is the corresponding talent supply. This includes two aspects: talent cultivation in universities and industry talent exchange. The former refers to the major setup in universities and the latter refers to the construction of academic groups. Smart physical education teaching provides a beautiful vision for the transformation of modern physical education teaching. Different from traditional liberal arts or social sciences majors in professional settings, under the background of cross integration of new engineering disciplines, sports has made new developments. The integration of sports and engineering majors is a promising direction. The Sports Equipment Engineering major is a new major established by the intersection and integration of sports science, mechanical engineering, materials science, mechanics, and other disciplines. Mainly cultivate senior specialized talents who possess both basic theories and knowledge of sports science and engineering, possess strong innovative spirit and development and design abilities, and can engage in research, design, development, evaluation, marketing, and management of sports equipment in the fields of sports equipment manufacturing, marketing, and research institutions. The main courses include English, Further Mathematics, College Physics, Engineering Mathematics, Applied mechanics, Engineering Fluid mechanics, Mechanical Drawing and CAD, Fundamentals of Mechanical Design, Mechatronics, Mechanical Manufacturing Technology, Electrical and Electronic Technology, Computer Interface Technology, Single Chip Microcomputer Principle and Application Technology, Sensor Technology, Computer High-level programming language, Ergonomics, Sports Biomechanics, Sports Anatomy, Exercise physiology Sports biochemistry, sports training, etc. When students graduate, they can major in sports equipment engineering can mainly work as engineering technicians and management personnel in the sports equipment manufacturing and operation industries. A small portion are engaged in research, design, development, and evaluation of sports equipment. Table 2 is a major setup in universities in China where very few universities offering cross disciplinary programs.

Table 2: Major setup in universities.

University	Major
Shenyang university of technology	Sports Equipment Engineering
Wuhan sports university	Sports Equipment Engineering/ Mechanical Electronic engineering
Beijing sports university	Intelligent Sports Engineering
Zhejiang university	Intelligent Sports Engineering
Harbin Institute of Technology	Intelligent Sports Engineering

In terms of the construction of academic groups, from July 7th to 9th, 2023, Chinese Association for Artificial Intelligence (CAAI) establishes the Sports Artificial Intelligence Special Committee and holds the first national conference on artificial intelligence in sports. The topic of the conference is strong, smart, and syncretic. They intend to provide an academic exchange platform for basic theoretical research, engineering technology, and product development in the field of artificial intelligence in domestic sports. In addition, they will showcase the latest theoretical and technological achievements, promote the transformation of achievements and industrial development.

4. Conclusion and Suggestion

In the era of artificial intelligence, the emerging technologies introduced across multiple disciplines have indeed had a positive impact on the field of sports. The combination of traditional sports, big data, artificial intelligence and other new Internet technologies can produce greater market value, promote the transformation and upgrading of the entire sports service industry and manufacturing industry, integrate the "fragmented" traditional sports industry with the Internet in all aspects of resources, thus forming a large-scale industrial chain. However, it is still in the ascendant stage of development. In the future, it is necessary to cultivate more versatile talents so that the sports industry can develop better.

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