

Locating the Innovation and Application of Artificial Intelligence in Sports and Training

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ABSTRACT

The field of Artificial Intelligence (AI) has shown skyrocketing trend of growth in the 21st century. The evolution of AI has advanced the development of human society in contemporary times, driven by both theoretical innovations and technological breakthroughs. In this era of rapid advancement in computer science, cybernetics, interdisciplinary sciences, automation, mathematical logic, linguistics, physical education, and sports journalism, AI has transitioned from theory to widespread application, becoming a key technology in modern society. AI is increasingly influencing all aspects of human life, including game and sports training. The rise of intelligent systems has introduced a positive impact through precision technologies that continue to enhance the sports arena. Real-time personalized training plans, player performance analytics, automated scouting and recruitment systems, match predictions, and AI-driven sports are among the many practical applications transforming the world of sports. These technologies are not only viable but also essential in improving efficiency, performance, and audience engagement. This study explores how these diverse AI applications support and elevate modern game and sports training.

Keywords: Innovation, Artificial Intelligence, Sports, Game, Sports Journalism, AI Application

INTRODUCTION

Artificial Intelligence (AI) has emerged as one of the most transformative technologies of the 21st century, revolutionizing nearly every domain of human endeavour from healthcare and finance to education, manufacturing, and sports etc. (Yang, 2022; Ting Xu, Baghaei, 2025). Within this broader technological revolution, the domain of sports has increasingly become a fertile ground for AI-driven innovation. While traditional athletic training and sports management relied heavily on intuition, experience, and rudimentary statistics, the contemporary integration of AI allows for a more nuanced, data-driven, and adaptive approach to performance analysis, coaching, fan engagement, and strategic planning. As AI continues to be institutionalized across sectors, its role in sports is rapidly shifting from experimental to essential.

The advancement of AI represents the convergence of multiple disciplines, including computer science, automation, cybernetics, mathematical logic, cognitive psychology, and linguistics. In the context of sports and physical education, this interdisciplinary application of AI offers new methods of engaging with the human body, optimizing physical performance, and improving both individual and team-based outcomes (Tyler et al., 2022; Kelly et al., 2021). The integration of AI technologies with physical education and sports training has not only redefined the concept of athletic excellence but has also reimaged the infrastructures of sports management, broadcasting, and fan culture.

One popular cultural representation of this technological shift can be seen in the 2011 film Moneyball, which narrates the story of how Billy Beane, the general manager of the Oakland Athletics, utilized sabermetrics a form of empirical statistical analysis to assemble a competitive team despite severe budget constraints (Lewis, 2003). This case illustrates a seminal moment in the history of sports analytics, where decisions were no longer solely reliant on human judgment or traditional scouting practices but increasingly informed by algorithmic reasoning

and big data analysis (Davenport, 2006). The Moneyball phenomenon paved the way for more sophisticated applications of machine learning and AI in sports, shifting the narrative from descriptive analytics to predictive and prescriptive models.

AI technologies today simulate several aspects of human cognition, including perception, reasoning, learning, and decision-making. These capabilities enable AI systems to perform complex tasks such as recognizing movement patterns, predicting injury risks, customizing training programs, and analyzing real-time game scenarios. Unlike earlier generations of statistical tools, AI systems are adaptive; they learn from new data, refine their predictions, and adjust their recommendations. This is particularly beneficial in the highly dynamic and variable environments of competitive sports, where decisions must often be made in milliseconds and where the margin for error is slim. (Parks et al., 2019; Thomas et al., 2017). The use of AI in sports spans a wide spectrum of applications. For instance, in athlete performance analysis, AI algorithms can process data from wearable sensors, GPS trackers, and video recordings to provide coaches with real-time feedback on movement efficiency, fatigue levels, and recovery rates. In sports medicine, AI supports early diagnosis of injuries and designs personalized rehabilitation programs. In coaching, AI-powered software aids in strategizing by simulating different game scenarios based on historical data and opponent analysis. Fan engagement platforms increasingly use AI to deliver personalized content, manage ticketing systems, and create immersive virtual experiences. Such technologies do not merely supplement traditional methods; they reconfigure the fundamental structures through which sports are played, watched, and understood.

This technological momentum is further evidenced by the increasing number of AI startups and multinational technology firms investing in sports innovation. For example, Stats Perform uses AI to generate live predictions during football matches, offering insights into player performance and game outcomes. In basketball, the Home Court app uses AI to provide real-time feedback on players' shooting techniques. Cricket employs AI in the Umpire Decision Review System (UDRS) and the Duckworth-Lewis method to aid in weather-affected matches. Additionally, wearable AI devices such as My Swing Professional for golf, Spot VU for tennis, and biomechanical analysis tools for baseball and football are becoming common across training academies and professional teams (Onifade, Ogunnowo and Moronfolu, 2025). These developments illustrate that AI is not merely a supplementary innovation but a central component in the future of athletic training and management.

Despite these advances, there are also critical concerns associated with AI adoption in sports. One significant challenge is the ethical use of biometric data. With the rise of wearables and surveillance technologies, questions of data ownership, privacy, and consent become increasingly urgent. Athletes especially at the amateur or community levels may not always have the autonomy or awareness to control how their data is used, stored, or monetized. Furthermore, access to advanced AI tools is unevenly distributed, favoring elite institutions and wealthier teams. This deepens existing disparities in sports training infrastructure, creating a gap between technologically empowered and underserved groups.

Another area of concern is the overreliance on algorithmic decision-making, which may overshadow the intuitive, creative, and emotional aspects of sports. While data is invaluable, it cannot fully encapsulate the spontaneous and humanistic dimensions of athletic performance. Coaches and athletes must strike a balance between machine-generated insights and lived experience. Scholars have also cautioned against algorithmic biases; AI systems trained on limited datasets may produce skewed or misleading results, especially in multicultural and diverse sporting contexts (Suman, 2022). Therefore, critical engagement with AI's limitations is essential to ensure its responsible and equitable application. Moreover, the integration of AI into educational and training institutions calls for a reevaluation of physical education curricula. Physical education is no longer just about physicality but also about data literacy, technological fluency, and interdisciplinary collaboration. As AI reshapes how sports are conceptualized and practiced, educators must prepare students not only to perform but to interpret, critique, and co-design emerging technologies. This reorientation of education is critical to developing a new generation of athlete-technologists and coach-analysts who are capable of navigating the evolving landscape of sports innovation.

This study aims to locate and critically examine the role of AI in sports and training by identifying its key applications, benefits, and challenges. It seeks to organize the discourse into distinct but interconnected thematic domains: (1) AI in performance analysis and athlete monitoring, (2) AI in coaching and tactical decision-making,

and (3) AI in fan engagement and sports media. In addition to mapping current innovations, the study also explores the ethical, social, and economic implications of AI in sports, advocating for a more inclusive and context-sensitive approach to its adoption. Furthermore, by incorporating regional and community-level insights, this paper attempts to highlight the global relevance of AI in sports, moving beyond elite institutions and spotlighting diverse use cases in countries such as India, Brazil, and Kenya. AI represents a paradigm shift in the way sports are played, trained for, and experienced. As this technology continues to evolve, so too must our frameworks for understanding and evaluating its impact. This paper contributes to the growing academic conversation around AI and sport by offering both a thematic structure and a critical lens for examining the potentials and pitfalls of this transformative technology.

Influence Of Artificial Intelligence in Game and Sports

The integration of Artificial Intelligence (AI) into the world of sports has emerged as a transformative force, reshaping how games are played, managed, analyzed, and experienced. As AI technology advances across sectors, its application in sports represents a major shift from tradition toward highly automated, data-driven systems (Yang, 2022; Suman, 2022, Ting Xu, Baghaei, 2025). In contemporary athletic practice, AI enhances performance through its ability to collect, process, and analyze vast datasets derived from wearable technologies, GPS systems, and biometric sensors. These devices offer real-time insights into an athlete's physical condition, such as fatigue levels, heart rate variability, and biomechanical posture. Such data enables coaches and trainers to devise personalized training plans that are not only scientifically sound but also optimized for injury prevention and peak performance (Ding, 2019).

In the case of live recording, AI tools assist coaches in making tactical decisions by identifying patterns in opponents' behavior and suggesting strategic adaptations (Barlow & Sriskandarajah, 2019). The knowledge base embedded in these AI systems grows continuously through machine learning, incorporating insights from sports scientists, biomechanical analysts, and historical performance data. This evolving system of tactical intelligence offers teams an unprecedented edge, allowing them to anticipate, react, and outperform in highly competitive environments.

Simultaneously, AI technologies are revolutionizing fan engagement and media consumption. Smart algorithms curate customized content streams based on user preferences, allowing fans to access real-time statistics, personalized commentary, and interactive visualizations that deepen their understanding and enjoyment of the game (Penichet-Tomas, , 2024, Cavallaro et al., 2011). Broadcasters employ AI to generate dynamic graphics, such as trajectory predictions, virtual replays, and augmented visuals like moving offside lines or real-time ball speed indicators. These tools not only enrich the viewing experience but also open new avenues for targeted advertising and sponsorship integration without disrupting the broadcast flow.

The expansion of AI in sports also extends to refereeing and officiating. Systems such as the Decision Review System (DRS), Video Assistant Referee (VAR), and Hawk-Eye are now integral to decision-making in sports like cricket, football, and tennis. By leveraging computer vision, high-speed cameras, and trajectory modeling, these tools ensure greater accuracy and fairness in adjudicating on-field events (Lawrence, 2015). With advancements in real-time computer vision and wearable referee technologies, officials may eventually use AI-powered glasses or earpieces to receive instantaneous decisions during matches, drastically reducing errors and enhancing fairness.

The integration of eye-tracking systems to analyze athletes' visual focus has provided further insight into player cognition and decision-making. Eye-tracking technology, such as video-oculography, maps eye movement and attention, which allows analysts to evaluate athletes' situational awareness and perceptual-cognitive behavior. For instance, if a footballer misplaces a pass, AI-assisted gaze analysis can reveal whether it was due to visual occlusion, poor judgment, or misinterpretation (Penichet-Tomas, 2024; Pires & Kanade, 2013). Such insights help refine training for improved spatial awareness and anticipation skills.

Beyond elite professional sports, AI's reach is gradually extending to grassroots and amateur levels. In regions like India, where traditional games such as kabaddi and hockey maintain strong cultural relevance, AI implementation remains in early stages due to cost, infrastructure, and policy challenges. However, there is

increasing recognition of AI's potential in these contexts. Low-cost solutions, including mobile-based analytics apps and simplified wearables, can offer schools and community programs a starting point for data-informed training and injury prevention (Toledo et al., 2012). As AI becomes more accessible, these technologies could help democratize sports performance enhancement and reduce regional disparities.

Moreover, AI is playing a vital role in injury prediction and rehabilitation. By identifying anomalous movement patterns or dangerous biomechanical stresses, AI systems can alert trainers to impending risks before they become acute injuries. This allows for preemptive intervention, safeguarding athletes' careers and ensuring long-term well-being (Barlow, 2019). Rehabilitation programs are also becoming increasingly data-guided, with AI tailoring recovery protocols to each athlete's unique physiology and progress. Through predictive analytics, AI can assess load management, fatigue levels, and mechanical inefficiencies to propose personalized recovery strategies.

While these applications offer tremendous promise, they also raise important ethical and logistical questions. Chief among them is the issue of data privacy and informed consent. The sensitive biometric data collected by AI tools must be managed responsibly to protect athletes from exploitation or discriminatory practices in recruitment, selection, and performance evaluation. Additionally, the widening gap between resource-rich and resource-poor sports environments may lead to a digital divide, where access to AI becomes a marker of privilege. In developing nations, without inclusive policy frameworks and subsidized technologies, AI could exacerbate existing inequities in sports participation and performance (Mohammed, Othman & Abdullah, 2024; Ding, 2019).

Alongside performance optimization and fan experience, AI is also embedded in the broader governance and commercial dimensions of sports. Professional teams and sports organizations use AI for scouting talent, forecasting ticket sales, managing logistics, and even predicting crowd behavior to ensure safety at large events (Mahajan, Pal & Desai, 2023). AI is also increasingly employed in eSports, a rapidly growing domain where machine learning algorithms assist in opponent modeling, reaction time enhancement, and streamlining in-game strategy. Such applications blur the boundary between physical and virtual sport, reflecting the hybrid nature of athletic competition in the digital era.

The educational sector has also begun to integrate AI into the curriculum of sports science and physical education. Universities and coaching academies utilize AI-generated simulations and performance data to train the next generation of athletes, analysts, and physiologists. These digital tools facilitate an evidence-based approach to coaching, replacing outdated intuition-based practices with rigorously tested methodologies. In basketball, for example, researchers have developed AI models that analyze shooting accuracy, team dynamics, and injury risks. AI-enhanced training arenas and robotic coaches are also in development, offering athletes immediate feedback and adaptive learning environments (Li & Xu, 2021). These innovations are not limited to developed countries. Though implementation in countries like India is at an experimental stage, interest is growing in integrating AI with traditional and region-specific sports to elevate them to global standards. The challenge lies in creating scalable, affordable, and culturally relevant AI tools that can be adopted without displacing the ethos of local sporting traditions.

The rapid advancement of AI has also introduced a new conceptual framework for understanding its role in sports. This framework can be organized around three interconnected pillars: performance optimization, fan engagement, and regulatory governance. Performance optimization encompasses the use of AI in training, strategy, injury management, and rehabilitation. Fan engagement includes personalized media, broadcast enhancements, and immersive technologies (Xu & Baghaei, 2025). Regulatory governance involves officiating systems, ethical protocols, and policy development around data use and competitive fairness. This triadic structure provides a holistic lens for evaluating AI's present and future impact. It also underscores the importance of interdisciplinary collaboration among technologists, ethicists, policymakers, coaches, and athletes. Despite, the influence of Artificial Intelligence in game and sports is multifaceted, profound, and evolving. While it offers unparalleled advancements in athlete performance, coaching, fan experience, and governance, it also demands careful navigation of ethical, economic, and cultural challenges. As we continue into a data-intensive sporting future, it is imperative that stakeholders prioritize equitable access, safeguard athlete privacy, and preserve the human spirit that defines competition. AI, if guided responsibly, can serve not as a replacement for the human

element, but as a powerful ally in refining and enriching the sporting experience for all.

Artificial Intelligence Technology Located Applications

PIQ Robotic Device

The PIQ Robot is an advanced wearable sensor system considered to analyze thousands of data points during training sessions across multiple sports. It enables athletes to enhance key skills such as speed, strength, and accuracy. Integrating state-of-the-art inertial sensors, BLE (Bluetooth Low Energy), NFC (Near Field Communication), and a pressure sensor, the PIQ Robot is fortified with a high-performance microprocessor. Its compact, lightweight, waterproof, and flexible design allows it to be optimally positioned for data collection regardless of the sport.

According to Bezobracy et al. (2019), the PIQ Robot was altered in a specialized engineering mode to access nerve sensor data via the BLE optical connector. A dedicated Android tool named PIQ Log, developed by Octonion Technology, facilitates data learning by saving sensor data files to the smartphone's memory in a comma-separated format (CSV). These files can effortlessly be exported to Microsoft Excel or other data processing software. Each data file includes acceleration with gravity along three axes, angular speed across three axes in the area indicator frame, and quaternion data for converting local PIQ orientation to global coordinates.

Companion apps developed in collaboration with leading sports brands such as Everlast (boxing), Mobitee (golf), Babolat (tennis), North Kiteboarding (kiteboarding), and Rossignol (skiing) allow athletes to analyze performance, share results on social media, and engage with a wider training community. Users can compare their achievements on PIQ Robot leaderboards, which enhances motivation and competition.

SportVU Electronic Navigation Technology

SportVU, developed in 2005 by an Israeli scientist, is a product of SportVU Ltd. based in Tel Aviv, Israel. Since the 2010–11 NBA season, SportVU has been used to analyze over 3,000 games, and by 2013, it had been applied in all NBA stadiums. The system employs six cameras strategically positioned around the arena to track every player's and the ball's movements on the court, capturing data at 25 frames per second.

SportVU revolutionizes how basketball is analyzed and viewed. It collects extensive positional data in real-time, which broadcasters use to improve live coverage by overlaying player trajectories, shot paths, and statistical predictions. The technology relies on sophisticated algorithms and computer vision to track location and create precise analytics. As a result, SportVU delivers in-depth insights about player movement, game dynamics, and officiating decisions, creating a richer and more engaging viewing experience.

In football, AI Referee – Video Assisting Technology

video-assisted technology powered by artificial intelligence aids referees make accurate decisions on critical matters such as penalties, offside calls, and red cards. A historic example illustrating the necessity of such technology is Diego Maradona's infamous "Hand of God" goal during the 1986 FIFA World Cup match between Argentina and England. Without AI or VAR at the time, the illegal goal stood, sparking worldwide controversy.

Today, AI-assisted referee systems aim to reduce such incidents by analyzing footage and offering real-time decision support. Although human-technology interaction is still evolving, these AI systems are being increasingly integrated to enhance officiating accuracy and reduce errors with serious financial or psychological consequences. As technological capabilities improve, the reliance on AI to support and potentially augment human referees continues to grow.

Scouting and Recruitment

In the digital era, teams are increasingly incorporating AI into scouting and recruitment processes. From tracking a baseball swing to analyzing running patterns in soccer and blocking in basketball, AI systems collect terabytes

of performance data during games. By using machine learning, teams can label player movements with key-point skeleton tools, build predictive models, and simulate various play scenarios.

These systems evaluate players' abilities across multiple stages of talent identification. Scholars highlight five crucial steps in this process: detection, identification, confirmation, selection, and development (Vaeyens et al., 2008; Williams & Reilly, 2000). AI facilitates more precise talent detection by analyzing biomechanics, skill execution, and future performance potential. It enables teams to make data-driven decisions, ensuring strategic recruitment and long-term success in team formation.

Computer Vision Applications in NASCAR

Argo AI, in collaboration with Ford Motor Company, has leveraged deep learning techniques originally developed for autonomous driving and applied them to improve safety in NASCAR motor racing. Their system uses a neural network trained on thousands of images to identify individual vehicles, even under challenging conditions such as motion blur caused by high-speed racing.

This AI model has proven proficient of outperforming human observers in identifying specific race cars during events. Its application is especially vital for promptly detecting malfunctions, such as overheating or mechanical failures, that could lead to dangerous situations. The AI system helps teams and safety personnel intervene quickly, thereby enhancing driver safety and minimizing race disruptions.

AI Integration in Sports Training Systems

Researchers have also developed AI-driven systems for training and performance enhancement across different sports: Badminton: Lei (2018) created a technical statistics and pace training system using an action recognition algorithm. The system achieved an accuracy rate of 96.7% in identifying player movements, which supports targeted improvements in training. Taekwondo: Liang (2021) applied a support vector machine (SVM) to construct an evaluation model that accurately assesses taekwondo techniques. This model enables scientific simulation-based instruction, correcting errors and enhancing athletes' performance.

Youth Physical Exercise: Du designed a youth physical training system comprising an object inspection module, data analysis module, and body posture determination module. The system estimates posture and provides scientifically grounded feedback, leading to measurable improvements in young athletes' physical health and performance quality. These examples underscore the transformative role of artificial intelligence in modern sports. From real-time decision support and safety enhancement to personalized coaching and talent development, AI continues to revolutionize the way sports are played, managed, and experienced.

Artificial intelligence technologies such as the PIQ Robotic Device, SportVU, AI-assisted refereeing, and advanced scouting systems are renovating sports performance, analysis, and safety. By capturing detailed biomechanical and positional data, these tools enable athletes and teams to optimize training, improve decision-making, and enhance viewer engagement. AI-powered computer vision applications in motorsports further ensure safety by rapidly detecting vehicle malfunctions. Additionally, AI-driven training models in sports like badminton, taekwondo, and youth fitness demonstrate significant potential in refining techniques and promoting physical health. Collectively, these innovations underscore AI's growing impact in revolutionizing sports at all levels.

CONCLUSION

The world is witnessing a transformative impact of Artificial Intelligence (AI) on sports, revolutionizing the way games are played, analysed, and experienced. AI is extensively applied across all aspects of sports and its monitoring activity, enhancing statistics, performance analysis, and game organization. As a hallmark of scientific progress, AI effectively supports athletes, coaches, and sports organizations by improving accuracy in scoring, player movement tracking, performance prediction, and even fan engagement. The rapid evolution of AI technologies empowers teams with advanced tools for talent identification, game preparation, and real-time decision-making. Consequently, AI not only enhances competitive performance but also enriches the overall sports experience for players and fans alike.

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