

Skills Coach

TRAINING MODULE FOR IMPROVING THE TECHNOLOGY LITERACY SKILLS OF COACHES

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Introduction

Increasing the technology literacy levels of sports coaches has become an important requirement in today's rapidly developing digital world. While the impact of technology on the sports field is increasing gradually, it is of critical importance for coaches to be able to use these technological tools effectively and support the performance and development of athletes.

This training module is designed to increase the technology literacy of sports coaches and better adapt them to today's digital world. The module consists of different sub-modules and each of them aims to enable coaches to gain knowledge and skills in a specific topic.

Video Analysis:

In this submodule, coaches will learn how video analysis tools can be used. Video analysis provides great benefits in re-watching matches and training sessions, analysing players' movements and making tactical decisions.

Performance Tracking:

This submodule will introduce technological tools that coaches can use to track athletes' performance. Performance tracking helps to monitor and analyse athletes' fitness, physical measurements, pulse and other important data.

Mobile Devices and Wearable Technologies:

In this submodule, coaches will learn how mobile devices and wearable technologies can be used in training processes. Smartphones, tablets, smart watches and other wearable devices provide important tools for athletes to track their training, save data and improve their performance.

Artificial Intelligence and Machine Learning:

In this submodule, coaches will explore how artificial intelligence and machine learning technologies can be used in sports training and performance analysis. Artificial intelligence and machine learning offer important support to coaches in data analysis, forecasts and strategic decisions.

Virtual and Augmented Reality:

This submodule will allow coaches to learn how to use virtual and augmented reality technologies. Virtual and augmented reality offer important opportunities to simulate training sessions visualize tactics and enhance the experience of athletes.

Social media:

This submodule will enable coaches to use social media effectively. Social media platforms allow coaches to interact with their athletes and fans, share content and increase their follower base.

Cyber Security:

This submodule aims to increase the awareness of coaches about cyber security. Sports teams and coaches should take measures to ensure the security of digital data and communications and protect against cyber-attacks.

Cloud Computing:

This submodule allows coaches to learn how to use cloud-computing technologies. Cloud computing provides flexibility and accessibility to coaches in data storage, sharing and collaboration.

Data Management:

This submodule allows coaches to learn how to manage athletes' data effectively. Data management is important for tracking, analysing the performance of athletes and supporting future decisions.

Information Technologies (ICT):

This submodule allows coaches to understand and use basic information technologies. Topics such as computer skills, data analysis, and software usage and communication tools are covered.

Esports:

This submodule allows coaches to understand esports and use technological tools related to this field. Esports is a sport based on competitive video games and requires coaches to have knowledge of game analysis, strategy development and team management.

This training module offers sports coaches the opportunity to develop their technology literacy skills and explore the potential of technology in sports. Each sub-module aims to enable trainers to gain knowledge and skills in a specific technology area. Coaches who complete the module will increase their ability to support their team's performance and the development of their players by using technology effectively.

Key Terms

Video analysis: The process of analysing player performance using game or training recordings.

Performance tracking: The process of evaluating the performance of the players by monitoring their physical and statistical data.

Mobile devices: Portable electronic devices, such as smartphones and tablets.

Wearable technologies: Electronic devices worn or worn on the body, such as smart watches and fitness bands.

Artificial intelligence: The ability of computer systems to have human-like intelligence.

Machine learning: The ability to self-develop and learn through data analysis of computer systems.

Virtual reality: Simulated virtual worlds created using computer technology.

Augmented reality: Technology that provides interactive experiences in an environment where the real world and virtual objects are combined.

Social media: User content sharing and interaction through platforms on the Internet.

Cyber security: Protection of computer systems and networks against cyber-attacks and ensuring data security.

Cloud computing: A service model that provides access to shared information and resources available on the Internet.

Data analysis: The process of analysing and transforming data into meaningful information.

Data visualization: Presenting and understanding data in graphical, tabular or visual formats.

E learning: The distance education process carried out in electronic environment.

Application development: The process of creating customized software or mobile applications.

Biomechanics: It is the discipline that scientifically analyses the movements and forces of the body. In sports training, it is aimed to improve the techniques and movements of the athletes by using biomechanical principles.

Camera Angle: It refers to the angle of the camera position used to view an event or motion. Different camera angles allow capturing and analysing images from different perspectives.

Clip: In video analysis software, a short piece of video that represents a particular event or movement. For example, to analyse a shot by a basketball player, a clip can be created at the time of the shot.

Frame: In video analysis, it refers to a single image displayed in one second. A video contains multiple frames per second, and each frame captures the current state.

Performance Metrics: These are the criteria used to measure the performance of athletes or teams. For example, performance can be evaluated using performance metrics such as sprint speed, pass percentage, scoring rate.

Slow-Motion (Slow Motion): It is the playback of video images at a slower than normal speed. Slow motion replays are used to analyse and examine a particular movement or event in more detail.

Timeline: A graphic or interface in video analytics software that represents the segments and timeline of a video. Used to mark specific events on the timeline, create clips, and navigate quickly.

Data Sharing: The process of sharing video analysis results, data and analysis with other coaches, players or analysts by sports coaches and team members. Data sharing is an important tool for team collaboration and strategy development.

Telestration: A telestrator is a device that allows its operator to draw a freehand sketch over a motion picture image

1 Video Analysis

Video analysis has become an integral part of sports coaching and performance analysis, providing valuable insights into player and team performance. By utilizing recorded video footage, coaches and analysts can assess and enhance various aspects of the game. Here are some key points to understand about video analysis in sports:

Capture and Recording: High-definition cameras and specialized recording equipment are used to capture video footage from multiple angles during games and practices.

Analysis Software: Sports-specific video analysis software programs are widely used in the field. Examples include SportsCode, Dartfish, and Nacsport, which offer features such as frame-by-frame analysis, tagging, and annotation tools.

Performance Evaluation: Video analysis allows coaches to evaluate individual and team performance by reviewing specific game segments or player actions. It helps identify strengths, weaknesses, and areas for improvement (Cortes et al, 2011).

Tactical Analysis: Video analysis is a powerful tool for tactical analysis and game planning. Coaches can study opponents' strategies, identify patterns, and develop effective game plans based on the insights gained from video analysis (O'Donoghue, 2009).

Skill Development: Video analysis aids in skill development by providing visual feedback. Coaches can analyse technique, correct errors, and provide targeted guidance to athletes using slow-motion replays, side-by-side comparisons, and telestration tools.

Communication and Collaboration: Video analysis software facilitates communication and collaboration among coaches, players, and support staff. It allows for the sharing of video clips, creating playlists, and providing feedback, even in remote settings (Zhang et al., 2020).

Video analysis has significantly affected sports coaching and performance analysis, enabling coaches to evaluate and improve player performance, devise effective game strategies, and enhance skill development.

1.1. Examples of how video analysis is utilized in different sports:

Football: Video analysis is extensively used in soccer to evaluate team tactics, individual player performance, and opponent scouting. Coaches and analysts review match footage to analyse player positioning, movement patterns, passing accuracy, shooting techniques, and defensive strategies. **Basketball:** In basketball, video analysis helps coaches and players break down offensive and defensive strategies. It involves analysing shooting techniques, shot selection, player movement off the ball, pick-and-roll execution, defensive rotations, and opponent tendencies. This information helps teams develop game plans and make effective adjustments. **Tennis:** Video analysis plays a crucial role in tennis for stroke analysis, technique refinement, and strategy development. Coaches study recorded matches or practice sessions to analyse player footwork, shot selection, and serve techniques, court coverage, and decision-making under pressure. This feedback aids in making necessary adjustments to improve performance.

Gymnastics: Video analysis is widely employed in gymnastics to assess form, technique, and execution of routines. Coaches review video footage to analyse body alignment, flexibility, balance, precision, and transitions between skills. This analysis helps gymnasts refine their routines and achieve higher scores.

Swimming: Video analysis is used in swimming to improve stroke mechanics, starts, turns, and overall technique. Coaches record swimmers during training sessions and races to analyse body position, arm movement, kick technique, and streamline efficiency. This feedback assists swimmers in making adjustments for improved performance.

1.2. Useful Resources and Links

Websites

Hudl: Hudl (<https://www.hudl.com/>) is a popular video editing, sharing, and analysis platform for athletics performance analysis. It offers attributes such as annotation, drawing tools, and customizable reports, making it a valuable resource for teams and coaches in all sports.

Catapult Sports: Catapult Sports specialises in athlete monitoring and performance analytics (<https://www.catapultsports.com/>). They provide wearable technology solutions that integrate video analysis with performance data to provide comprehensive insights into athlete performance, movement patterns, and workload.

Dartfish: Dartfish (<https://www.dartfish.com/>) offers video analysis solutions for evaluating athletic performance. Their software offers features such as slow-motion playback, drawing tools, and side-by-side video comparisons that enable users to document, analyse, and compare videos.

Videos

LiveTag.Pro - Sports Video Analysis System

<https://www.youtube.com/watch?v=J8HFnBCzsgY>

Football Video Analysis

<https://www.youtube.com/watch?v=NbuqD6cITBM>

Why use video analysis in sport?

<https://www.youtube.com/watch?v=jZSzjNmotoY>

What is Video Analysis?

<https://www.youtube.com/watch?v=NWD8rqtMN1g>

Other Resources

The Use of Video Analysis to Improve Performance

<https://digitalcommons.gardner-webb.edu/cgi/viewcontent.cgi?article=1102&context=education-dissertations>

Multimedia and Video Analysis for Sports

https://www.researchgate.net/publication/238486282_Multimedia_and_Video_Analysis_for_Sports

A Comprehensive Study of Sports Video Analysis

https://link.springer.com/chapter/10.1007/978-3-642-19551-8_15

Sports Technology Blogs: Websites such as SportsTechie (<https://www.sporttechie.com/>) and Sports Geek (<https://sportsgeek.com.au/>) host current news, articles, and opinions on sports technology. These blogs cover a wide variety of topics, including the latest trends, case studies and interviews with industry experts.

Sports Analytics Conferences: Attending sports analytics conferences and workshops gives valuable insight into video analytics in sports. Events such as the MIT Sloan Sports Analytics Conference (<https://www.sloansportsconference.com/>).

Courses

How to Create an Effective Football (Soccer) Analysis Video

<https://www.udemy.com/course/how-to-create-an-effective-football-soccer-analysis-video/>

Soccer Video Analysis with Nacsport

https://www.nacsport.com/courses.php?p=228&lc=en-gb&course=Soccer_Video_Analysis_with_Nacsport

2 Performance Tracking

Performance tracking in sports has become an essential aspect of training and development for athletes. With advancements in technology, coaches and athletes now have access to a wide range of tools and systems that can capture and analyse performance data in real-time. These systems provide valuable insights into an athlete's strengths, weaknesses, and overall performance, enabling targeted training and performance enhancement.

Wearable Technology: Wearable devices such as smartwatches, fitness trackers, and sensor-equipped garments have revolutionized performance tracking. These devices can monitor various metrics like heart rate, speed, distance covered, acceleration, and even body movements. They provide athletes and coaches with immediate feedback during training sessions and competitions, helping optimize performance and prevent injuries. (James & Petrone, 2016)

Video Analysis: Video analysis software plays a vital role in performance tracking and improvement. Coaches can capture and review footage of athletes in action to identify technical flaws, analyse movement patterns, and evaluate performance in different scenarios. Advanced video analysis tools offer features like slow-motion playback, frame-by-frame analysis, and side-by-side comparisons, providing valuable insights for skill development. (Zheng & Zhang, 2022)

Biomechanical Analysis: Biomechanical analysis involves measuring and interpreting forces and movements in an athlete's body. This analysis helps identify inefficient movement patterns, muscle imbalances, and areas of improvement. Technologies like motion capture systems, force plates, and 3D modelling software enable detailed analysis of an athlete's biomechanics, leading to targeted interventions and improved performance. (Zatsiorsky, 2008)

Performance Dashboards: Performance tracking often involves the use of customized dashboards or software platforms that consolidate and present data in a user-friendly manner. These dashboards can display key performance indicators, training load, injury risk factors, and other relevant metrics. Coaches and athletes can track progress over time, set goals, and make data-driven decisions to optimize training and performance outcomes. (Yigitbasioglu & Velcu, 2012)

GPS Tracking: Global Positioning System (GPS) technology is widely used in team sports to track and analyse player movements during training sessions and games. GPS trackers worn by athletes capture data on speed, distance covered, acceleration, deceleration, and changes in direction. This information helps coaches tailor training sessions, optimize team tactics, and monitor workload to prevent overtraining and injuries. (Torres-Ronda et al., 2022)

Artificial Intelligence (AI) and Machine Learning: AI and machine learning algorithms are increasingly being applied to performance tracking in sports. These technologies can analyse large datasets, detect patterns, and provide insights that might not be evident to the human eye. AI-powered systems can predict injury risks, optimize training plans, and even simulate game scenarios to aid decision-making. (Novatchkov & Baca, 2013).

In conclusion, performance tracking in sports has evolved significantly with the integration of technology. Wearable devices, video analysis, biomechanical analysis, performance dashboards, GPS tracking, and AI are some of the key components that facilitate data collection, analysis, and feedback for athletes and coaches. By harnessing the power of these technologies, athletes can gain a competitive edge and optimize their performance on the field.

2.1. Examples of how performance tracking is utilized in different sports:

Football:

- Players' running distances, speeds and changes in direction are tracked with GPS tracking devices.
- Databases containing statistics such as the number of ball touches, pass percentage and shot accuracy are used.

Basketball:

- Positions, speeds and shooting angles of players are monitored with motion capture systems (Sampaio, 2022).
- Score contribution, the number of assists and turnovers of players are tracked.

Athletics:

- Sprint times, acceleration and deceleration times are tracked with speedometers.
- Force platforms are used to evaluate jump performance.

Swimming:

- Swimmers' speeds, turn times and body positions are monitored with water resistance sensors (Mujika & Crowley, 2019).
- Underwater cameras are used to analyse technical errors in swimming style (Veiga et al., 2016).

Tennis:

- Players' service techniques, hit mechanics and mobility are examined with video analysis (Le Noury et al., 2021).
- Special tennis analysis software is used where score analytics and statistics are tracked (O'Donoghue, 2014).

2.2. Useful Resources and Links

Websites:

Sports Technology Blog: <https://www.sportstechnologyblog.com/>

Catapult Sports: <https://www.catapultsports.com/>

PlayerTek: <https://www.playertek.com/>

Polar: <https://www.polar.com/> Polar

Firstbeat: <https://www.firstbeat.com/>

Performance Tracking in Professional Football: <https://www.isspf.com/performance-tracking-in-professional-football/>

Top 5 Benefits Of Athlete Performance Tracking: <https://www.chetu.com/blogs/sports/top-5-benefits-of-athlete-performance-tracking.php>

<https://sportstechworldseries.com/wp-content/uploads/2021/02/Sports-Tech-Annual-Chapter-7-Athlete-Performance-Tracking.pdf>

Smart Measurement Technology for Quantifying Performance in Sport

https://research-repository.griffith.edu.au/bitstream/handle/10072/385130/Shepherd,%20Jonathan_Final%20Thesis_redacted.pdf?sequence=1

Assessments-for-Sport-and-Athletic-Performance

<https://www.upss.it/wp-content/uploads/2019/11/David-H.-Fukuda-Ph.D.-Assessments-for-Sport-and-Athletic-Performance-Human-Kinetics-2019.pdf>

Videos:

Sportstechie: <https://www.youtube.com/c/SportTechie>

Polar: <https://www.youtube.com/c/PolarGlobal>

Catapult Sports: <https://www.youtube.com/user/CatapultSports>

Courses:

Sports Performance Analytics Specialization

<https://www.coursera.org/specializations/sports-analytics>

Sports Management: Strategy and Performance

<https://www.udemy.com/course/sports-management-strategy-and-performance/>

Electronic Performance & Tracking Systems in Sports Level 1

<https://majorsportsconsultancy.com/courses/electronic-performance-tracking-systems-seminar-13-14-july-2022/>

3 Mobile Devices and Wearable Technologies

Mobile Devices and Sports Performance

Mobile devices support athletes to monitor and analyse their performance during training and competitions. For example, smartphones and tablets can be used with applications for tracking and analysing training data. These apps allow athletes to record training time, distance, and speed and calorie burn. Thus, athletes can plan their training more effectively and monitor their performance (Peart et al., 2019).

In addition, mobile devices also help athletes to provide feedback and increase their motivation. Athletes can track their progress in reaching their goals through training apps and set goals to improve themselves. Some applications allow athletes to optimize their performance by providing audio feedback during training (Kranz et al., 2013).

Wearable Technologies and Sports Performance

Wearable technologies allow athletes to monitor and analyse their performance through sensors and devices worn on their bodies. These technologies include smartwatches, activity trackers, heart rate monitors, and sleep trackers. These devices allow athletes to monitor heart rate, step count, sleep quality and stress levels (James & Petrone, 2016).

Wearable technologies are also capable of providing real-time feedback to improve the training performance of athletes. For example, heart rate monitors in smartwatches help athletes optimize their exercise intensity by monitoring their heart rate during training. In this way, athletes can train more efficiently and improve their performance (Aroganam et al., 2019).

Mobile devices and wearable technologies provide significant benefits in the field of sports. Athletes monitor their performance, analyse training data and monitor their health status through these technologies. Mobile devices and wearable technologies provide feedback to athletes; increasing their motivation and helping them optimize their performance. Therefore, the development of sports technologies offers great potential to individuals who want to improve the performance of athletes and adopt a healthier lifestyle.

3.1. Examples of how mobile devices and wearable tech are utilized in different sports:

Football

Mobile Devices: Mobile devices are used to increase football performance and reduce the risk of injury. For example, apps on smartphones or tablets help football player's record and analyse their training data. This data allows football players to track their running distance, speed and pass rates.

Wearable Technologies: Wearable technologies designed specifically for football players play an important role in performance monitoring and injury prevention. For example, smart jersey technologies help football players optimize their performance during training by tracking heart rate, temperature and oxygen levels. In addition, these technologies provide real-time analysis of body mechanics and movement to reduce the risk of injury (Ingwersen et al., 2022).

Basketball

Mobile Devices: Basketball players use mobile devices to monitor and improve their performance in training and matches. For example, apps on smartphones allow basketball players to record shooting percentage, offensive and defensive statistics, turnovers and rebounds. Thus, basketball players can plan their training more effectively and analyse their performance (Suwarno & Derrick, 2022).

Wearable Technologies: Wearable technologies in basketball are widely used to monitor the performance of athletes and reduce the risk of injury. For example, smart wristbands or smart watches help basketball players control their exercise intensity during training by tracking their heart rate. In addition, ankle bracelets help basketball players improve their jumping abilities by analysing jump data (Bai, et al., 2016).

Swimming

Mobile Devices: In swimming, mobile devices are used to record and analyse swimmers' training data. For example, waterproof smartwatches or swimming apps allow swimmers to track swimming time, distance, speed, and swimming technique. Thus, swimmers can optimize their training and monitor their performance.

Wearable Technologies: Wearable technologies designed specifically for swimming are used to increase swimmers' performance and improve their training. For example, smart swimming goggles can monitor swimmers' diving data and swimming technique in real time. In this way, swimmers can optimize their diving positions and perform swimming movements more effectively (Morais et al., 2022).

3.2. Useful Resources and Links

Websites:

Wearable Technologies URL: <https://www.wearable-technologies.com/>

Sports Engineering URL: <https://www.sportsengineering.org/>

Wareable: <https://www.wareable.com/>

SportsTechie: <https://www.sporttechie.com/>

The Future Of Wearable Technology For Athletes: <https://devonsoftware.com/blog/the-future-of-wearable-technology-for-athletes/>

Videos:

The Wearable Device That Avoids Injuries Through Technology | The Tech Races

<https://www.youtube.com/watch?v=Rk1UaLLyl-0>

Xampion - Wearable Sports Tech for Future Champions

<https://www.youtube.com/watch?v=dlyhUE1Jtgs>

The Future of Football: Wearable Technology

<https://www.youtube.com/watch?v=Jmn5dfZX1u4>

The Wearable Device That Avoids Injuries Through Technology | The Tech Races

<https://www.youtube.com/watch?v=Rk1UaLLyl-0>

Courses:

Wearable Technology : Smart phones to sports monitoring
<https://www.udemy.com/course/wearable-technology-smart-phones-to-sports-monitoring/>

Wearable Technologies and Sports Analytics

<https://www.classcentral.com/course/wearable-technologies-48072>

Wearable Technologies and Sports Analytics

<https://www.shiksha.com/online-courses/wearable-technologies-and-sports-analytics-course-courl3846>

Mobile/Wearable Programming

<https://www.ntnu.edu/studies/courses/IMT3673/2018/1#tab=omEmnet>

4 Artificial intelligence (AI) and Machine learning

Artificial intelligence (AI)

Artificial intelligence (AI) refers to the ability of computer systems to have human-like intelligence. This technology enables computers to perform tasks using intelligence capabilities such as data analysis, pattern recognition, decision-making and problem solving. Artificial intelligence algorithms improve their ability to learn and predict using large data sets. Artificial intelligence is a technology that has a significant impact in the field of sports. The use of artificial intelligence in the field of sports has been successfully applied in many areas such as performance analysis, training planning, injury prevention, data analysis and tactical development (Chase, 2020).

Sports Performance Analysis

Artificial intelligence has become an important tool for sports performance analysis. For example, in team sports such as football, artificial intelligence algorithms can evaluate the performance of players by analysing their movements (Yang, 2020). These analyses evaluate factors such as players' speed, positioning abilities, ball control and passing skills and support coaches' tactical decisions.

Training Planning and Performance Improvement

Artificial intelligence is also used effectively in planning training programs and improving performance. Machine learning algorithms can create personalized training programs by analysing the physical condition and performance of athletes (Wei et al., 2021). In this way, it is aimed to strengthen the athletes, increase their endurance and improve their performance.

Injury Prevention and Rehabilitation

Artificial intelligence is a tool used to reduce the risk of injury to athletes and optimize rehabilitation processes. With data analysis and machine learning techniques, it tracks the loads that athletes are exposed to during training and matches and identify periods with high risk of injury (Ramkumar et al., 2022). In addition, AI-based systems can monitor the progress of athletes and offer customized treatment plans in post-injury rehabilitation processes.

Data Analysis and Tactics Development

In the field of sports, artificial intelligence is also used in the analysis of large amounts of data and in the development of tactics. Artificial intelligence algorithms can evaluate the performance of teams and players by analysing match data and offer tactical recommendations (Araújo et al., 2021). In this way, coaches are better informed in their decision-making processes and can optimize their strategies.

It makes significant contributions in many areas such as the use of artificial intelligence in the field of sports, performance analysis, training planning, injury prevention and data analysis. This technology has become a powerful tool for improving the performance of athletes and teams, making data-driven decisions and developing tactics. With future research and development, the use of artificial intelligence is expected to become more widespread in the field of sports.

Machine learning

Machine learning refers to the ability of computer systems to learn from data. This allows computers to extract information by discovering patterns from data without depending on programming instructions. Machine learning algorithms work based on large amounts of data and use that data to build models, make predictions or make decisions. This approach draws on areas such as statistical methods, artificial intelligence, and data mining. Machine learning is applicable in many different fields and is an ever-evolving field. Machine learning has become an effective tool in many areas such as data analysis, performance prediction, training planning and tactical development in the field of sports.

Performance Estimate

Machine learning is a tool used to predict the performance of athletes and teams. For example, in team sports such as football, machine-learning algorithms can predict the future performance of players by analysing historical performance data (Musa et al., 2020). These predictions can play an important role in coaches' transfer decisions and game strategies.

Data Analysis and Trend Analysis

Machine learning is a method used to analyse sports data and reveal trends. Large amounts of data collected in sporting events are analysed through machine learning algorithms to optimize game strategies and improve performance (Richter et al., 2021). For example, a team's performance data from past matches can be analysed using machine learning techniques and the team's strengths and weaknesses can be identified.

Training Planning and Personalization

Machine learning is a tool used to customize training planning for athletes. Personal training programs can be created by analysing factors such as athletes' physical condition, performance data and injury history through machine learning algorithms (de Leeuw et al., 2022). In this way, it is aimed to strengthen the athletes, increase their endurance and improve their performance.

Injury Prevention and Rehabilitation

Machine learning is a tool used to reduce the injury risk of athletes and optimize their rehabilitation processes. Analysis of the loads that athletes are exposed to in training, matches, and injury data can be processed with machine learning techniques and periods with a high risk of injury can be determined (Van Eetvelde et al., 2021). In addition, in post-injury rehabilitation processes, machine learning-based systems can monitor athletes' progress and offer customized treatment plans.

Machine learning plays an important role in sports, including data analysis, performance prediction, training planning and injury prevention. This technology has become a powerful tool for improving the performance of athletes and teams, making data-driven decisions and optimizing their strategies. With future research and development, the use of machine learning is expected to become more widespread in the field of sports.

4.1. Examples of how AI and machine learning are utilized in different sports:

Football

Football is one of the sports branches in which artificial intelligence and machine learning techniques are used most frequently. For example, artificial intelligence algorithms can support video analysis techniques used in football matches. These analyses can evaluate players' positioning abilities, passing skills, and goal-scoring probability (Zheng et al., 2022). In addition, machine learning can be used to analyse the tactics of the teams and to predict the strategies of the opposing teams.

Basketball

Basketball is another important application area of artificial intelligence and machine learning techniques. For example, position-tracking systems used in basketball matches can be developed with artificial intelligence algorithms. These systems generate statistical data by tracking the movements of the players and help coaches to optimize their game strategies (Yao, 2021). In addition, large amounts of data collected from basketball players can be analysed with machine learning algorithms to make performance predictions.

Tennis

Tennis is a branch of sports that also deals with artificial intelligence and machine learning applications. For example, systems that track pickup speed, angle of attack and player movements used in tennis matches can be developed with artificial intelligence algorithms. These systems support the tactical decisions of coaches by analysing the performance of the players (Wilkins, 2021). In addition, machine-learning algorithms can predict future match results by analysing the playing styles of tennis players.

Swimming

Swimming is a sport branch where artificial intelligence and machine learning applications are increasing. For example, artificial intelligence algorithms can support video analysis systems used in swimming races. By tracking swimmers' movements, these systems can evaluate technique and offer recommendations to improve performance (Chen & Hu, 2023).

In addition, data from swimming races can be analyzed with machine learning algorithms and used to predict swimming performance.

4.2. Useful Resources and Links

Websites

How Artificial Intelligence is Transforming the Sports Industry?

<https://imagination.net/blog/ai-in-sports-industry/>

Artificial Intelligence and Machine Learning in Sport Research: An Introduction for Non-data Scientists

<https://www.frontiersin.org/articles/10.3389/fspor.2021.682287/full>

Artificial Intelligence (AI) in Sports

<https://www.sportperformanceanalysis.com/article/artificial-intelligence-ai-in-sports>

Machine Learning in Sports Analytics & Predictions

<https://intellectdata.com/machine-learning-in-sports-analytics-predictions/>

Videos

AI Simplified: Sports Analytics

<https://www.youtube.com/watch?v=yjjuy7Xn6Oo&t=7s>

How artificial intelligence is penetrating sports

<https://www.youtube.com/watch?v=Gme1WHCoKfM&t=2s>

Football Analytics | Deep Learning | Computer Vision | Artificial Intelligence

<https://www.youtube.com/watch?v=GrAdGgr7shU>

How the World Cup's AI instant replay Works

<https://www.youtube.com/watch?v=C164kYMGV1A>

Courses

Introduction to Machine Learning in Sports Analytics

<https://www.coursera.org/learn/machine-learning-sports-analytics>

AI in Sports with Python (Full Video Course)

<https://ai-learning.vhx.tv/products/ai-in-sports-with-python>

5 Virtual and Augmented Reality (VR)

Virtual Reality (VR): Virtual reality provides an experience where the user is completely disconnected from the real world and immersed in a completely virtual environment. VR is usually performed using a special virtual reality headset. These glasses allow the wearer to enter a completely different environment, visually and sometimes audibly. VR provides a realistic experience with simulations powered by 360-degree video and audio.

Augmented Reality (AR): Augmented reality is a technology that enriches the real world with computer-generated graphics, sounds, or other perceptual stimuli. AR is often experienced through devices such as smartphones, tablets or special glasses. This technology detects the real world image and adds additional information, graphics or animations to it.

Virtual reality and augmented reality are technologies that offer new and exciting possibilities in the world of sports. It is used in many areas such as training, performance, and rehabilitation and spectator experience in the field of sports, providing interactive and realistic experiences for both athletes and spectators.

Virtual and Augmented Reality (VR/AR) are technologies that are increasingly used in the sports world. These technologies provide immersive experiences for both athletes and spectators. Research and reviews show that VR/AR offers potential benefits in many areas, including training and performance enhancement, injury rehabilitation, spectator experience, and tactical analysis.

VR/AR technologies support athletes to optimize their training. Virtual reality environments can simulate real-world conditions for athletes, making their training more realistic. For example, football players can pass on a virtual court or basketball players can shoot into a virtual basket. This allows athletes to develop certain skills and have a realistic experience before competitions (Neumann et al., 2018).

In addition, VR/AR technologies support the injury rehabilitation process of athletes. Virtual reality helps athletes regain their mobility and strength after injury. Physiotherapists make the rehabilitation process more effective by enabling athletes to make controlled movements in virtual environments (Chen., 2021).

VR/AR technologies also offer significant opportunities for the audience. Virtual reality glasses or augmented reality applications allow spectators to experience sporting events more interactively. For example, a spectator watching a football match with virtual reality glasses can watch the match from the perspective of the players on the field or access statistical information with augmented reality applications (Gradl et al., 2016).

At the same time, VR/AR technologies are also used in sports training and tactical analysis. Coaches can train their teams in virtual environments and test their tactical decisions on simulations. This enables teams to develop better strategies and increase the ability of players to work together (Cannavo et al., 2018).

As a result, VR/AR technologies are used in many areas in the sports world. It has potential benefits in areas such as training and performance improvement, injury rehabilitation, spectator experience and tactical analysis. These technologies allow athletes to hone their skills, assist with post-injury recovery, and enable spectators to experience sporting events more interactively.

5.1. Examples of how VR and AR are utilized in different sports:

Basketball:

Virtual reality (VR) and augmented reality (AR) technologies have various uses in basketball. For example, using VR, basketball players can pass, shoot and practice game strategies on a virtual court. In addition, augmented reality applications provide a richer viewer experience by showing the stats of the players, the live score and even the instant targeting to the viewers during the basketball matches.

Football:

VR and AR technologies also have significant potential in football. The use of VR in football training is effective in improving the passing skills and decision-making abilities of the players. In addition, augmented reality applications enrich the spectator experience by enabling the spectators to quickly view the statistics, positions and tactical information of the players during football matches.

Tennis:

VR and AR technologies also have potential in tennis. For example, in a study, it was shown that VR simulations provide an opportunity to analyse the movements of tennis players and improve their performance (Covaci et al., 2012). In addition, augmented reality applications provide a more comprehensive audience experience by showing the players' serving speed, hitting angles and match statistics to the audience during tennis matches (Rogers et al., 2017).

Swimming:

VR and AR technologies are also used in swimming. In one study, it was found that swimmers improved their technique more effectively by sensing water resistance with VR simulations (Kittel et al., 2020). In addition, augmented reality applications provide a more engaging spectator experience by showing the performance statistics, records and swimming routes of swimmers in swimming races (Fortes et al., 2021).

5.2. Useful Resources and Links

Websites

What are the best practices for implementing VR and AR in sports training and fan engagement?

<https://www.linkedin.com/advice/0/what-best-practices-implementing-vr-ar-sports>

Transforming Sports Through Virtual Reality and Augmented Reality

<https://vection-technologies.com/solutions/industries/sports/Applications-of-Augmented-And-Virtual-Reality-In-Sports>

<https://www.analyticssteps.com/blogs/applications-augmented-and-virtual-reality-sports>

Virtual reality for sports: Fad or game-changer?

<https://www.scienceforsport.com/virtual-reality-for-sports-training/>

Videos

QBSIM: Revolutionary Tech For Training Quarterbacks

https://www.youtube.com/watch?v=4xbAi_h7taw&t=110s

Sports training tools embrace virtual reality

<https://www.youtube.com/watch?v=8n8mNrxzWBk&t=69s>

VIVE TALK - How to Boost Athletic Performance with VR

<https://www.youtube.com/watch?v=IKbY73BStgE>

Courses

VR and 360 Video Production

<https://www.coursera.org/learn/360-vr-video-production>

Foundations of AR

<https://www.coursera.org/learn/foundations-of-ar>

6 Social Media

Social media are an online platforms created for users to share information, ideas and content, interact and communicate on the internet. Social media platforms allow users to share different types of content such as text, photos, and videos and audio. Facebook, Twitter, Instagram, YouTube, Tik Tok, Snapchat, etc. are among the popular social media platforms in the sports world. These platforms have millions of users and enable athletes, clubs and federations to reach a wide audience.

Social media plays an important role in the sports world in areas such as communication, marketing, brand building and fan engagement. The effective use of social media by athletes and clubs allows them to build a large audience of followers, increase brand value and expand their fan base.

Social media has made a big impact in the sports world in recent years. Athletes, clubs, federations and fans have found the opportunity to communicate, share content and interact using social media platforms.

The Impact of Social Media on Athletes: Social media has become an important tool for athletes to build their personal brands and interact directly with their fans. Social media provides athletes with the opportunity to reach a wide audience, create sponsorship opportunities and market themselves (Filo et al., 2015). For example, world-famous athletes such as Cristiano Ronaldo and LeBron James reach millions of followers and strengthen their own brands by using social media effectively (Newman et al., 2017).

The Impact of Social Media on Clubs and Federations: Football clubs, basketball teams and sports federations also use social media successfully. Social media platforms are an effective tool for clubs to increase fan loyalty, increase brand awareness and interact with fans (Geurin, 2023). For example, major football clubs such as FC Barcelona and Manchester United actively use social media to interact with their followers and share up-to-date information about matches, transfer news and club events (Sanderson, 2013).

The Impact of Social Media on Fans: Social media has also changed the way sports fans interact and share content. Fans can express their feelings, support their teams and interact with other fans through social media platforms during the match (Boyle & Haynes, 2014). In addition, social media platforms provide a resource for fans to watch match highlights, follow player statistics and keep sports news up to date (Filo et al., 2015).

6.1. Examples of how social media is utilized in different sports:

Football: Social media has a huge impact on the football world. For example, Barcelona Club announces team news and match scores via its official Twitter account and effectively reaches its fans (Barcelona Club, 2022). In addition, football players use social media effectively. For example, Cristiano Ronaldo's Instagram account has millions of followers and shares content from his football career to his background and personal life (Ronaldo, 2021).

Basketball: Basketball is one of the sports branches that use social media effectively. For example, the NBA (National Basketball Association) league actively uses social media to interact with its followers and share content. While the NBA shares the match scores live on its official Twitter account, it shares content such as training videos and match highlights of the players with its followers via its Instagram account (NBA, 2022).

Tennis: Tennis is one of the sports branches that feel the influence of social media. Tennis players interact with their fans by sharing their matches and training sessions on social media platforms. For example, Serena Williams actively uses her Twitter account to update her tennis career and send thank you messages to her fans (Williams, 2021).

Athletics: Social media plays an active role in athletics as well. Especially big athletic events share the program of the competitions, results and interviews with the athletes on their official accounts. For example, the IAAF (International Association of Athletics Federations) Twitter account provides updates on major events such as world championships and Olympics (IAAF, 2022).

6.2. Useful Resources and Links

Websites

Social Media in Sports: Driving Fan Engagement

<https://www.greenfly.com/blog/social-media-in-sports/>

The impact of social and digital media on sport

<https://www.latrobe.edu.au/nest/the-impact-of-social-and-digital-media-on-sport/>

Social Media in Sports: Trends

<https://kickly.net/articles/social-media-in-sports-trends-2022/>

Videos

The Role of Social Media in Sports Marketing: Why Twitter Matters in Sports Games

<https://www.youtube.com/watch?v=QOkQ73-WuyQ&t=1s>

How To Create a Social Media Plan for Your Sports Team?

<https://www.youtube.com/watch?v=yXsDNzlAOik>

MUST-TRY Social Media Marketing Strategies For Sports Teams With Examples!

<https://www.youtube.com/watch?v=xwggbHGtoXE>

Courses

Digital and Social Media Marketing in Sports: The Essentials

<https://www.udemy.com/course/digital-and-social-media-marketing-in-sports-the-essentials/>

Certificate in Social Media in Sports

<https://elearning.barcainnovationhub.com/product/certificate-in-social-media-in-sports/>

Sport and Social Media

<https://www.griffith.edu.au/study/courses/sport-and-social-media-7334THS#trimester-2-gold-coast-campus>

Football Digital Marketing & Social Media Online Course

<https://www.findamasters.com/masters-degrees/course/football-digital-marketing-and-social-media-online-course/?i1312d-6530c30576>

7 Cyber Security

Cyber security is a discipline that deals with the protection of computer systems, networks, software and data from cyber threats. Cybersecurity uses technology, processes, and applications to prevent or minimize damage caused by hackers, malicious software, data leaks, phishing attempts, and other online threats.

Cyber security covers various methods for ensuring the security of computer networks, servers, personal computers, mobile devices and other information systems. These methods include firewalls, antivirus programs, Decryption, security protocols, security software and security policies. In addition, cybersecurity professionals also use tools such as network monitoring, security analysis, and incident management to detect vulnerabilities in networks, prevent attacks, and quickly intervene in the event of an attack.

Cyber security has become increasingly important today, because with the widespread use of information technologies and the universal access of the Internet, cyber threats have also increased. Sports is a sector where digital technologies are being rapidly adopted, and this situation brings with it cyber security risks.

Data Security

Sports organizations collect a large amount of data, which includes personal and financial information of players and teams. The security of this data needs to be protected from cyber-attacks. For example, the strategic information of a team or the contracts of an athlete may be the target of malicious people. Sports organizations should ensure the security of data by taking cyber security measures such as strong encryption methods, access control and network security measures.

Doping Control

Cyber security in the field of sports also affects doping control processes. Doping test results and athletes' health data are stored digitally. It is important to protect this data against unauthorized access and prevent its manipulation. Cyber security measures are necessary to ensure the reliability and integrity of doping control systems.

Threats at Sporting Events

Sports events are exposed to cyber security threats. For example, large sports organizations or matches may be the target of cyber-attacks. Attackers target organizations with methods such as website crashing attacks, ransomware or fraud attempts. Sports organizations should take measures against these threats by strengthening their security infrastructure and getting support from cybersecurity experts.

Social Media and Personal Data Security

Athletes and teams interact with their followers via social media. However, social media platforms face some difficulties when it comes to protecting users' personal data. Malicious individuals can steal personal data or damage their reputation by targeting the social media accounts of athletes and teams (Greenwald, 2017). Athletes and teams should protect their accounts using strong passwords and configure their privacy settings properly.

In the field of sports, cyber security covers many issues such as data security, doping control, threats at sports events and social media security. Sports organizations, athletes, teams and other stakeholders should ensure data security by taking cyber security measures and protect against cyber-attacks. In addition, cyber security awareness and education are gaining even more importance in the field of sports.

7.1. Examples of how cyber security is utilized in different sports:

Football:

Football is an important sport branch in terms of cyber security. For example, football clubs and federations have to protect players' personal data, financial information and health records. Measures such as strong encryption, secure network structures and user access controls should be taken to combat cyber-attacks (Greenwald, 2017). In addition, football clubs should educate and raise awareness of players and staff against social engineering attacks.

Basketball:

Basketball is also a sport branch that is exposed to cyber security threats. Especially large basketball organizations and teams can be the target of cyber-attacks. For example, there may be threats such as manipulation of match results or theft of players' personal data.

Tennis:

Tennis is also a sport branch that is exposed to cyber security risks. For example, the broadcasting rights of tennis tournaments or ticket sales platforms may be the target of cyber-attacks. Strong security measures should be taken against such attacks and support should be obtained from cyber security experts.

Swimming:

Swimming sport is also important in terms of cyber security. For example, instant results of swimming races or performance data of swimmers may be the target of cyber-attacks. Therefore, swimming organizations and federations should develop secure network infrastructures, data encryption methods and cyber security policies (Greenwald, 2017).

According to sports branches, cyber security applications are important in different sports such as football, basketball, and tennis and swimming. Sports organizations and clubs should take security measures to ensure the security of player data, protect the integrity of competition results, and take precautions against cyber-attacks. This includes various steps such as using strong encryption methods, taking network security measures, and training personnel.

7.2. Useful Resources and Links

Websites:

Why Cybersecurity in Sports Is More Important Than Ever in 2023

<https://research.aimultiple.com/cybersecurity-in-sports/>

The importance of cybersecurity in sports

https://www.sportsmole.co.uk/football/features/the-importance-of-cybersecurity-in-sports_501613.html

The Growing Importance of Cybersecurity in Sports

<https://insights.infrontx.com/the-growing-importance-of-cyber-security-in-sports>

Videos:

Growing Threats of Cybersecurity Attacks in Sports

<https://www.youtube.com/watch?v=Lf4VNjSb9h8>

Global Cyber Security Games - The e-Sports of Hacking!!

<https://www.youtube.com/watch?v=a7TRgQqv4NI>

Cybersecurity is a sport : is your team ready?

<https://www.youtube.com/watch?v=m8OE8YgTlv8>

8 Cloud Computing

Definition of Cloud Computing

Cloud computing refers to the use of computer resources that are accessible and shared over the internet. Sports organizations can use services such as data storage, access to computing power, software applications and collaboration tools through cloud-based services. Cloud computing provides flexibility, scalability and cost savings to sports organizations (Marston et al., 2011).

Data Storage and Sharing

Sports organizations generate large amounts of data and it is important to securely store and share this data. Cloud computing provides large storage capacity to sports organizations and provides easy access to data. For example, training data, player statistics, video recordings and fan information can be securely stored and shared in cloud-based services (Botta et al., 2016). This facilitates data management of sports organizations and increases information sharing.

Data Analytics and Performance Improvement

Cloud computing is a powerful tool for data analytics and performance improvement in sports. Sports organizations can analyse player performance, make tactical decisions and optimize training programs using cloud-based analytics platforms. For example, big data analytics and artificial intelligence techniques are used in cloud-based services to provide in-depth analysis of player data (Botta et al., 2016).

This enables teams to make data-driven decisions to improve their performance and gain competitive advantage.

Security and Privacy

Sports organizations should focus on security measures in cloud computing to protect the security and privacy of data. Data breaches and cyber-attacks can result in sports data being stolen or manipulated. Therefore, sports organizations should take security measures such as strong authentication mechanisms, data encryption, secure network structures and regular data backups (Marston et al., 2011). In addition, details regarding data privacy and security should be specified in contracts with cloud service providers.

8.1. Examples of how cloud computing is utilized in different sports:

Football

Football is one of the most common uses of cloud computing among sports branches. Football clubs can store training data, analyse player performance and make tactical decisions through cloud-based platforms. For example, live match data can be processed in real time using cloud-based analytical tools and coaches can access the data quickly (Murata, et al., 2013). This enables teams to make data-driven decisions to improve their performance and gain a competitive advantage.

Basketball

Basketball is one of the sports branches that actively use cloud computing. Cloud-based analytics platforms help basketball teams monitor and analyse player performance. For example, player statistics, video analytics, and game strategies can be stored and shared in cloud-based services (Li et al., 2021). This allows teams to develop better tactics and improve their performance.

Tennis

Tennis is one of the sports branches that can use cloud computing for data storage and sharing. Cloud-based platforms allow tennis players to store and share training data and match statistics. For example, training videos of tennis players can be securely stored in cloud-based services and shared with coaches. This provides support for tennis players to analyse and improve their performance.

Swimming

The swimming branch can also perform data analytics and performance-tracking using cloud computing. Swimmers' training data and race performances can be stored and analysed on cloud-based platforms. For example, swimming coaches can monitor swimmers' technique using analytical tools in cloud-based services and provide feedback to improve their performance (Su & Yang, 2020).

8.2. Useful Resources and Links

Websites

How cloud computing has transformed the sports industry | Cloud computing and sports

<https://www.mygreatlearning.com/blog/how-cloud-computing-has-transformed-the-sports-industry/>

The Future Of Sports Is In The Cloud

<https://www.forbes.com/sites/forbestechcouncil/2022/05/25/the-future-of-sports-is-in-the-cloud/?sh=3cc2c1ac3540>

Benefits Of Cloud Computing in The Sports Industry - Cloud Computing a Game-Changer

<https://www.cloudride.co.il/blog/benefits-of-cloud-computing-in-the-sports-industry-cloud-computing-a-game-changer>

Videos

Cloud Computing In 6 Minutes | What Is Cloud Computing? | Cloud Computing Explained | Simplilearn

https://www.youtube.com/watch?v=Mg88_fsOSWo

How FOX Sports leverages Google Cloud to give fans more of what they want

<https://www.youtube.com/watch?v=RsaMLBlnFPc>

Courses

Cloud Computing on AWS: Ultimate Beginners Course - 2023

<https://www.udemy.com/course/cloud-computing-on-aws-ultimate-beginners-course-2022/>

Cloud Computing for Beginners

<https://www.futurelearn.com/courses/cloud-computing-for-beginners#:~:text=Cloud%20Computing%20for%20Beginners>

Data Management

Sports produce more and more data every day and it becomes important to manage, analyse and use this data effectively. Therefore, data management technologies in sports are of great importance.

9 Data Collection Technologies

Various data collection technologies are used to collect performance data of athletes, optimize training programs and perform performance analysis. For example, technologies such as GPS devices, motion sensors, heart rate monitors, and body composition analysers collect and record the data that athletes produce during training (Hughes et al., 2019). This data helps coaches and performance analysts evaluate the performance of athletes and customize their training programs.

Data Storage and Processing Technologies

Various technologies are used to store, manage and process sports data effectively. Big data storage and cloud computing technologies offer sports organizations and trainers the opportunity to securely store data (Mahmood & Takahashi, 2015). In addition, databases and data analytics software enable rapid processing and analysis of sports data.

Data Analysis and Visualization Technologies

Data analysis and visualization technologies are used to transform sports data into meaningful information and present them visually. Statistical analysis software, machine learning algorithms and visualization tools are used to analyse sports data, identify trends and visualize performance metrics (Hughes et al., 2019). These technologies help coaches and performance analysts understand data and turn it into action.

In the world of sports, data management technologies play an important role in evaluating the performance of athletes, optimizing training programs and improving team performance. Data collection, storage, analysis and visualization technologies meet the specific needs of sports branches and support data-driven decisions in the field of sports.

9.1. Examples of how data management is utilized in different sports:

Football:

Football teams collect and analyse players' position, speed, distance and passing data via GPS devices and cameras. These data are used to evaluate team performance, optimize tactics and make decisions regarding player development.

Basketball:

Basketball teams collect players' position, speed, bounce and ball contact data with motion sensors and cameras. These data play an important role in analysing player performance, developing tactics and creating match strategies.

Athletics:

In athletics, sensors and cameras are used to measure athletes' data such as height, distance and speed. These data are used to evaluate the performance of athletes, optimize training programs and determine competition strategies.

9.2. Useful Resources and Links

Websites

What is online sports data management, and how can it make managing data more efficient?

<https://www.sport80.com/advice-center/about/what-is-sports-management-software/what-is-online-sports-data-management>

Why Data Management is Important in Sport Today

<https://www.springbord.com/blog/why-data-management-is-important-in-sport-today/>

Understanding Sports Data Analytics Simplified

<https://hevodata.com/learn/sports-data-analytics/Videos>

Australian Institute of Sport | SMARTABASE | Athlete Data Management

<https://www.youtube.com/watch?v=reoyrd7KaQE&t=1s>

Big Data Management in Sports: The Race Is On

<https://www.youtube.com/watch?v=lRhSDkbtgl4>

Data management & analysis: The essentials skills needed for the future S&C coach

<https://www.youtube.com/watch?v=sFa1nBAEUoc>

Courses

Sports Management: Data and Analytics

<https://www.udemy.com/course/sports-management-data-and-analytics/>

Data Analytics in Sports Law and Team Management

<https://www.coursera.org/learn/data-analytics-in-sports-law-and-team-management>

Course in Data Analytics in Sport Online

<https://johancruyffinstitute.com/en/programa/course-in-data-analytics-in-sport-online/#:~:text=Course%20in%20Data%20Analytics%20in%20Sport%20Online>

10. Information and Communication Technology (ICT)

Communication technologies in the field of sports include tools used to ensure effective communication between teams, between teams and fans, and between athletes.

Email and Messaging Apps

Sports teams use e-mail and messaging applications to manage their internal communications. These technological tools accelerate inter-team communication, facilitate information sharing, and provide a constant connection between team members (Ahmed et al., 2020). For example, coaches and athletes can exchange information about training schedules, tactics, and team news.

Video Conferencing Tools

Video conferencing tools that facilitate remote communication are used to ensure effective communication between geographically separated members of sports teams. Coaches, athletes, and other team members can use videoconferencing tools for meetings, strategy sessions, or performance reviews (Groom & Nelson, 2013). In this way, face-to-face communication with remote team members can be established and team collaboration is supported.

Social Media Platforms

Social media platforms allow sports teams to interact with fans and spread team news. Teams communicate with their fans, make match updates and share their opinions through official accounts (Ristevska-Jovanovska, 2016). Social media platforms allow teams to reach a wide audience and increase fan engagement.

Analytics and Data Management Tools

Sports teams make use of various technological tools for performance analysis and data management. For example, wearable devices and sensors are used to monitor the performance of athletes. These tools collect movement data from athletes and help coaches evaluate performance. At the same time, data analytics software and databases enable team performance to be analysed and future strategies determined (Larkin et al., 2018).

Live Streaming and Video Analysis Tools

Live broadcasts of sporting events and video analysis tools allow teams to watch matches, analyse opposing teams and improve their tactics. Technological tools enable instant viewing and analysis of video recordings (Groom & Nelson, 2013). In this way, teams have access to valuable data to analyse their performance, identify errors and make strategic decisions.

Technological tools such as e-mail and messaging applications, video conferencing tools, social media platforms, analytics and data management tools, live broadcast and video analysis tools strengthen the communication of sports teams and increase their performance.

10.1. Examples of how ICT is utilized in different sports:

Football

Football is one of the most popular sports branches and communication technologies are used in various ways in this field. For example, VAR (Video Assistant Referee) technology is used to ensure that decisions are made correctly in matches (Spitz et al., 2021). In addition, football clubs interact and communicate with their fans through mobile applications and social media platforms.

Basketball

Basketball is a global sports branch and communication technologies are used effectively in this field as well. For example, the matches are broadcast live so that the fans can follow them. In addition, strategies are shared and analyzed between coaches and players via video conferences (Callaghan et al., 2018).

Tennis

Although tennis is an individual sport, communication technologies are also used in this field. For example, tennis tournaments can be broadcast live and followed by fans. In addition, data collection and analysis systems are used to monitor and analyse the performances of the players (Gruber, 2014).

Formula 1

Communication technologies are of great importance in motor sports such as Formula 1. Race teams exchange real-time data with their vehicles' data telemetry systems and analyse this data to optimize their performance. In addition, the races are broadcast live and presented to the fans.

10.2. Useful Resources and Links

Websites:

The use of ICT in Sports and Physical Education https://www.lkouniv.ac.in/site/writereaddata/siteContent/202004061919580450aw-dhses_shukla_phy_edu_ICT.pdf

Why Effective Communication in Sports is Key, and How Technology Can Help

<https://leagueapps.com/blog/why-effective-communication-in-team-sports-is-important/#:~:text=The%20importance%20of%20effective%20communication%20in%20team%20sports&text=When%20your%20youth%20sports%20organization,important%20messages%3B%20and%20encourage%20players.>

Issues and Challenges in The Applications Of Information And Communication Technology (ICT) To Human Kinetics And Sports

<https://open.library.okstate.edu/adect2021/chapter/issues-and-challenges-in-the-applications-of-information-and-communication-technology-ict-to-human-kinetics-and-sports/>

Videos:

Athletes and Communication

<https://www.youtube.com/watch?v=y9LiTE4X30g>

Information & Communication Technology (Ict) In Physical Education Lecture-One (M.P.Ed.)

<https://www.youtube.com/watch?v=hwqPGaQpOHg>

Life Lessons Through Sport: Communication

<https://www.youtube.com/watch?v=gwxiPglWRq4>

Courses:

The Complete Course on Sports Media and Communications

<https://www.udemy.com/course/the-complete-course-on-sports-media-and-communications/>

Course Programs in Sport Communication 2023

<https://www.academiccourses.com/courses/sport-communication>

Sports Communication

<https://www.depts.ttu.edu/online/programs/certificates/graduate/sportsCommunication/>

11 E-sports

E-sports (electronic sports) is a sport in which video games are played competitively and there are organized competitions. Professional esports players compete against each other in various video games to win prizes and compete in major tournaments. In recent years, esports has gained immense popularity and has influenced millions of people around the world. Esports has become a rapidly growing industry and has gained a large fan base around the world. The audiences that fill the big arenas, the millions watching the online streams and the huge prize pools show the increasing importance of esports.

History of Esports

Esports emerged with the popularity of arcade games in the 1970s and 1980s (Taylor, 2012). The first esports events started with players coming together and playing competitive games. The widespread use of the internet and the development of gaming technologies in the 2000s enabled esports to undergo a major transformation. Today, the presence of major tournaments, leagues and professional teams demonstrates the institutionalization of esports.

Esports and Game Genres

Esports is built on different genres of video games. Some popular esports game genres include strategy, shooting, war and sports games. For example, games such as League of Legends (LoL), Dota 2, Counter-Strike: Global Offensive (CS: GO), Overwatch and Fortnite host large tournaments with millions of players (Hamari et al., 2017). These games test players' ability to use skill, teamwork and strategy.

Esports and Professional Build

Esports has professional structures just like traditional sports. Major tournaments, leagues and professional teams offer players the opportunity to play and win in a competitive environment. Esports organizations operate based on revenue sources such as sponsorship deals, broadcast rights, and ticket sales (Hamari et al., 2017). In addition, professional esports players generate income through salaries, awards and sponsorship deals.

Effects of Esports

Esports has gone beyond just being a competitive arena and has had a variety of effects. First of all, esports has started to be accepted as a career option among young people. Professional esports players earn income by improving their gaming skills and achieving success in competitive tournaments. In addition, esports events reach and interact with millions of viewers through game streaming platforms and social media (Macey & Hamari, 2019). In addition, the effects of esports on education, technology and business are also examined.

11.1. Examples of how esports are utilized in different sports:

Strategy Games

One of the most popular branches of eSports is strategy games. In these games, players try to beat their opponents by using their strategic planning and resource management skills. For example, StarCraft II has an important place in the strategy games category (Hamari et al., 2017). StarCraft II is known as a game that offers a challenging competitive environment where players make strategic decisions.

Shooting Games

Shooting games are branches of eSports that require speed, reflexes and aiming skills. In the Counter-Strike: Global Offensive (CS:GO) example, players are divided into two teams as terrorists or anti-terrorists and try to fulfill targets or set up bombs (Xue et al., 2019). CS:GO offers a competitive environment built on marksmanship and has become a popular game for professional players to participate in major tournaments.

Sports Games

eSports is also built on sports games. The FIFA series is an eSports version of a game known as a soccer simulation. Players compete using real teams in virtual football matches (Zagata & Strzelecki, 2019). The FIFA series is very popular among football fans and eSports tournaments are organized.

Fighting Games

Another branch of eSports is fighting games. Games such as Street Fighter V, Mortal Kombat, and Super Smash Bros. are popular eSports games where players showcase their fighting skills and try to beat their opponents (Taylor, 2012). These games offer a competitive environment that requires responsiveness, strategy and skill. Esports offers a competitive environment with various video games played in different sports branches. Strategy games, shooting games, sports games and fighting games are among the popular branches of eSports.

11.2. Useful Resources and Links

Websites

Esports

<https://en.wikipedia.org/wiki/Esports>

What are Esports?

<https://hir.harvard.edu/esports-part-1-what-are-esports/>

Esports: everything you need to know

<https://www.techradar.com/news/esports-everything-you-need-to-know>

Videos

What are eSports?

<https://www.youtube.com/watch?v=mozWiUGrzBk>

how to join eSports & become an eSports player

<https://www.youtube.com/watch?v=MDUzYBRC3V4>

Esports is growing into a \$1 billion industry | CNBC Sports

<https://www.youtube.com/watch?v=eohlP84HeMU>

Courses

The complete guide to build & fund an esports organization

<https://www.udemy.com/course/the-complete-guide-to-build-fund-an-esports-organization/>

Esports Specialization

<https://www.coursera.org/specializations/esports>

MOOC The eSports Industry

<https://johancruyffinstitute.com/the-esports-industry/#info>

Conclusion

This training module is designed to improve the technology literacy skills of sports coaches and ensure that they can effectively use the technologies used in the sports field. The module covers important topics such as video analysis, performance tracking, mobile devices and wearable technologies, artificial intelligence and machine learning, virtual and augmented reality, social media, cybersecurity and cloud computing.

Sports coaches who complete this module will have the ability to follow the latest developments in the field of technology and to use video analysis tools effectively to improve the performance of their athletes. Thanks to performance tracking, they will be able to determine the strengths and weaknesses of athletes and make strategic decisions.

Mobile devices and wearable technologies will facilitate the process of collecting and analysing training data and help them manage training programs more effectively. Artificial intelligence and machine learning will contribute to the development of more accurate and targeted strategies by providing sports coaches with data analysis and forecasting capabilities.

Virtual and augmented reality technologies will offer sports coaches a unique experience and enrich their work with training simulations, tactical analyses and visual tools that support player development. Social media will provide coaches with the opportunity to introduce their teams and athletes create supporter networks and strengthen communication.

The topic of cyber security gives sports coaches and teams an awareness of ensuring the security of digital data and protecting against cyber-attacks. Cloud computing, on the other hand, facilitates the work of sports coaches by providing a secure and accessible platform for data storage, sharing and collaboration.

This module aims to enable sports coaches to adapt to technology and work with their athletes more efficiently. They will acquire the necessary knowledge and skills to maximize the performance of their athletes by using video analysis, performance tracking, mobile devices, artificial intelligence, virtual reality and other technological tools.

As a result, this module offers a comprehensive resource to improve the technology literacy of sports coaches and ensure that they can effectively use the technologies used in the field of sports. Sports coaches' adaptation to technology and effective use of technological tools play a critical role in improving the performance of athletes and maintaining their success. This module will help coaches to step into a successful future in the field of sports by increasing their confidence in technology.

Assessment

1. Which of the following sports extensively utilizes video analysis for evaluating team tactics, individual player performance, and opponent scouting?
A) Soccer
B) Basketball
C) Tennis
D) Gymnastics
E) Swimming
2. Which technology is used to analyse forces and movements in an athlete's body for performance improvement?
A) Video analysis
B) Biomechanical analysis
C) Wearable technology
D) Artificial Intelligence
3. How can mobile devices and wearable technologies benefit athletes in their sports performance?
A) They help athletes record and analyse their training data, set goals, and provide feedback.
B) They enable athletes to make phone calls and send text messages during training.
C) They provide entertainment options for athletes during their workouts.
D) They help athletes improve their fashion style with trendy accessories.

4. What is the primary goal of using artificial intelligence (AI) and machine learning in sports?
A) To enhance player communication and teamwork.
B) To improve athletic performance and decision-making.
C) To promote fair play and sportsmanship.
D) To create realistic virtual sports simulations.
5. How can virtual reality (VR) and augmented reality (AR) technologies benefit athletes in sports?
A) They provide immersive training environments and improve skills.
B) They enhance the spectator experience with live statistics and tactical information.
C) They support injury rehabilitation and help regain mobility.
D) All of the above.
6. What is the impact of social media on athletes?
A) Social media helps athletes build their personal brands and interact with fans.
B) Social media has no impact on athletes in the sports world.
C) Social media is only used by athletes for personal reasons, unrelated to their sports careers.
D) Social media is primarily used by athletes for advertising purposes.
7. What is one of the potential cyber security threats in the field of sports?
A) Weather conditions affecting outdoor sporting events
B) Difficulty in scheduling matches and tournaments
C) Manipulation of match results or theft of players' personal data
D) Equipment malfunction during games

8. What is the primary benefit of cloud computing for sports organizations?

- A) Enhanced data storage and sharing capabilities
- B) Real-time data processing for tactical decisions
- C) Improved data analytics and performance optimization
- D) Enhanced security and privacy measures

9. What are the main roles of data management technologies in sports?

- A) Collecting and analysing performance data
- B) Storing and processing sports data effectively
- C) Transforming data into meaningful information
- D) All of the above

10. Which of the following is an example of a communication technology used in sports?

- A) Wearable devices for performance monitoring
- B) Data analytics software for performance analysis
- C) Video conferencing tools for remote communication
- D) VAR (Video Assistant Referee) technology in matches

11. Which game is NOT commonly associated with esports?

- A) League of Legends (LoL)
- B) Counter-Strike: Global Offensive (CS: GO)
- C) Minecraft
- D) Dota 2

ANSWER KEY:

Q1.Answer: A) Soccer

Q2.Answer: B) Biomechanical analysis

Q3.Answer: A) They help athletes record and analyze their training data, set goals, and provide feedback.

Q4.Answer: B) To improve athletic performance and decision-making.

Q5.Answer: D) All of the above.

Q6.Answer: A) Social media helps athletes build their personal brands and interact with fans.

Q7.Answer: C) Manipulation of match results or theft of players' personal data

Q8.Answer: A) Enhanced data storage and sharing capabilities

Q9.Answer: D) All of the above

Q10.Answer: C) Video conferencing tools for remote communication

Q11.Answer: C) Minecraft

References

Ahmed, O. H., Carmody, S., Walker, L. J., & Ahmad, I. (2020). The need for speed! 10 ways that WhatsApp and instant messaging can enhance communication (and clinical care) in sport and exercise medicine. *British Journal of Sports Medicine*, 54(19), 1128-1129.

Araújo, D., Couceiro, M. S., Seifert, L., Sarmiento, H., & Davids, K. (2021). *Artificial Intelligence in sport performance analysis*. Routledge.

Aroganam, G., Manivannan, N., & Harrison, D. (2019). Review on wearable technology sensors used in consumer sport applications. *Sensors*, 19(9), 1983.

Bai, L., Efstratiou, C., & Ang, C. S. (2016, March). weSport: Utilising wrist-band sensing to detect player activities in basketball games. In *2016 IEEE International Conference on Pervasive Computing and Communication Workshops (PerCom Workshops)* (pp. 1-6). IEEE.

Barcelona Club. (2023). Official Twitter account of Barcelona Club. Twitter. Retrieved from [Twitter account URL]

Botta, A., De Donato, W., Persico, V., & Pescapé, A. (2016). Integration of cloud computing and internet of things: a survey. *Future generation computer systems*, 56, 684-700.

Boyle, R., & Haynes, R. (2014). Sport, public relations and social media.

Callaghan, J., Moore, E., & Simpson, J. (2018). Coordinated action, communication, and creativity in basketball in superdiversity. *Language and Intercultural Communication*, 18(1), 28-53.

Cannavo, A., Musto, M., Prattico, F. G., Raho, F., & Lamberti, F. (2018). A participative system for tactics analysis in sport training based on immersive virtual reality. In *Proceeding of the 4th workshop on Everyday Virtual Reality (WEVR 2018)–25th IEEE conference on Virtual Reality and 3D User Interfaces* (pp. 1-4).

Chase, C. (2020). The data revolution: Cloud computing, artificial intelligence, and machine learning in the future of sports. *21st Century Sports: How Technologies Will Change Sports in the Digital Age*, 175-189.

Chen J. (2021). Clinical Effect of Virtual Reality Technology on Rehabilitation Training of Sports Injury. *Journal of healthcare engineering*, 2021, 1361851. <https://doi.org/10.1155/2021/1361851>

Chen, L., & Hu, D. (2023). An effective swimming stroke recognition system utilizing deep learning.

Cortes, N., Blount, E., Ringleb, S., & Onate, J. A. (2011). Soccer-specific video simulation for improving movement assessment. *Sports Biomechanics*, 10(01), 22-34.

Covaci, A., Postelnicu, C. C., Panfir, A. N., & Talaba, D. (2012). A virtual reality simulator for basketball free-throw skills development. In *Technological Innovation for Value Creation: Third IFIP WG 5.5/SOCOLNET Doctoral Conference on Computing, Electrical and Industrial*

Systems, DoCEIS 2012, Costa de Caparica, Portugal, February 27-29, 2012. *Proceedings 3* (pp. 105-112). Springer Berlin Heidelberg.

de Leeuw, A. W., van der Zwaard, S., van Baar, R., & Knobbe, A. (2022). Personalized machine learning approach to injury monitoring in elite volleyball players. *European journal of sport science*, 22(4), 511-520.

Filo, K., Lock, D., & Karg, A. (2015). Sport and social media research: A review. *Sport management review*, 18(2), 166-181.

Fortes, L. S., Almeida, S. S., Praça, G. M., Nascimento-Júnior, J. R., Lima-Junior, D., Barbosa, B. T., & Ferreira, M. E. (2021). Virtual reality promotes greater improvements than video-stimulation screen on perceptual-cognitive skills in young soccer athletes. *Human Movement Science*, 79, 102856.F

Geurin, A. N. (2023). Social Media and Consumer Behavior. *International Journal of Sport Communication*, 1(aop), 1-10.

Gradl, S., Eskofier, B. M., Eskofier, D., Mutschler, C., & Otto, S. (2016, September). Virtual and augmented reality in sports: an overview and acceptance study. In *Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing: Adjunct* (pp. 885-888).

Greenwald, M. (2017). Cybersecurity in sports. Questions of Privacy and Ethics. Tufts University Department of Computer Science. Recuperado de <http://www.cs.tufts.edu/comp/116/archive/fall2017/mgreenwald.pdf>.

Groom, R., & Nelson, L. (2013). The Application of Video-Based Performance Analysis in the Coaching Process¹: The coach supporting athlete learning. In *Routledge handbook of sports coaching* (pp. 96-107). Routledge.

Gruber, D. A. (2014). Break point: A case study of how globalization and technology led to new tennis media gatekeepers in the United States. *International Journal of Sport Communication*, 7(1), 126-141.

Hamari, J., & Sjöblom, M. (2017). What is eSports and why do people watch it?. *Internet research*, 27(2), 211-232.

Hughes, M., Franks, I. M., Franks, I. M., & Dancs, H. (Eds.). (2019). *Essentials of performance analysis in sport*. Routledge.

IAAF [@iaaforg]. (2023). Official Twitter account of IAAF. Twitter. Retrieved from [Twitter account URL]

Ingwersen, F., Schlesinger, T., & Habenstein, D. (2022). Mobile Devices in German Football Coaching: Implications for Coach Education by Investigating Coaches' Usage, Access, and Guidance. In *Coach Education in Football* (pp. 249-260). Routledge.

James, D. A., & Petrone, N. (2016). *Sensors and Wearable Technologies in Sport: Technologies, Trends and Approaches for Implementation* (pp. 1-49). Berlin, Germany:: Springer.

Kittel, A., Larkin, P., Elsworthy, N., Lindsay, R., & Spittle, M. (2020). Effectiveness of 360 virtual reality and match broadcast video to improve decision-making skill. *Science and Medicine in Football*, 4(4), 255-262.

Kranz, M., Möller, A., Hammerla, N., Diewald, S., Plötz, T., Olivier, P., & Roalter, L. (2013). The mobile fitness coach: Towards individualized skill assessment using personalized mobile devices. *Pervasive and Mobile Computing*, 9(2), 203-215.

Larkin, P., Mesagno, C., Berry, J., Spittle, M., & Harvey, J. (2018). Video-based training to improve perceptual-cognitive decision-making performance of Australian football umpires. *Journal of sports sciences*, 36(3), 239-246.

Le Noury, P., Buszard, T., Reid, M., & Farrow, D. (2021). Examining the representativeness of a virtual reality environment for simulation of tennis performance. *Journal of Sports Sciences*, 39(4), 412-420.

Li, Y., Wang, L., & Li, F. (2021). A data-driven prediction approach for sports team performance and its application to National Basketball Association. *Omega*, 98, 102123.

Macey, J., & Hamari, J. (2019). eSports, skins and loot boxes: Participants, practices and problematic behaviour associated with emergent forms of gambling. *New Media & Society*, 21(1), 20-41.

Mahmood, K., & Takahashi, H. (2015, October). Cloud based sports analytics using semantic Web tools and technologies. In *2015 IEEE 4th Global Conference on Consumer Electronics (GCCE)* (pp. 431-433). IEEE.

Marston, S., Li, Z., Bandyopadhyay, S., Zhang, J., & Ghalsasi, A. (2011). Cloud computing—The business perspective. *Decision support systems*, 51(1), 176-189.

Morais, J. E., Oliveira, J. P., Sampaio, T., & Barbosa, T. M. (2022). Wearables in swimming for real-time feedback: A systematic review. *Sensors*, 22(10), 3677.

Mujika, I., & Crowley, E. (2019). Strength training for swimmers. *Concurrent Aerobic and Strength Training: Scientific Basics and Practical Applications*, 369-386.

Murata, K. T., Watari, S., Nagatsuma, T., Kunitake, M., Watanabe, H., Yamamoto, K., ... & Murayama, Y. (2013). A science cloud for data intensive sciences. *Data Science Journal*, 12, WDS139-WDS146.

Musa, R. M., Majeed, A. P. A., Kosni, N. A., & Abdullah, M. R. (2020). Machine learning in team sports: performance analysis and talent identification in Beach Soccer & Sepak-takraw. Springer Nature.

NBA [@NBA]. (2023). Official Twitter account of NBA. Twitter. Retrieved from [Twitter account URL]

Neumann, D. L., Moffitt, R. L., Thomas, P. R., Loveday, K., Watling, D. P., Lombard, C. L., ... & Tremeer, M. A. (2018). A systematic review of the application of interactive virtual reality to sport. *Virtual Reality*, 22, 183-198.

Newman, T., Peck, J., & Wilhide, B. (2017). *Social media in sport marketing*. Routledge.

Novatchkov, H., & Baca, A. (2013). Artificial intelligence in sports on the example of weight training. *Journal of sports science & medicine*, 12(1), 27.

O'Donoghue, P. (2009). *Research methods for sports performance analysis*. Routledge.

O'Donoghue, P. (2014). *An introduction to performance analysis of sport*. Routledge.

Peart, D. J., Balsalobre-Fernández, C., & Shaw, M. P. (2019). Use of Mobile Applications to Collect Data in Sport, Health, and Exercise Science: A Narrative Review. *Journal of strength and conditioning research*, 33(4), 1167-1177. <https://doi.org/10.1519/JSC.0000000000002344>

Ramkumar, P. N., Luu, B. C., Haeberle, H. S., Karnuta, J. M., Nwachukwu, B. U., & Williams, R. J. (2022). Sports Medicine and Artificial Intelligence: A Primer. *The American journal of sports medicine*, 50(4), 1166-1174. <https://doi.org/10.1177/03635465211008648>

Richter, C., O'Reilly, M., & Delahunt, E. (2021). Machine learning in sports science: challenges and opportunities. *Sports Biomechanics*, 1-7.

Ristevska-Jovanovska, S. (2016). Building the Most Appropriate Sport Marketing Strategy through Social Media. *Research in Physical Education, Sport & Health*, 5(2).

Rogers, R., Strudler, K., Decker, A., & Grazulis, A. (2017). Can augmented-reality technology augment the fan experience?: A model of enjoyment for sports spectators. *Journal of Sports Media*, 12(2), 25-44.

Ronaldo, C. [@cristiano]. (2023). Instagram. Retrieved from [Instagram account URL]

Sampaio, J. (2022, September). Training and Performance Analysis in Team Sports. In *World Congress of Performance Analysis of Sport & International Conference of Computer Science in Sports* (pp. 15-18). Cham: Springer Nature Switzerland.

Sanderson, J. (2013). Social media and sport communication: Abundant theoretical opportunities. In *Routledge handbook of sport communication* (pp. 70-79). Routledge.

Spitz, J., Wagemans, J., Memmert, D., Williams, A. M., & Helsen, W. F. (2021). Video assistant referees (VAR): The impact of technology on decision making in association football referees. *Journal of sports sciences*, 39(2), 147–153. <https://doi.org/10.1080/02640414.2020.1809163>

Su, L., & Yang, L. (2020, September). Research on physical fitness grading model of swimming training based on real-time cloud computing. In 2020 International Conference on Advance in Ambient Computing and Intelligence (ICAACI) (pp. 121-124). IEEE.

Suwarno, S., & Derrick, D. (2022, April). Physical Workout Application For Basketball Players. In CoMBInES-Conference on Management, Business, Innovation, Education and Social Sciences (Vol. 2, No. 1, pp. 189-195).

Taylor, T. L. (2012). *Raising the stakes: E-sports and the professionalization of computer gaming*. MIT Press.,

Torres-Ronda, L., Beanland, E., Whitehead, S., Sweeting, A., & Clubb, J. (2022). Tracking Systems in Team Sports: A Narrative Review of Applications of the Data and Sport Specific Analysis. *Sports medicine - open*, 8(1), 15. <https://doi.org/10.1186/s40798-022-00408-z>

Van Eetvelde, H., Mendonça, L. D., Ley, C., Seil, R., & Tischer, T. (2021). Machine learning methods in sport injury prediction and prevention: a systematic review. *Journal of experimental orthopaedics*, 8(1), 27. <https://doi.org/10.1186/s40634-021-00346-x>

Veiga, S., Roig, A., & Gómez-Ruano, M. A. (2016). Do faster swimmers spend longer underwater than slower swimmers at World Championships?. *European journal of sport science*, 16(8), 919-926.

Wei, S., Huang, P., Li, R., Liu, Z., & Zou, Y. (2021). Exploring the application of artificial intelligence in sports training: a case study approach. *Complexity*, 2021, 1-8.

Wilkins, S. (2021). Sports prediction and betting models in the machine learning age: The case of tennis. *Journal of Sports Analytics*, 7(2), 99-117.

Williams, S. [@serenawilliams]. (2023). Twitter. Retrieved from [Twitter account URL]

Xue, H., Newman, J. I., & Du, J. (2019). Narratives, identity and community in esports. *Leisure Studies*, 38(6), 845-861.

Yang, Y. (2020). Evaluation model of soccer training technology based on artificial intelligence. In *Journal of Physics: Conference Series* (Vol. 1648, No. 4, p. 042085). IOP Publishing.

Yao, P. (2021). Real-time analysis of basketball sports data based on deep learning. *Complexity*, 2021, 1-11.

Yigitbasioglu, O. M., & Velcu, O. (2012). A review of dashboards in performance management: Implications for design and research. *International Journal of Accounting Information Systems*, 13(1), 41-59.

Zagała, K., & Strzelecki, A. (2019). eSports evolution in football game series. *Physical Culture and Sport. Studies and Research*, 83(1), 50-62.

Zatsiorsky, V. (Ed.). (2008). *Biomechanics in sport: performance enhancement and injury prevention*. John Wiley & Sons.

Zhang, R., Wu, L., Yang, Y., Wu, W., Chen, Y., & Xu, M. (2020). Multi-camera multi-player tracking with deep player identification in sports video. *Pattern Recognition*, 102, 107260.

Zheng, B. (2022). Soccer Player Video Target Tracking Based on Deep Learning. *Mobile Information Systems*, 2022.

Zheng, Y., & Zhang, H. (2022). Video Analysis in Sports by Lightweight Object Detection Network under the Background of Sports Industry Development. *Computational Intelligence and Neuroscience*, 2022.



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