



Evolution In Motion Analysis Technology In Sports For Sports Performance: A Review Study

Dharmendra Singh Narwaria, Ashish Kumar Nigam, Vivek Badhe,
JNKVV Jabalpur

Abstract

The Purpose of article is to explore the latest developments in the field of capture science and the corresponding study. Motion capture has advancement significantly in recent age, acting an important role in the way of entertainment, sports, healthcare, and science. The paper investigate into the key concerning details progresses, challenges, and applications of motion capture plans, stressing the association of cutting-edge fittings and complex study program. The intersection of science and sports biomechanics has concreted the habit for extraordinary observations into the procedures of agile performance. This division specifies a survey of the historical development of sports biomechanics and the important duty of technology plays in change the surroundings. It has into the transformational function of technology in boosting sports biomechanics, planning to perfect athletic conduct, avoid harms, and enhance preparation methods. It helps to investigate the integration of miscellaneous sciences to a degree motion capture, force plates, wearable sensors, and virtual reality, emphasize their requests and affect understanding human evolution in sports. It survey the vital countryside of technology in sports biomechanics reasoning, planning allure evolution from early methods to the contemporary sciences employed contemporary. From program reasoning to complex wearable sensors and artificial intelligence, to check the transformational impact of these electronics on understanding and optimizing human movement in sports.

Keywords: Motion capture, Analysis software, Marker-based systems, Markerless systems, hybrid systems, sports etc

Introduction

The area of spots performance enhancement has become more challenging for the sports scientist and coaches to match their application of knowledge with the athletes' individual requirements. The constant arrival of new technologies and its practical application may endorse to the intrinsic desire to achieve advantage over the opponent in elite and competitive sports. The experimental approaches to the technologies can provide additional information to the coaches and athletes during training sessions. Performance analysis of sport aims at evaluating athletes' performance enhancement as a result of training over an extended period of time. Also, it helps to analyse improvements of physical condition and technical expertise obtained as an outcome of different training methodologies adopted by the coaches. Coaches looking for optimal performance and technique develop a tailored training plan and monitor outcomes by

means of different tools (Southgate, Prinold, & Weinert-Aplin, 2016)¹. Biomechanics is defined as the study of the structure and function of biological systems by the methods of mechanics. The range of applications and methodologies in biomechanics is varied, from gait analysis to manufacturing of implants, orthotics or prosthetics devices, and rehabilitation technology, fluid dynamics analysis in biological systems, and tissue and cellular biomechanics. An underlying understanding of fundamental applied mechanics principles is required to understand the stresses and strains the body components cause, or are subject to, under different activities (C. Bandejas, 2019)². Like other aspects of life, sport, and exercise science have been significantly impacted by technological breakthroughs. Modern sports and the different subfields of exercise research are impossible to envision without technology. The usage of technologies is always clouded with ambivalence and irritation. Ironically, it is people's failure to completely comprehend the scale and depth of technology's influence and also doubt as to what function certain technical improvements play in sports that have contributed most to its pervasiveness. Sports technology has, in fact, significantly altered the field of exercise and sport research. It's important to note that technology has significantly altered how we perceive the athletic body. The impact of technology on sports performance is thus examined in this essay, taking into account technological ideas, the pursuit of increased performance, various sports technology kinds, and the benefits and drawbacks of sports technology in contemporary sports (Habibi, Faraidoon & Khairandish, Mohammad Omid. 2023)³. The association of technology and sports biomechanics has covered the way for unparalleled insights into the mechanics of the athlete performance. The segment provides an overview of the chronological evolution of sports biomechanics and the important role of technology plays in reshaping the background.

Time-Based Segmentation

This section explores traditional time-based segmentation methods, such as dividing movements into distinct phases based on key events or time intervals. It discusses the strengths and limitations of this approach in capturing general movement patterns but highlights challenges in handling variability among athletes⁴.

Kinematic-Based Segmentation

Kinematic-based segmentation involves dividing movements based on joint angles, angular velocities, or other kinematic parameters. This section examines the application of kinematic criteria for segmenting movements and its efficacy in capturing biomechanically relevant events during athletic activities.

Marker-based Systems

Discuss improvements in marker placement techniques and their impact on accuracy. Explore the integration of wearable sensors for enhanced portability and flexibility.

Markerless Motion Capture Technologies

Advancements in markerless motion capture technologies have eliminated the need for physical markers, enhancing the naturalness and freedom of movement analysis. This section investigates the use of depth-sensing cameras, computer vision algorithms, and artificial intelligence in markerless motion capture systems. (Wade, L. et.al 2022)⁵.

Hybrid Motion Capture Systems

Investigate hybrid approaches combining marker-based and markerless technologies for improved performance. The emergence of motion capture systems marks a pivotal point in the evolution of sports

biomechanics technology. This section explores the development of motion capture, from early marker-based systems to the current markerless and hybrid approaches. It discusses how these systems provide detailed insights into joint kinetics, kinematics, and overall movement patterns. (Franzo et.al. 2023)⁶

High-Speed Motion Capture Systems

This section explores the latest advancements in high-speed motion capture systems, detailing improvements in marker technology, camera resolution, and synchronization techniques. It discusses how these systems provide unprecedented accuracy in capturing intricate details of athletes' movements during training and competition. Motion capture technology has witnessed substantial advancements, offering new possibilities for real-time movement tracking and analysis. Explore the latest hardware innovations in motion capture systems. Evaluate the capabilities of analysis software for interpreting captured motion data. Examine applications across diverse industries and their impact on respective fields. Hardware Advancements: Analyzing the intricate details of an athlete's movements has become more precise with motion capture technology. This section explores the applications of optical and inertial motion capture systems, discussing their contributions to gait analysis, joint kinematics, and skill acquisition in various sports. (K. Yamane, T. Kuroda and Y. Nakamura, 2004)⁷.

Wearable Sensors and Biometric Monitoring

Advancements in wearable sensor technology enable real-time data collection during training and competition. This section explores the use of accelerometers, gyroscopes, and physiological sensors to monitor athletes' movements, quantify biomechanical parameters, and assess physiological responses. Advancements in miniaturized sensors have led to the widespread use of wearable devices and IMUs in sports biomechanics. This section examines the role of accelerometers, gyroscopes, and magnetometers in capturing real-time data, allowing for on-field analysis of athletes' movements and biomechanical parameters. (Possamai, Carolina & Ravard, Philippe & Ghosn, Lina & Tran, Viet. 2020)⁸.

Visualization Tools

Explore advanced visualization tools for interpreting motion data. Discuss the integration of virtual reality (VR) and augmented reality (AR) in motion analysis. Virtual reality (VR) has emerged as a powerful tool in sports biomechanics, providing immersive environments for training and analysis. This section investigates the applications of VR in skill development, cognitive training, and enhancing proprioception for athletes. (M. Gayathri and V. Kavitha 2023)⁹.

Artificial Intelligence in sports Biomechanics:

The rise of artificial intelligence (AI) has significantly impacted sports biomechanics analysis. This section explores the applications of machine learning algorithms and AI in processing vast biomechanical datasets, predicting performance outcomes, and personalizing training programs. (Bartlett R. (2006)¹⁰.

There are software available frequently used for the analysis of sports movement and performance of the athletes, each software have special used and features. Vicon nexus, motion analysis cortex, dartfish, kinovea, visual 3D, biomech software (tool box for matlab), qualysis track manager, Simi motion, peak motus etc.¹¹

Conclusion

In this paper, systematic reviews of the recent progress of motion capture systems for the analysis of sport performance. It reviews key findings, emphasizing on transformative impact of advanced motion capture technology and analysis software across various sports events. While Conclude with insights into future trends and potential breakthroughs in the field. The integration of cutting-edge technology in sports biomechanics holds immense potential for revolutionizing athletic performance. This paper emphasizes the need for continued research, collaboration between scientists and practitioners, and ethical considerations to ensure the responsible use of technology in the pursuit of optimizing human movement in sports. In views, this paper highlights the evolutionary journey of technology in sports biomechanics analysis. From early video analysis to the current era of AI-driven insights, the advancements discussed demonstrate the transformative power of technology in unraveling the complexities of human movement in sports. Continued research and innovation in this field are essential for unlocking new frontiers in sports performance optimization and injury prevention.

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