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New technological implications of movement analysis in sports

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Abstract

Methods used for biomechanical analysis are the key components of designing and structuring the training sessions for various relevant sports performance improvement. When comparing the other methods of performance analysis, the biomechanical feedback applications performs better in performance enhancement. This paper aims to explore the current methods used for biomechanical analysis of sports performance. Also, this paper discusses new technologies used for motion capture and its application in sports performance analysis. The application of tools and materials recommended for biomechanical analysis in sports can help both quantitative and qualitative analysis of the performances. The 3D motion analysis system drones and post millennium smart devices are the current technologies used for movement analysis. Therefore, it has been recommended that tools and materials needed for biomechanical analyses should be made available to sport and exercise scientists to enable more quantitative research, for optimal performance. The limitations faced by the sports scientist, coaches and the athletes are also discussed in this paper.

Keywords: Biomechanical analysis, motion capture technology, drones, post millennium devices

1. Introduction

The area of sports 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) ^[12]. Analysis of human motion can be regarded as one of the most precise technique to discourse elite sports' outcomes. Biomechanics is the branch of physics deals with the mechanism of human motion. Physics of human motion. It is a branch of science concerned with interrelationship of body segments and their functions with respect to the kinematics and kinetics of motion (Adrian and Cooper, 2005) ^[2]. Kinematics analysis in sports describes the positions, angles, velocities and accelerations of body segments and joints during movements, while kinetic analysis describes forces that produce the movement (Rugai, 2016) ^[10]. Methods of analysis used in sports biomechanics varies from low cost and easy to use measurement tools (e.g. goniometer, hand held camera) up to expensive and sophisticated

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systems (e.g. isokinetic dynamometers or three dimensional motion systems). However, the purpose of predictive analysis is to use a computer model of a person or piece of equipment to predict changes which would occur in a movement as a result of alterations to the input factors. Some of the examples of the new technologies in sports reviews are: global positioning systems (GPS) and micro-technology sensors in team sports, Cummins, Orr, O'Connor & West, 2013; a vision-based motion analysis in sport, Barris & Button, 2008; video use in coaching, Wilson, 2008; integrated technologies such as GPS, accelerometer and heart rate monitors in team sport, Dellaserra, Gao, & Ransdell, 2014). Athletes and coaches are always aims at peak performance. The current available evidence advocates that the use of technology makes it possible for coaches to provide their athletes with the best possible prospects to achieve maximal performance (Adegbesan and Ekpo, 2004) [3]. Therefore, sports bio mechanists need to adopt the correct methods of analysis to improve skills and optimize the performance of athletes and coaches.

2. Historical overview

The process of learning and training human motor skills has a history of over thousands of years. The early form of feedback learning was the immediate feedback given after each skill practice according to the coaches observation. The feedback and training was completely knowledge based and depended on trainers' experience. Until last century the bio feedback was fully based on multiple parameters such as heart rate, respiratory rate, muscle activity, body temperature, impact rate, joint angle etc. The applications were fully lab oriented and not practical in motor learning and movement correction based. Due to the limitations of wireless sensors technology, the applicants were equipped with wires. As such the feedback was more concentrated on areas of health care and rehabilitation and less on human mobility and movement complexity.

3. The present aspect

Feedback learning has its own importance in past era as well as in current scenario. The advantages of feedback learning are (1) it allows for a learner to find the mistakes and correct it by constant practice at his or her own pace (2) it reduces the learning time, produces and low error rate and (3) it improves learning efficiency through immediate feedback (Zhang *et al* 2019) [13]. The sports scientist across the world have researched on different technologies in order to develop better hardware and software tools to improve methods to capture and analyse the players performance. These innovations help the sports researchers and trainers to readily measure the key aspects of performance at the field setting itself. One of the most important developments in the area of data collection and processing method involves the computer vision. The computer based system of performance analysis allows getting the feedback immediately without disturbing the player and his playing environment. According to (Glazier *et al*, 2003) [6], the concern of many influential investigators, the biomechanical researches move from its descriptive phase to a more analytical level (Baumann 2007, Normann 2009, Nigg, 2003) [4, 8, 7].

4. Importance of biomechanical feed backs

From the scientific point of view, human motor skill development is a biological process. Therefore, the changes in biological parameters of human motor system are related to

influential feedbacks. Objective or quantitative evaluation of movement requires permanent record of data that has collected from a number of trials. It has been observed that a successful performance of the skill is supported by useful and timely feed back to the sports person who is aiming at correcting the performance defects. A systematic, objective and reliable performance analysis and evaluation can be done by means of quantitative analysis of biomechanical variables. These observations can provide the optimal feedback to the athletes for adapting better training strategies.

5. Impact of technology in sports

Philosophically, technology can be defined as any physical instruments that can be used for problem solving (Soltanzadeh, 2015) [11]. So far, technology is not new for the field of sports. Computer simulation and optimisation techniques are the widely used parameters used in studies of sport techniques. Therefore, it has been recommended that tools and materials needed for biomechanical analyses should be made available to sport and exercise scientists to enable more quantitative research, for optimal performance. Computer algorithms help to combine the anatomical characteristics and mathematical modelling of the human movements for further quantitative movement analysis studies. Also, it helps in predictive analysis of the player that helps both player and the trainer to apply the measures to improve the performance variables.

5.1 Electronic field production cameras

Electronic field production cameras are similar to studio cameras in that they are used primarily in multiple camera switched configurations, but outside the studio environment, for concerts, sports and live news coverage of special events. These versatile cameras can be carried on the shoulder, or mounted on camera pedestals and cranes, with the large, very long focal length zoom lenses made for studio camera mounting. These cameras have no recording ability of their own, and transmit their signals back to the broadcast truck through a fibre optic, triax, radio frequency or the virtually obsolete multicore cable. Computer vision system typically requires multiple cameras to be placed at different angles around the player at the field without distracting the players' performance.

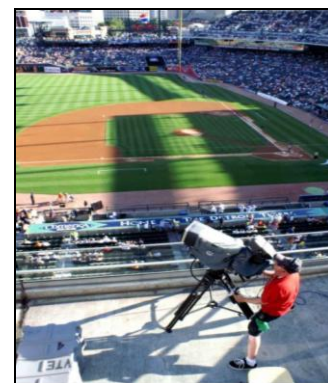


Fig 1: Example of Electronic field production camera

5.2 Electronic news gathering video cameras

ENG (electronic news gathering) video cameras were some similarities to the smaller consumer camcorder, they differ in several regards: They have interchangeable lenses. The lens is focused manually and directly, without intermediate servo controls. However the lens zoom and focus can be operated

with remote controls with a television studio configuration Operated by a camera control unit (CCU). Recording is to a professional medium like some variant of Betacam or DVCPRO or Direct to disk recording or flash memory. If as in the latter two, it's a data recording, much higher data rates (or less video compression) are used than in consumer devices.



Fig 2: Example of ENG (electronic news gathering) video camera

Traditionally three dimensional motion capture system require body markers to identify the position, estimation and orientation of each segment. Now a days marker less motion capture system has also emerged; but still this system require more development in order to raise its standard to more acceptable accuracy (Giblin, Parrington, Tor, 2016) [5].

5.3 Drones

Another great evolution of technology in sports performance analysis is the innovation of drones. They are the unmanned aerial vehicles. It uses aerodynamic forces to provide vehicle lift, can fly autonomously or be piloted remotely. The flight path of drones can be controlled via remote or smart device applications providing more flexible solutions rather than placing multiple cameras around the field and coordinating it.



Fig 3: Example of a drone

Position and movement sensors attached to the aircraft give information about its state. Exteroceptive sensors deal with external information like distance dimensions, while exproprioceptive ones correlate internal and external states. Varied types of device capabilities such as tracking through GPS or combined sonar, computer vision and computer learning technologies are available in consumer market drones (eg. Hexo+, Hexoplus, Grenoble, France; Phantom 4) (Giblin, Parrington, Tor, 2016) [5].

5.4 Smart devices

Finally, a commonplace technology for the Post –Millennials

includes smart phone devices for the analysis purposes, Smartphones, I pads, tablets are often using complimentary to the software packages. The portable handheld devices are used for collection of the date (eg: Swift Performance, Wacol, Australia; Sports tech, Warriewood, Australia; The Tarn group Dunedin, New Zealand) The data collection has become more simplified by the used of new technologies and it may provide more advantage than the traditional technologies. However, the application and successful use of the technology is ultimately depend upon how the information gained is used.

6. Considerations for the use of technology in sports

There is no doubt that technology has a high impact on sports. Technology can produce wonders if the coaches, scientists and sports persons can appropriately use the up - dated benefits of the technological progress. The equipment such as force plates, isokinetic dynamometer, and three dimensional motion capture system are considered as gold standard equipment (Giblin, Parrington and Tor, 2016) [5]. The limitations of these gold standard equipment is that their applications are to be made available for purchase. Unfortunately not all the devices can provide the valid and reliable data. Only meaningful and reliable data can improve the performance otherwise chocking by overloading may be the outcome of the analytical studies and training. Furthermore, technology is only effective if the athlete individually aware of his aims and needs to carry out the required corrections in the techniques through constant practice. (Liebermann *et al*, 2002) [9].

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