ANALYZING SPORTS PERFORMANCE USING VIRTUAL TECHNOLOGY

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Abstract:

The process to improve performance in sports can be very difficult as there are several factors such as biomechanical, physiological and psychological that takes place in a competitive game. To get a better understanding of these factors a perception based action loop is deployed. This is required to isolate the major factors contributing in the role of a player’s performance. Due to several limitations, video playback does not help us in obtaining such in-depth analysis. A virtual reality with the application of interactive means can help us overcome these limitations and can be used to obtain a better understanding of the sport through various perspectives. Two case studies using a VR and a high end graphic engine can be used to input data and obtain or predict the outcome of the performance by the player. The first study using VR would be to capture the actions of the player and form the main limbs, i.e. the joints and human movement stability into the model. This is not only important to gather the data required but also can be used to compare it with other players. The second study is to create an outer humanoid body using the data received to modify the part of the simulation and to make an even flow. The third and final process is virtual presentation using a high end graphic engine.

Keywords: Biomechanical, physiological, psychological, video playback, graphic engine.

1. Introduction:

Science has brought several methods and systems to anticipate and predict several key factors in a sport, mainly in areas such as biomechanics, physiology, and psychological factors. Biomechanical analyses give trainers kinematic and dynamic data to help understand particular movements or learn new techniques through strength and conditioning training programs[1]. Physiological analyses can determine the amount of energy used in human movements and how
metabolism adapts to training[2]. Behavioral neuroscience is the technical and strategical choices that players make during competition, such as anticipating an opponent’s actions or simultaneously moving to intercept a ball[2]. The physical, behavioral and psychological consequences occur constantly during competition, making it difficult to study complex situations such as teamwork and interaction between players[2]. The ability to anticipate and observe movements of an opponent and obtain information about the next move the opponent is going to make, i.e. anticipation skills is an essential skill in all major sports. The information the player acquires mainly comes from kinematics or other dynamic variables, such as the body acceleration or the position of limbs when the player moves[3].

Due to the lack of technology both in the hardware and software department, video playback has been the most traditional way to understand anticipatory behaviors through different methods[6]. However, video playback is limited and obsolete because it’s fixed to the camera’s angle and position during the recording. This prevents interactivity through which the player can be moved to get better information. More importantly, video playback can only depend on the actions that took place at the moment. Thanks to the recent advancements in technology, virtual reality can overcome these limitations and provide a “N” number of simulations that the user desires with immersive and interactive environment[6]. The block diagram given below can helps us understand the procedure involved in the case studies.

![Block Diagram for the procedure involved in VR case study.](image)

We use VR to study intuition based action loop. We ask players to state which list out important information necessary to read the game based on its importance, i.e. what happens when a ball is blocked at the last moment. To perform such functions and experiments we design a framework that uses a video-game inspired graphic engine. We use this framework to conduct two case studies. The first one is an intuition based study which is done to understand evaluate the
deceptive movement in a football player. The second one is to analyze the goalkeeper’s actions when facing different ball blocking moments. These case studies can help us describe the advantages of using a VR and help us analyze sports performance in a more efficient manner.

2. Literature and Technical Overview:

Using a VR to predict sports performance comprises of a 3-step process. The first step is to capture the players action in the particular sport[1]. These actions are not only important for the animation of the outer body but to also provide a way to compare the player movement in real life sport situations[1]. The second step involves the actual animation of the outer body forming a humanoid form. This is mainly to understand the adaptations to certain situations and to modify that one part of the simulation[5]. The first two steps are quite similar to each other for all types of applications. The third depends on the mainly on the application because each display system has its own advantage and vice versa. i.e. The football player case study only tries to identify the movements of the opponent; hence a normal VR headset (head-mounted) is all that is required. Whereas, the goalkeeper case study requires a setting identical to the real life ground so that the player can move freely[4]. After several researches on anticipatory behavior in testing and sportive situations through temporal oculus, which controls the amount of visual information presented to the player[4]. This method is displays a prerecorded video and is used to gather information by stopping the key points such as the ball and foot contact for football. Later the predictions had to made based on the information acquired from the video playback method. Although this method is common and universally accepted, observing a playback video is considerably gives less information in comparison to experience acquired from an in-game experience[3]. The players must be able to see the other players key body parts such as the limbs, shoulders and joints to understand the performance, hence eye tracking systems were introduced to search behavioral parameters when the player performed an anticipatory skill[1]. Such systems were able to identify the direction at which the player looked when the player executed an anticipatory skill, hence determining where the ball moved based on the anticipatory judgements made by the player. Although this approach is one of a kind and useful, the application of this approach is very difficult due to lack of advancement in todays technology. Virtual reality can overcome many of these limitations and has several advantages over video playback method.
In virtual reality, the subjects and the simulated objects or opponents can interact with each other, while the in charge carefully controls the environment. [6] All factors that can affect a player’s judgement can be changed with accordance to hold different trials and acquire various results.[1] Tracking of head movement is possible, hence giving the user a feel of presence in the virtual environment in comparison to real life sport.[1] VR displays are stereoscopic (have depth in their display), which gives the user the vital depth required to acquire information, that the video playback method lacks.[5] VR can also be used to study the curve free-kicks in football matches. Researchers wanted to know whether the side spin caused by player during a free-kick that causes the ball to spin would cloud the judgement of a well-seasoned and experienced goalkeeper any difficulties. By using VR technology, the researchers used to vary the sidespin caused and keeping the other majority of the factors constant.[3]

3. Methodical Survey:

The first case study is to understand the deceptive move used by a football player, we can use temporal occlusion. We categorize players into two groups based on their decision making skills and their experience. The players present in the two groups had to predict the virtual position that the player would be at, based on the actions, movements and the direction the body moved at. Their responses and the time taken to come to a conclusion are both taken into consideration and tabulated.[3] We use the information we have obtained to determine which of them has a higher ability to read the game and understand the immediate action taken by the opposing player to move in his desired direction. The result showed that the players with higher experience were able to predict the final position of the player in simulation faster in comparison to the younger and novice players.[3]

![Figure 2: Graph to depict overall success between the young and experienced.](image-url)
The above chart is used to depict the overall success rate obtained by both the groups.[3]

The second case study, the goalkeeper simulation is used to determine the goalkeeper’s deception skills based on where the ball would land and the chances of him able to read it and save the ball. The main goal here is to analyze the anticipatory skill of the goalkeeper[3]. We determine this skill based on the goalkeeper’s ability to intercept the ball based on its direction, force and other conditions and trajectories[1]. In this experiment, standardizing the kick and providing real time movement between the player, goalkeeper movement and the ball trajectory is imperative for evaluating the success in intervention[1]. Therefore, analyzing these anticipation skills is not possible using real life setting or video playback. In any of the cases a real person would have to kick the ball for the case study, making it almost impossible to repeat the same kicking posture and providing challenging ball placements[4]. VR helps us overcome such difficulties by providing an artificial environment with standardized postures and real time interaction between the goalkeeper and the ball trajectories.[6]

![Figure 3: Graph to depict the performance by two individuals in goalkeeping.](image)

After the case study was completed, the anticipation skill was calculated based on the success rates and the response time. Based on the motion capture data, at least one part of the body colliding with the virtual ball was considered as a success.

On the basis of the result, we were able to relate the performance level to that of the response time. Hence we can come to the conclusion that successful movements are characterized by faster response time. The results showed us that the response time and the successful moments differed in both the individuals. Hence further testing was required to
determine whether the anticipatory movement performed by the two individuals were either based on body posture or ball trajectory or in some cases even both.[3]

4. Conclusion:

Therefore a computer generated visual environment help us control experimental factors that would otherwise be very difficult, but not impossible. Furthermore, VR's immersive and interactive factors helps to facilitate high speed recordings of the users movement and anticipatory responses. This data is very helpful for researchers to perform a full behavioral analysis on how the event's dynamics takes place.

More applications may include training players to be attentive so that they can make advanced and more accurate judgement when they are in situation where anticipatory movement is required. Through VR, researchers could also harness or combine the powerful combination of animation and simulation to help players face training scenarios which players have never faced or confronted, i.e. Facing a freekick from the retired football prodigy Roberto Carlos will help them understand how the free-kick is taken and what measures can be taken to save the free-kick, hence gaining experience safely.

Hence VR technology's future looks bright and effective and virtual sports trainers could be the next big thing yet to happen.

References: