Overview of Virtual Reality Apply to Sports

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Abstract
Summarized sports simulation systems based virtual reality. The function include construction of virtual training scenarios, sports data capture, physiological and psychological data acquisition, action reproduce and training effectiveness icon analysis. The key technologies include physical and physiological modeling, virtual human animation, motion capture and real-time rendering and interaction. In the future, 3D simulation of technique action reproduce will continually be the hot point, need to cultivate talents both accomplished in sports and computer sciences.

Keywords: Virtual Reality, Sport Events, Sports Simulation

1. Introduction
Modern sports developed rapidly, The improvement of athletic performance is reducing over time, because the challenge which from instincts of human beings rely on their own strength to the limits of self-physiological level has reached the limit. In order to maximize human potential ability. Modern sports need the science and technology intervene continuously. From the perspective of sports techniques, to improve athletic performance or to obtain a breakthrough, two changes must be done on the sports technology research methodological: the change from the traditional observation based on the human eye to the measurement of human motion technology based on high-precision motion capture and analysis. The change from experience and methods based on too much emotional to human motion analysis which is process-based human motion simulation and emulation[1].

2. Virtual Reality
Virtual Reality based upon computer technology, utilizes and synthesizes many kinds of advanced high-technology to produce a virtual world of multiple sense experience, which is a vivid 3D visual perception, tactile sensation, and olfactory sensation, etc. Accordingly, VR cause people to produce the sensation to personally go through a situation.

VR is an extremely sophisticated system, which, with its referred techniques, includes figure and image processing, speech processing, audio mode recognition, artificial intelligence, intelligent interface, transducer, real time compartment system, database, parallel processing, system modelling and simulation, system integration, trace positioning, etc. A typical VR system consists of virtual environment generator, effect generator, and interface device.

3. Function of VR-Based Sports Simulation

3.1. Construction of Virtual Training Scenarios
The virtual training system of some sports have specific requirements for training scenarios. For example, the modeling of virtual training ground, virtual training equipment and virtual human, etc.

3.2. Sports Data Capture
Record sports physical data of movement directly according to sensor tracking devices and use it
generate computer animation. The biggest advantage of this approach is the ability to capture the human’s (including training equipment) real movement of data[2]. As the generated animation is basically the main person’s (or device) movement copy, so the effect is very realistic, and it can ensure the scientific of the training.

3.3. Physiological and Psychological Data Acquisition
Physiological and psychological indicators are important expression of the athletes’ state. According to the different sports, we can collect physiological and biochemical data, psychological data of the athletes using various of sensors and intelligent instruments. For example, physiological data capture mainly includes pulse, blood pressure which is the indicators of the body’s metabolism and the function indicators of each organs and systems.

3.4. Action Reproduce
Action reproduce is important requirements of the sports simulation system. A traditional camera can not analysis the action from all angles and innovative of new action can not be achieved through the camera. Simulations and reproduce to the technology action can help athletes improve and innovate, improve technical level.

3.5. Icon of the Training Effectiveness Analysis
Generally, error Assessment which indicate the error analysis of the results using the icon is divided into on-line and off-line assessment methods.

4. Key Technologies

4.1. Modeling of Physical and Physiological
Currently, VR-based sports simulation system usually refers to modeling of physical characteristics and physiological characteristics of the human body. Physical characteristics include the body shape, structure, quality, exercise capacity and adaptive capacity. Physiological characteristics include the pulse, blood pressure, vital capacity and other indicators of the body’s metabolism and organs.

4.2. Virtual Human Animation
From the last century, human animation has gone through four stages of development: kinematic control, dynamic control, controller-based motion control and motion capture[4]. motion capture technology has characteristics of efficient and real strong sense, researchers have attached great importance to it.

4.3. Motion Capture
Motion capture use sensors to record the three-dimensional information form of body action, then the computer according to the recorded data to drive the virtual human[1]. The advantage of this approach is capture the real movement of body data, basically due to the formation is the copies of the body, so the effect is very realistic, and can generate many complex motion. Motion capture have three kinds of devices: optical devices, mechanical devices and electromagnetic devices. Motion capturing include planning, raw data acquisition, tracking, identification, frame conversion and mapping. The processing methods include signal processing, mapping offsetting, motion blending, motion texture and motion diagrams.

4.4. Real-time Rendering and Interaction
Virtual sports related to the virtual scene and virtual athletes, real-time rendering and interaction is particularly important. Real-time rendering technology include the foreseeable judgement, details and image-based rendering[1]. Interaction refers to the user use the VR devices (electromagnetic tracking
devices, cameras, haptic devices, three-dimensional navigation devices and verbal or non verbal communication devices) to interact with the system.

5. Applications in Different Sport Events

A master of Chinese sports science Tian Maijui and his colleagues named sports generic as "event-groups". Not only more accurate than the general training theory and in-depth reveal the law of similar projects, but also sublime and improve the specific training theory of, and can enhance the link between general training theory and specific training theory. Which will no doubt greatly enriched the theory of sports training system, thus promoting the rapid development of the practice of sports training.

5.1. Technique Oriented Difficulty and Beauty Events

Technique oriented difficulty and beauty events include diving, gymnastics, trampoline, artistic gymnastics, figure skating, synchronized swimming and skills, martial arts (exercise routine) and other competitive sports. This event's athletics contains abnormal and rich technology movements. In the contest, we made an evaluation based primarily on athletes' completed action and technical status. The request is very high which contains the accuracy of movement, rhythm, amplitude, beauty, coordination, flexibility and balance, etc.

Technique oriented difficulty and beauty events is the key point of application of virtual reality technology, with a typical application example is the three dimensional human motion simulation system VHTrampoline, and has been applied to the Chinese trampoline team's training. The VHTrampoline deriving from human motion biomechanics data and motion capture data of real performance, the simulated motion is verified and analyzed with dynamic human motion equations. Meanwhile, the visual analysis can be reached through comparing the videotaped motion with the simulated one synchronously[3].

A computer aided motion design system for rhythmic gymnastics designed by Chinese doctor Sun Shouqian. The system based on the features and rules of rhythmic gymnastics, makes use of various technologies in the motion capture, motion editing, motion synthesis and music feature extraction by using the system, coaches could be assisted in the whole motion design process for both individual athlete and team athletes. As a result, we could reduce the design time, increase the design creativity and improve the design quality[4].
The Sheffield Hallam University's sports scientists have invented an virtual gym system fixed for athletes which can guide the real gymnasts how to improve performance and as much as possible to avoid injuries. By modeling the real movement of gymnasts, it can cause the virtual gymnast reproduce accurately gymnast's gymnastic movements, and help gymnast improve technology and upgrade skill levels[5].

![Fig.3 Virtual Gym System](image)

### 5.2. Stamina Oriented Speedy Strength Events

Stamina oriented speedy strength events include jumping, throwing and weight lifting. This item cluster technology is a single fixed structure, technical training aimed at learning, mastering, raise a single motor skills, until automation. Virtual reality technology can create the ideal action technology model, athletes can understand their technical status by contrast, and find the gap with the ideal target, and can improve technical training more effective.

Scientists attempted to apply the virtual reality technology, including poser6.0 and 3dsmax7.0 and shockwave3d into the demonstration of glide shot[6]. The purpose was to replace the traditional pictures and videos with shockwave3d and integrate director MX2004 into the courseware to improve the weight lifting training.

### 5.3. Stamina Oriented Speed Events

Stamina oriented speed events include sprint, hurdles, short distance swimming, short track speed skating, short skiing, short bike and short boating and other project. The flexibility of the athlete’s nervous response process is higher than ordinary, and their nerve impulse transmit quickly and strength, the function of the cardiovascular system is strong. They have better anti-hypoxia ability and a high level of anaerobic metabolism of the body. Technical training emphasis on the coherence of the full technical and rhythm action, the effectiveness of key technology, and the close integration between physical and key technology.

In 2004, during the preparations for the Athens Olympic Games, chinese 110m hurdles athlete Liu Xiang have a motion capture technical group containing 4 people[7]. They bought a motion capture system from Germany which worth nearly one million. The sysem capture the technical features which contain Liu Xiang’s daily training and competition and his rival such as Alan Johnson’s and so on. Compare the data of Liu Xiang and his rival, and feedback the results and recommendations to improve training to the coaches, it laid the scientific foundation for Liu Xiang’s winning the Olympics.

![Fig.4 Liu Xiang’s Motion Pictures](image)
Bicycle Simulator is used to simulate the movement of bicycle. It simulates the movement under different load conditions, measures the real-time heart rate according to the Polar table, so as to dynamically adjust for athletes. It combines graphic simulation, constructing scenes of competition and training venues allowing athletes to train in a realistic environment[8].

![Fig.5 Bicycle Simulator]

5.4. Stamina Oriented Endurance Events

Stamina oriented endurance events include walking, long-distance running, long-distance swimming, long-distance cycling, rowing, canoeing, sailing, cross-country skiing, long-distance speed skating and many other projects. They need a variety of athletic ability leading to physical, a variety of racing ability leading to special endurance, and a variety of metabolic capacity mainly depending on glycolytic energy supply and aerobic oxidation energy supply.

Jim Rodnunsky invented skis and sleds simulator which can simulate a well-known Colorado ski venue so that those who do not go to the mountains to experience the true ski venues will be able to experience shocks, sway, ups and downs, pitch and yaw of the skiing and other real feelings. U.S. sled team use the virtual environment simulation experience the runway that they will have to face in the 1998 Winter Olympics in Nagano. Obviously, this experience has contributed to improving race performance. In the future, it is entirely possible to use a virtual simulation environment for true competition.

5.5. Technique and Tactic Oriented Team Antagonistic Events

Technique and tactic oriented team antagonist events include football, basketball, handball, field hockey, ice hockey, water polo and so on. Technique and tactic play a decisive role in the athlete's athletic ability. Require comprehensive and special techniques, combination of tactical methods, lineup and consciousness, organic combination of offensive and defensive, and coordinated development between individual and team.

Hockey training system (GTRS-1) use a camera to capture images to calculate velocity, acceleration, angle, angular velocity of athletes’ specific joint points, through and with its height, compared to high-level athletes to construct the ideal module, and then correct the action, to enhance their competitive ability. It can also construct virtual venues.

![Fig.6 Hockey Training System GTRS-1]
5.6. Technique and Tactic Oriented Single Antagonistic Events

Technique and tactic oriented single antagonistic events including wrestling, boxing, fencing, judo, taekwondo and other projects. With features of one to one competitive and compete accord to weight. The figure shows a virtual Karate-Makoto form Amusitronix Co..

5.7. Technique and Psychological Oriented Accuracy Events

Technique and psychological oriented accuracy events include archery, shooting and crossbow, the technical action of these three items are a single action structure, in the training process, should pay attention to players’ shooting stability, accuracy and psychological qualities. There is no specialized training system for these events. Researchers should to develope a training system adapt to these events , it can register the trajectory of gunpoint in the process of athletes aiming and pulling the trigger, and the corresponding breathing, heart rate and other physiological indicators. Increase the stability and accuracy.

5. Current of VR Apply to Sports

The core issues of Sports Technical Analysis which use virtual reality technology is making model for athletes. At present, human body modeling method generally use the inverse of the kinematics and dynamics or finite element analysis. These methods simplified the human body model. They all have their own advantages and characteristics. However, they all have deficiencies, especially in the athlete modeling and simulation. Due to the computational complexity and a long research cycle of these modeling while they haven’t been amended in practice applications, the actual effect of the simulation is poor. In addition, how to determine the boundary conditions to eliminate singularity is a difficult problem to solve[9]. Tang Yi, who searches in the Chinese Academy proposed the concept of digital players. The main idea of it is that it simulates human motion model of the athletes using neural networks and computational intelligence methods such as genetic algorithms and it is based on multi-objective test data. It also uses kinematics data of the three-dimensional human motion image analysis and the kinetic data measured by Six-dimensional force platform. Modeling method using neural networks and the joint space optimization based on expert knowledge, their core idea is that they use neural networks to complete the mapping from the kinetic parameters to the joint space. In addition, using further expert knowledge to optimize the joint space, we can take the motion simulation for the key action of the athletes.

At present, the Virtual Reality technology are more similar to the desktop virtual reality system and the immersive virtual reality system. Because of the Birth defects of their own, they can not truly integrate with the practice of sports. Only the Distributed and Network or Combining them can create the scene close to conditions for competition and achieve saving investment of scientific research in sports and popular. This is the direction of development of the Virtual Reality Technology in sports.

Sports simulation must obtain information about the action firstly, such as three-dimensional coordinates of each joints, angle, profile, the order of movement and other information. Researchers often use motion capture, video cutting technology. Currently, capture the action often use active tracking method (recording moving objects by tracking reflective label affixed to the joint) or non-contact video-based motion tracking. The latter does not exert any influence on training and competition, so it become popular. But it also has disadvantages, we can not track action without any scotomata. To achieve the fidelity of simulation, the model of virtual objects must have six dimensional.

In technical analysis for movement research and innovation, the computer experts must co-operation with sports experts in order to improve athletic performance. Because the special character of sports, computer experts can not get an intuitive sense of high level competition without sports experts. Athletes’ physical, psychological and other characters is the key factor of training, without this factors, the production can not meet requirements of training and competition. Need to cultivate talents both accomplished in sports and computer sciences.

6. Conclusion

No matter what type of events, virtual reality applications focus on action reproduce, especially in the
technique oriented difficulty and beauty events. This is very much related to the technical characteristics of virtual reality. Technique and tactic oriented team antagonistic events, Technique and tactic oriented single antagonist events and Technique and tactic oriented net separated antagonist events have high requirement to tactics, and the competition is one-to-one or team-to-team, much variables change fast, modeling and algorithm complexity. Therefore, the development of a simulation system has changeable capabilities of the technical and tactical and can simulate the characters of rival,is the urgent requirement to promote scientific training for such events. Scientific training system can regarded the competitive ability dominant factor as the key, to form a universalization training system for a certain type of events through functional integration. Can reduce development costs and improve application efficiency.

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References