An Improved Approach for Human Motion Simulation and Sports Analysis based on Dynamic Image Analysis

Hua-xin Zhang and Li Sun

Jiaxing Vocational Technical College, Jiaxing, Zhejiang 314036, China

ABSTRACT. With the development of computer vision technology, human motion capture can accurately analyse the mobile state of human body and transform it into accurate data report, so as to achieve better physical training effect. In this paper, the author makes an improved approach for human motion simulation and sports analysis based on dynamic image analysis. In the virtual reality, the most intuitive application of motion capture is the 3D animation film. The motion capture algorithm is used to estimate the body's posture and body shape by taking the action posture of the human being.The results showed that the proposed design can improve the accuracy of motion estimation, it can also effectively analyse the sports movement. At the same time, through the analysis of the motion state, the action capture can achieve better physical training effect.

1. Introduction

In the field of computer vision, it is often necessary to capture and recognize the body posture of the human body or animal in the movement and reproduce the 3 dimensional model. Human motion capture is the task from a single perspective or more has the same pressure step or not from the perspective of data synchronization or sequence recovery attitude parameter of human body. It is simple, and with camera shooting pressure of human or animal movement, and then through a certain algorithm, real-time 3 dimensional model shows the human or animal body movements. In the analysis of sports field, movement of a simple application of motion capture is the real-time recording of body parts and transformed to the data report accurately, and then through the application software provided real-time motion analysis, allowing users to achieve better effect of physical exercise. In addition to the hard training of athletes, scientific training methods and means are important and effective ways to improve athletic performance. For a long time, our country basketball training technical level is relatively low, has been used in training and teaching methods based on experience, coaches with the naked eye and experience of the athlete's skill guidance, the athletes can only be through repeated

practice to master the technical essentials, seriously affect the further rapid increase in the level of basketball in China. The basketball teaching and training process, players need to have a large number of observations, imitation, feedback and revision in addition to proprioceptive sensory signals outside especially audiovisual sensations, characteristics of basketball technology of 3D simulation system has good make up for these deficiencies. With the help of this system, the athletes can understand and master the details and key points of the technical movements of the top players. Basketball technology of 3D simulation system can not only help the traditional teaching and training methods, but also conducive to learning, inspire athletes in training, improve the ability of cognition, improve access and realize the effective organization and management of teaching and training of information knowledge and skills, learning and training provides the ideal environment for teaching and training. At present, the domestic and foreign basketball after long-term practice and research were identified: the introduction of 3D simulation technology in basketball technical training, can help athletes to master the technical essentials of action as soon as possible in the training process, reduce blind repetition, greatly improve training efficiency and reduce the possibility of injury of the athletes, to achieve the best effect of training.

Human motion capture is a through accurate and rapid 3D computer virtual model technology method of human motion state in real life, real time reduced, its essence is through equipment on limb movement data use and even facial expression data collection and processing, and use these gestures or facial expression data drive virtual three-dimensional models, simulation figures of all movements, is a multidisciplinary cross integrated sensor network, virtual reality technology and pattern recognition. Basketball is a training to imitate the operation skills, students need to obtain a large number of sensing signal observation, imitation, feedback, correction of body feeling, especially audiovisual sensations, in the current teaching mode, students are always through the observation of teachers' personal demonstration and explanation to understand sports technology. But because of the limitation of teachers' professional level, the demonstration of the accuracy and the single model in a certain extent influence the effect of learning, and the lack of communication with the correct time, will cause the students forming the wrong action, will easily lead to sports injury. If the use of three-dimensional animation in the teaching process, all-round demonstration of advantages, shows the content of teaching technology, it can make up for the shortcomings of traditional learning methods. At present, the creation of 3D motion animation by motion capture technology has become the mainstream of computer animation research. It can save the animation cycle, enhance the screen texture fidelity, development and production, pay attention to many aspects in the film and game animation of human engineering research, simulation training, advanced but rarely applied to physical education teaching.

## 2. The Overall Design of Motion Capture Device

2.1. Whole design

Through the inertial sensing method, the 3D model is used to track the real human movement in real time. Motion sensing human motion capture is by placing the sensor in the body parts of the key nodes based on attitude information acquisition to the process of human motion in real time, and through the data solution calculation parameters calculated by the fusion process of human motion tracking, data driven, virtual model of real human motion. The human motion capture system based on motion sensor mainly includes data acquisition, processing, communication and motion reduction. The following parts are introduced in detail:

(1)　Data acquisition: The main data collection by the deployment of the sensor nodes and the data in different parts of the body sink nodes, each sensor node through tight wear deployed in the limbs, real-time motion signal real-time acquisition of various parts of the body, and through the node data package, and through the wireless module to realize data communication with the host machine. By processing the original motion signal, it can restore the trajectory of human body in three-dimensional space. For human motion capture system based on inertial sensors, the initial signals include three axis acceleration, three axis angular velocity and geomagnetic information. By processing the information, the final motion characteristic parameters can be restored.

(2)　Data communication: In the motion capture system, data communication protocol is one of the most important links. How to design the communication mode of the system has a great influence on the system. In this system, the communication link is mainly includes two parts, one is the data communication of sensor node and sink node, two is a computer software and hardware terminal part of the communication mode, considering the influence of convenient wear and transmission rate, wired communication mode between the sensor node and sink node, wireless the communication mode between the upper and lower machine.

(3)　Data processing: In the motion capture system, the human motion characteristic data collected by inertial sensors must have some errors and data noises, so it needs to be filtered and corrected. At the same time the data processing procedure, also need the characteristic parameters of human motion speed calculation, according to the relevant fusion algorithm from the original signal parses the movement characteristics and trajectory effectively, and the combination of these characteristic parameters and 3D motion model, real-time driver models to simulate the movement of the human body.

(4)　Motion reduction: In a motion capture system, the reduction effect of motion is the evaluation of the motion capture product quality standard, the system designed in this paper, the kinematics and anatomy reference principle, through the relevant software to build the 3D platform from the perspective of skeleton stack based motion capture algorithm, driving and combining human motion, real-time driving characteristic parameters the model.
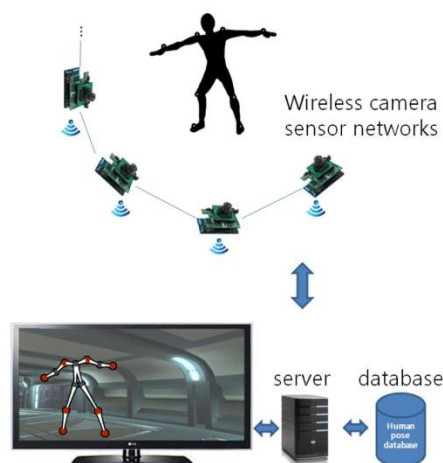
Figure 1. Motion capture system

2.2. Virtual model building

Closely related to construction and system model of the advantages and disadvantages of different models of the performance there is a big difference, at present, the common model of the human body is divided into rod model, entity model, surface model and multi level model. Select the finite rigid rod model fragment and joint link, lack fidelity; solid model by a simple solid graphical simulation of the structure of the human body, large amount of calculation, and poor stability; multi level model including skeleton layer, muscle layer and skin layer, high complexity, the calculation is relatively large; the surface model by the skeleton layer and the skin layer, easy realization, small amount of calculation. Based on the surface model, a 3D hierarchical human skeleton model construction method is proposed. Through the hierarchical modeling theory, the human skeleton movement model based on 3D is established, which can effectively track the movement of human body. The human body model is a human motion capture technology through abstraction to the human body, which ignores the muscle deformation and surface expression data, the abstract human joints as rigid body structure and a description of the human form of graphics to get. Human motion capture inertial sensor based on the features of human action data collected by the inertial sensor on the 3D human body model is established for data driven, so as to realize the real-time tracking of real human motion, so the 3D virtual human model is a key part in this system.

Figure 2. *3D virtual model*

In the current animation design and film production process, because the outer skin dynamics model based on 3D mesh surface to the muscles and skin contour features realistic description of the image of the human body, is very beneficial for the performance of the true state of motion, it is more commonly used. But because the muscles of the human body in motion deformation will occur, if the use of 3D mesh model in the modeling process, we need to model the degree of texture and muscle deformation rendering, it increases the difficulty of image reconstruction. Considering the reality of the situation, referring to the human skeleton and movement, established a three-dimensional model of the human skeleton completely accord with human body biomechanical characteristics, at the same time in the process of modeling, fusion and motion constraint boundary conditions between the human body movements, to constraints on the range of motion, in order to achieve accurate tracking of human body posture. In computer animation, skeletal movement usually consists of two kinds of motion, the forward kinematics and the reverse kinematics. Each of these two methods has its advantages and disadvantages. The following two principles are summarized: in forward kinematics, the joint position of the human body can be calculated by the length of the bone and the rotation of the joint connected with it. In the calculation process, the whole model is compared to a tree structure, and a skeleton coordinate system is set for each joint. In the process of human movement, the position of the whole joint tree can be obtained by calculating the direction and position of the joint, regardless of the position of any of the joints. According to the theory of human kinematics, in the computer graphics, the pelvis region is extracted as the root node of the whole body, and the center of the hand is chosen as the root node. In the forward kinematics theory based on joint tree, the rule of depth first is adopted to calculate, and the joint tree is ordered to traverse in order to estimate the exact location of skeleton space.
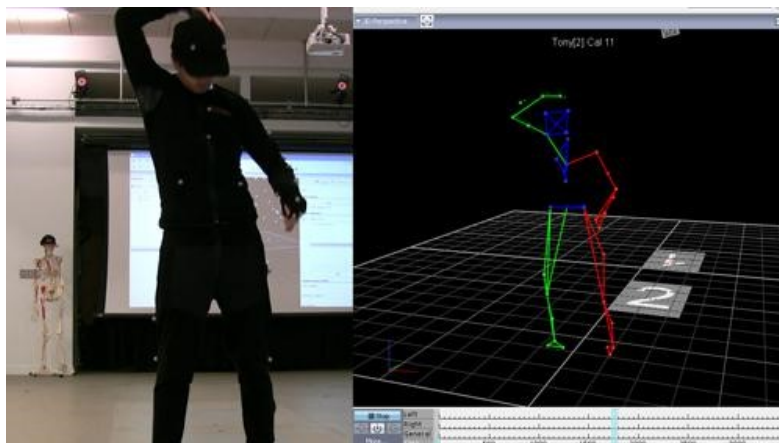
Figure 3. *Motion simulation*

3. Three Dimensional Simulation of Basketball Technology

3.1. Virtual basketball player

The goal of competitive sports is "higher, faster and stronger". Besides the hard training of athletes, the scientific training methods and means are important and effective ways to improve athletic performance. For a long time, our country basketball training technical level is relatively low, has been used in training and teaching methods based on experience, coaches with the naked eye and experience of the athlete's skill guidance, the athletes can only be through repeated practice to master the technical essentials, seriously affect the further rapid increase in the level of basketball in China. The basketball teaching and training process, players need to have a large number of observations, imitation, feedback and revision in addition to proprioceptive sensory signals outside especially audiovisual sensations, characteristics of basketball technology of 3D simulation system has good make up for these deficiencies. With the help of this system, players can understand and master the details and key points of the technical movements of the top players.

The research object of digital human body is human beings. It is a dynamic human body system based on multi temporal and spatial environment. It is a technical system with human body real-time observation, network and computer information processing as its main body. The research object of digitized virtual human "or" virtual "is dead, the body with a knife cutting into slices of human body after tens of thousands of pictures on the computer to carry on the integration of 3D reconstruction of human body structure. This is the essential difference between "digital human body" and "digital virtual human", but only in the field of digital virtual technology. Study on "digitized virtual human" including virtual visible human, virtual physical human and biological research level three, is currently the

virtual visible human, has a great difference with the living as a foothold in the study of digital human body. The purpose of digital virtual human body is to understand the human body system at a certain time and space scale, and its foothold is the living person.

3.2. Motion capture of technical information in basketball

Motion capture technology is a kind of high and new technology for real-time capture and digital analysis of athletes' technical movements and tactics, or the three-dimensional trajectory of moving objects by means of motion capture system. The motion capture system is a high technology equipment for accurate measurement of moving objects in 3D space motion, the principle is based on the computer graphics, the moving object through the arrangement of several video capture devices in space (tracker) motion status in the form of images recorded, processed by computer, different objects in different time the unit of measurement. And the typical motion capture equipment generally consists of sensors, signal capture equipment and data transmission equipment and data processing equipment of four parts. The sensor is fixed at a specific location and tracking device for moving objects, providing location information to the motion system, the level of detail of the tracker depends on the number of motion capture; signal capture equipment is responsible for analog signal acquisition, identification of motion trajectory of sensors to obtain the hardware equipment, the optical system is a high resolution infrared camera data transmission equipment; signal capture device converts the analog signal into a digital signal and obtain the fast and accurately transmitted to the computer system for processing; data processing equipment is composed of two parts: computer hardware and software for data processing of large amounts of data from the data transmission equipment, the modified action of 3D simulation, and has achieved initial results.
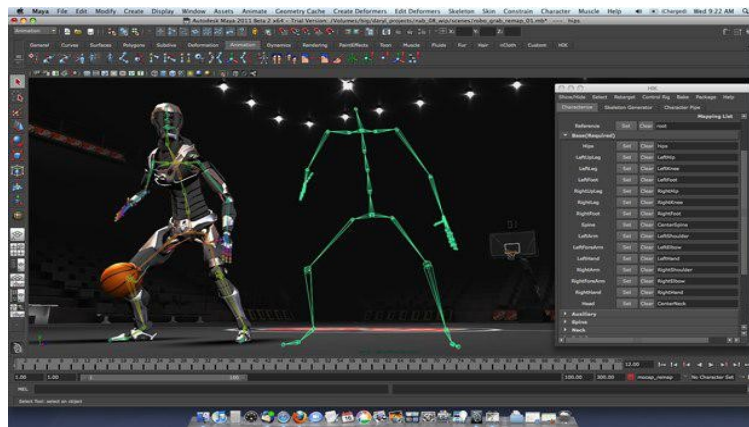

Figure 4. *Basketball capture*

Motion capture technology can capture the basketball movement, easy to carry on quantitative analysis, combined with human physiology, physics principle, research method, make physical training out of purely rely on the experience of the state, into the scientific and digital age. The poor performance of the athlete's motion capture down, with the excellent athletes action were analyzed, which help training, provide training index of accurate quantitative and quantitative basis for scientific training, improve sports level and achievement, realize the scientific foundation of sports research. By means of visual motion capture technology and computer image processing technology can greatly improve the basketball technical training, and help to make quantitative analysis of technical action, to graphically display the results of the analysis, including displacement, velocity, force etc.

4. Basketball Skill and Platform Construction

4.1 Characteristics of technical and tactical development of basketball

Basketball is a sport of basketball will define the extension, basketball as a special carrier of basketball culture refers to a substance, the spirit and the corresponding system construction; and basketball movement, sports spirit, movement skill, wisdom, competition scene, competition atmosphere the competition environment and the different regions of the humanistic philosophy, style, form of organization, competition system, competitive products, star effect, commercial symbol, operation characteristics, spiritual and material to meet the different participating in exchange for sightseeing, enjoy. Basketball as a special commodity products, refers to the events of basketball competition of tangible products and intangible products; competition based events have nuclear products, the quality of competition is undoubtedly an important factor in attracting audiences; tangible products in addition to the competition itself and the products and services around the competition of products, including products such as basketball equipment, sportswear, sports shoes, souvenirs and merchandise; intangible products are in service products, signs, including the club's home court design, media development and exploitation of intangible assets such as athlete endorsement. Pressure

The characteristics of technical and tactical development of basketball are embodied in the frequent changes of the offensive and defensive, the diversity of the lineup, the offensive tactics, the fierce defensive tactics and the internationalization of talent exchange. Through the construction of basketball network digital teaching resources, systematic induction and analysis of the definition and function of the features of basketball, the establishment of a knowledge level education system based on skill level teaching system for interactive system for bridge participation level method, appreciation level demonstrative system as a means of data mining system in smart level the development of system level, and to support the complete system of Sheng ball movement; using the research methods of the mind map, the construction of basketball skills, source, appreciation, analysis, sharing digital resources system; for the basketball education network and digital resources, provides professional and effective theoretical basis.
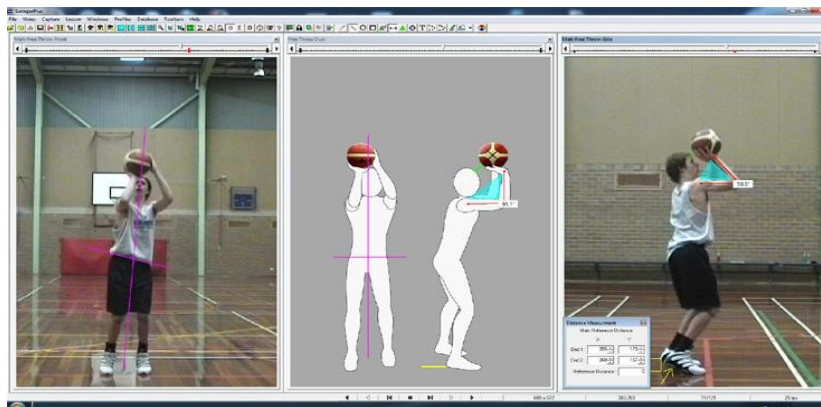
Figure 5. *Basketball teaching optimization*

By the early design and development, and gradually formed a text based tutorial, multimedia courseware, network courseware for support, database security, network platform, interactive sharing is also the core series of achievements. The early development of the ball position Sheng technology teaching network courseware, basketball basic skills training guide, basketball animation, basketball, basketball shield data analysis platform, basketball teaching resources selection preparation system eight digital resources system, through the digital resources system support, the formation of the online learning system based on knowledge, mainly double main teaching model to solve the practical problems in the line, the distance teaching can be learning to imitate the video upload network, through online communication or online consultation form, to give answers and corrective action by professional coach or teacher can form basketball teaching online diagnosis and remote teaching resources platform.

4.2. Basketball technique

Although the China Basketball Association, Sohu, Sina has established a basketball database, but the database is to provide public information, not to provide a team or an athlete as the goal of the search engine, and can not provide video clips related technical and tactical data analysis. As far as basketball skills and tactics are concerned, it has not yet been found that there are relevant and mature reports about the design of professional basketball technology database. In order to manage the massive basketball technical data effectively, it is the only choice to choose the construction of basketball technology database. The definition, the database administrator is responsible for the establishment and maintenance of database control; the main responsibility is the application of database application programmers to use the system to provide the advanced language, interface and database development tools used in the data, in order to achieve the establishment of

information retrieval, information, delete or change existing information or produce various forms of report and so on; database operator need not write procedure with language or tool, directly with the command or query language directly access and manipulate database operation. Basketball technology of 3D simulation database should be integrated covering classic technology many high level basketball players at home and abroad, the plane and 3D preview demo with output query and search order can be achieved on different basketball players dribbling, passing, shooting, moving, rebound, many personal defense technology

Research on 3D simulation technology in basketball teaching and training in modern basketball skills plays an important role, it can make quantitative analysis of technical movements and graphically display the results (including the basketball athlete's displacement speed and rhythm, movement speed, angle ball movement curve), based on the deep analysis of "the ideal" movement and the players action, the construction of athletes in training and competition environment of virtual, make up for the reason of weather, venue, equipment, funds or as a result of the negative influence to the injured athlete training brings. Compared with the real athletes training video through the simulation result, the simulation training action and standard action athletes displayed on the same screen, and at the same point of view, synchronous comparison, coaches and athletes to analysis differences, help to find out the shortcomings and improvement of technology, improve the training efficiency, but also the virtual players try to complete new action in advance this, to avoid sports injuries caused by difficult and complex technical movement, reduce the risk coefficient of sports training. Three dimensional simulation research of basketball technology requires computer experts to work closely with basketball experts to tackle the problem, and ensure that the results will be improved in sports training and competition. From the existing results, both the trampoline, diving, gymnastics and other performance sport, basketball, hockey or equivalent field competition project, because of not considering the individual physiological and psychological factors such as athletes and lead to the generalization of the study, in fact, the actual distance of sport training and competition requirements than computer expert labor too obvious. This is mainly related to the fact that there are too few experts and scholars who are proficient in computer information technology and the particularity of sports in our country, which make the computer experts unable to obtain the high-level visual perception of sports technology.

5. Conclusions

Basketball technology of 3D simulation system can not only help the traditional teaching and training methods, but also conducive to learning, inspire athletes in training, improve the ability of cognition, improve access and realize the effective organization and management of teaching and training of information knowledge and skills, learning and training provides the ideal environment for teaching and training. At present, the domestic and foreign basketball after long-term practice and research were identified: the introduction of 3D simulation technology in basketball technical training, can help athletes to master the technical essentials of action as

soon as possible in the training process, reduce blind repetition, greatly improve training efficiency and reduce the possibility of injury of the athletes, to achieve the best effect of training.

References

[1] Bao Wenshu. (2014). "Research on college English teaching based on intercultural communication in engineering universities". World Transactions on Engineering and TechnologyEducation, 12(3): 191-195.

[2] Bao Wenshu, Zhou Haiying, Lu Wang, Xie Feng. (2016). "The system of knowledge management using web based learning and education technology", COMPUTERSYSTEMS SCIENCEANDENGINEERING, 31(6): 469-473.

[3] Djelassi, S. and Decoopman, I. (2013). "Customers' participation in product development through crowd sourcing: Issues and implications". Industrial Marketing Management, 42, 683-692.

[4] Eijck, K., Lievens, J. (2008). "Cultural omnivorousness as a combination of highbrow, pop, and folk elements: The relation between taste patterns and attitudes concerning social integration". Poetics,36, 217-242.

[5] Dai, W., Fan, L. (2012). "Discussion about the Pros and Cons and Recommendations for Multimedia Teaching in Local Vocational Schools". PhysicsProcedia, 33, 1144-1148.

[6] Hu, M., Xu, S. (2012). "Research of Multimedia Teaching on Principles of Management". IERIProcedia, 2, 666-670.

[7] Huang, Y., Backman, S. (2013). "Experiencing student learning and tourism training in a 3D virtual world: An exploratory study". Journal of Hospitality,Leisure,Sport & TourismEducation, 13, 190-201.

[8] Jian-hua, S., Hong, L. (2012). "Explore the Effective Use of Multimedia Technology in College Physics Teaching". EnergyProcedia, 17, 1897-1900.

[9] Taghizadeh-Mehrjardi R, Nabiollahi K, Minasny B, et al. (2015). "Comparing data mining classifiers to predict spatial distribution of USDA-family soil groups in Baneh region, Iran", Geoderma, 253-254.

[10] Huo Xiongfei. (2015). "Vocational Education Teacher Education Competency Model Construction and Application", China Vocational and TechnicalEducation, (25): 81-85.

[11] Huang Yongchun, Lei Licing. (2016). "Analysis on Competency Structure of Entrepreneurs in Emerging Industries Based on Cross-case Analysis", Scienceand TechnologyManagement, 37 (10): 130-141.

[12] Pang Fei. (2014). "Research on the Cultivation of College Students' Entrepreneurship Based on the Growth of the New Generation Entrepreneurs" ,EnterpriseEconomy, 4 (6): 68-72.

[13] Sigala, M. (2012). "Investigating the role and impact of geovisualisation and geocollaborative portals on collaborative elearning in tourism education". JournalofHospitality, Leisure,Sport& Tourism Education, 11, 50-66.

[14] Zhang, C., Chen, X. (2012). "Use of Multimedia in Gross Infective Pathogen Experimental Teaching". Procedia Engineering, 37, 64-67.