A Sports Analysis System Based on Video Game Technology: Design and Implementation

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Abstract — **The use of athletes training, sports training game video image as a reference, physical motion analysis is an effective method widely used at home and abroad. Sports analysis using the research focus of today's popular image processing, human simulation, computer vision and other areas, to the athletes as the research object, its qualitative and quantitative analysis, achieve scientific aid training purposes. Sports Analysis Taking sports video images as the main object to video processing technology as the main research tool, designed and implemented a set of video control, panorama synthesis, static background suppression, moving target tracking and other functions as one of the quantization system. In this paper, monocular video for the study of human movement, designed and implemented a video-based sports analysis systems for sports fields to provide a complete analysis of qualitative and quantitative analysis system. Experimental procedure is to first get the sports video camera captured, then subjected to detection, segmentation and tracking, access to sports information and kinesiology parameters or a certain part of the body and get intuitive data and curves, reach further Objective analysis of human motion. Arithmetic system of each functional module has a certain robustness, the result is satisfactory.**

Keywords - Video Technology; Sports Analysis System; Sports Training; Human motion simulation

I. INTRODUCTION

Human motion analysis sports education and sports training in an essential work, a complete technical analysis process consists of observation, analysis and comprehensive decision composition. Simple technical analysis by the coaches in training athletes of the current state of technology through observation, and then analyzed on the basis of personal experience. This traditional methods of technical analysis there are obvious deficiencies. The purpose is to analyze human motion in time-varying image sequences, obtained on human attributes such as spatial position, attitude, velocity and restoring the three-dimensional structure of objects that scene and can make the appropriate interpretation and analysis at a higher level. Traditional sports analysis is mainly based on the observation and analysis experience and the human eye, apparently such methods have significant limitations and shortcomings. The main purpose of the analysis is through sports training and competition analysis athletes' video images, the use of video images on the temporal and spatial correlation, obtain various kinesiology parameter and all interested athletes and coach class information, and scientific guidance training [1-4]. The paper by means of Visual C ++. Net2003 development platform, research and design a video-based sports analysis system, the realization of motion video of qualitative and quantitative analysis, and highly practical.

The paper focused on monocular video human motion analysis using Direct show technology motion video control; the use-based mosaic image stitching technology to extract video background information, field segmentation of video images, the extraction of video moving target Finally, the panoramic image synthesis; use filter out static background frame difference method to achieve background suppression; Kalman filtering and color matching technology, key parts of the motion for automatic tracking, and get kinesiology parameters to establish video-based sports Analysis system [5-7]. The main function of the frame system, as shown in Figure 1.
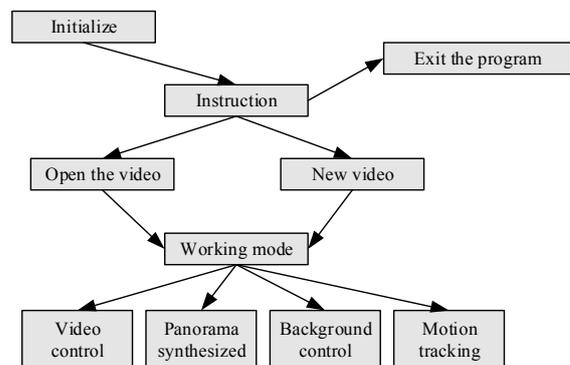

Figure 1. Structure of Video motion analysis system .

The system consists of four parts. Based on video image sequence of sports tracking technology is one of the hot spot in the field of computer vision. Sports track targets from the video image sequence detection, tracking, sports, for human motion parameters, edit and use has access to human movement data, reach the purpose of machine's understanding and analysis of sports behavior. Human motion tracking based on video in video monitoring, analysis of sports, auxiliary clinical medical diagnosis, animation,

games, virtual reality and augmented reality, human-computer interaction, and other fields has a broad application prospect.

II. THEORY OF HUMAN MOTION SIMULATION AND VIDEO ANALYSIS TECHNOLOGY

Human biomechanical study of the various kinematic and dynamical quantities limb volume between body movement, and then design, manufacture, bionic model human motion. Because all the action of human movement is at a certain time and space, in order to get the body in the course of the campaign as well as a variety of data in human-computer work environment, you must use the appropriate test system, capture video image sequences, split Images of moving objects and body parts and track in the image sequence analysis of the target of interest and even some joint movement, to establish a geometric model of the human body, 2D/3D motion and some articulation curve [8-9]. Therefore, in order to make sports teaching and training towards quantitative, objective and scientific, the author computer graphics image application of knowledge in the field of biomechanics, with VC ++ 6. 0 development platform, based on the study and implementation of a video sequence human motion analysis system.

3D human motion simulation and auxiliary training functions of different sports video analysis, based on a digital computer with three-dimensional human motion simulation technology, human movement biomechanics of human motion data and real data as the basis for 3D way realistic simulation, design and analysis technology, therefore, has a strong guiding significance [10]. Currently the most popular three-dimensional human motion tracking method based on three-dimensional model of the human skeleton matching principle is to use more than one joint model representation of the body movement, then the attitude of the state to find a group of spatial parameters, so that the body posture of the corresponding parameters and image feature extraction most in line with the bottom. Any motion estimation method based on the characteristics of the model [11-12].

A. Camera projection model

After the elimination of distortion, the camera perspective projection process can be described using the pinhole model. In this model, the 3D world coordinates of projective coordinates is

$$X = [X_w, Y_w, Z_w, 1]$$,

it follows

$$Z_c \begin{bmatrix} u \\ v \\ 1 \end{bmatrix} = M^{progect} X = M_{in} M_{ex} X$$,

and then it projects to image coordinates

$$[u, v, 1]$$.

(M_{in} is inside parameter matrix.

$$M_{ex} = \begin{bmatrix} R & t \\ O & 1 \end{bmatrix}$$

is the matrix of outside the camera parameter. R is "3 X 3" pattern rotation matrix, presented for the rotation of camera.)

We use open-CV provides a calibration algorithm to calculate the parameters of each camera. Camera external parameters, use the manual selection ground silkworm known world camera parameters calculated based on the coordinates of the point.

B. Human body model definition and projection process

Human model is divided into two categories, is 2 d and 3 d model. Blob model contains 2 d; 3 d include meatballs models. In order to restore the body's 3 dposture, we have defined three-dimensional human body model. Model consists of a skeletal structure and appearance. Bones of the human body determines the attitude of parameters describing the shape and appearance of the model of the body. After the projection, the appearance of the human body model is used to extract the image of relatively low-level features [13-14].

In order to compare the human body model and an image, the image of the current frame mannequin projection camera projection matrix of parameters and status, and then compare the current attitude and image similarity.

Assume one point X in the body surface belong to joint point

$$J_n, x^{local}$$

is the local coordinate of joint point in the surface point. From J_n up to root joint

$$J_k (1 \le k \le n)$$.

Partial transformation matrix for Each joint J_k relative and the parent joints J_{k-1} is M^{J_k}, according to the forward kinematics equation, the world coordinates of X is:

$$x^{world} = M^{globalJ_n} x^{local} = M^{J_1} M^{J_2} \dots M^{J_n} x^{local} \quad (1)$$

So the coordinates of the surface point's projection onto the image is:

$$x^{img} = M^{project(cami)} M^{globalJ_n} x^{local} \quad (2)$$

($x^{img}, x^{local}, x^{world}$ are homogeneous coordinates)

To sum up, the camera projection process can be expressed as a nonlinear function:

$$\mathrm{x}^{img} = f_{cami}\left(\varphi, x^{local}\right) \tag{3}$$

Accelerate projection model, we did not directly point to a projection surface 3D, but 2D graphics truncated cone or ellipsoid projection: a stepped shape and oval. Then, based on these 2D graphics sampling and analysis. We can get some predictions projection features, such as an internal point of each part of the body, predicted body contour points and boundary points and so on. Study of object motion is detected sequence of video images, multi-frame images acquired at different time included between the camera and scene present in relative motion information, moving target detection is the use of the motion information, through a certain area from the background motion algorithm carved out. Existing moving object detection, segmentation algorithm can be roughly divided into the following three categories background estimation method based on the method and the difference method based on optical flow method.

III. SPORTS VIDEO DETECTION TECHNOLOGY

Data can come from human joint motion capture system data (motion capture system) or Microsoft Kinect depth camera obtained after treatment. The key is how to build a three-dimensional human body model obtained after the data. The human skeleton model is the base model of the human body. Important because it contains the joint three-dimensional location information, it can better represent the human information. Artificial joint model used in Figure 2, which contains a total of 23 joints, the root of the waist. Because doing so would cause motion capture coordinate data is based on the world coordinate system, we first will coordinate every action will be converted to the root of the coordinate origin of the world coordinate system, in order to make action sequences absolute position data regardless of the body.
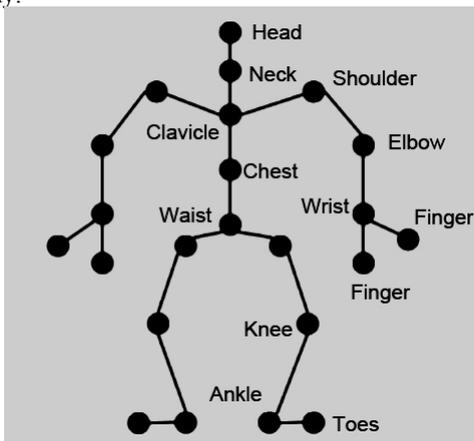

Figure 2. 3D human skeleton model.

Detection is the body's moving parts extracted from the image frame in the sequence of video images in video-based human motion limbs. Human detection is the basis of human motion analysis, it is the key technology of human motion

capture and gesture recognition field. Effective segmentation of parts of human motion tracking human motion recognition, reconstruction and other post-processing plays a vital role, directly affect the final result. Currently, video technology in the field of human detection human animation, human computer interaction, intelligent video surveillance, sports analysis have important applications. Although human motion detection technology has a broad prospect, however, due to the complexity of the video in the background, non-rigid and non-rigid structure of the human body movements and body self-occlusion and occlusion interoperability issues, making inter-difference method, background subtraction division, optical flow method, etc. These conventional moving object extraction technology can not achieve satisfactory results in terms of human detection, so far, human motion detection technology is still relatively difficult research topic. Currently, many studies of human motion tracking and recognition are ignored and simplify this step, we assume that the target has been detected, a direct follow-up treatment. The vast majority of human detection system also simplifies the background, or key parts of the human body joined the mark. Functionally, the existing systems can only be achieved on most people's identification and tracking overall position, but was unable to obtain the local motion information and physical body posture. Figure 1.1 shows the sports-based video capture and analysis system processes. First, shoot the training process of athletes from multiple angles, then use the video processing algorithms and tracking algorithm for shooting video processing to calculate the motion parameters athletes. On this basis, the use of domain knowledge in sports analysis, analysis of the movement parameter analysis results in a feedback manner to return to the scene sports specialists and coaches for on-site instruction basis. Further current measurement result movement and shooting video stored in the database for comparison and analysis of historical data.
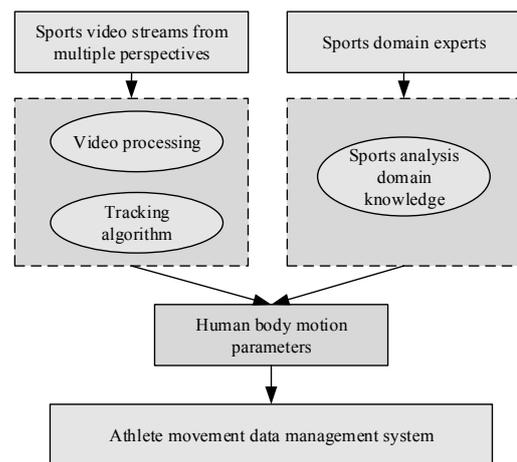

Figure 3. Video motion capture and analysis for sports.

Based on the analysis of human motion video is an important area of computer vision research, it is detected from the video sequence of moving objects, extracting the key parts of the body, to obtain useful information on the

body movements, to achieve further recognition of human movement, posture, etc. and analysis. Video-based human motion analysis technology as an important technology Biomechanical with digital image processing technology combined, in human-computer interaction, intelligent monitoring, sports analysis, medical diagnosis, virtual reality and other fields have broad application prospects. The overall block diagram in sports video analysis system based on tracking, the first image acquisition system to shoot some sports video, and then import the video tracking software on the PC, on the athlete's identity is automatic tracking, get each joint position in space coordinates, the last of these coordinates mathematical calculations to obtain the relevant kinematic parameters.

IV. ANALYSIS ON HUMAN MOTION SIMULATION AND VIDEO ANALYSIS SYSTEM

The system uses digital technology, three-dimensional computer simulation of human movement, human motion biomechanics of human motion data and real data, realistic 3D simulation, design a trampoline technology, simulation technology to generate sets of action choreography, and supplemented by human movement dynamics principle, verification, analysis, simulation operation last screen, synchronized with the actual training initiatives, stronger guidance.

System structure shown in Figure 4. Compared to the standard system is mainly technical action motion simulation and modeling actions and training of two major components, the so-called standard technology, refers to the presence of coaches and referees to endorse or ideological ideal technology movement, a technology in action in the game get scores. If it can coaches and referees graphics and quantitative knowledge, it will have a good supporting role in sports training. Therefore, it is necessary to use techniques designed coaches and referees.
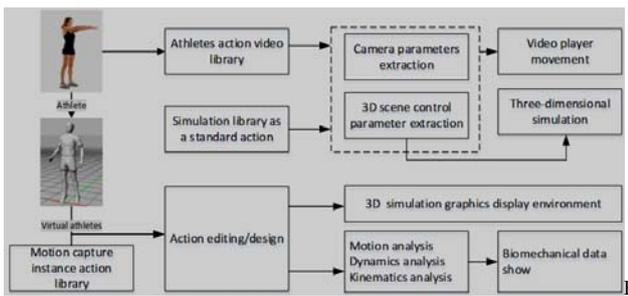

Figure 4. 3D human motion simulation and video analysis system structure.

The system is based on operating instance database, using the migration map, stitching motion editing method, such as editing, design personalized standard techniques. To narrow the differences between the simulation results and the actual situation, which requires the athlete physical parameter, budget inertia parameters according to human characteristic attitude parameters, and applied to the human body motion equations to verify the simulation results. In practice, training, coach or referee approved standard action, simulation and practical training athletes motion analysis.

Technology will help athletes aware of their shortcomings, to improve the quality of training. In this paper, by using an orthogonal projection camera model to calculate the camera parameters from athletes training videos, training videos can be identified and the same three-dimensional virtual scene angle control parameters. Athletes simulation training compared to actual movement, assist coaching sports training. The simulated action compared with the actual movement process is shown in figure 5.
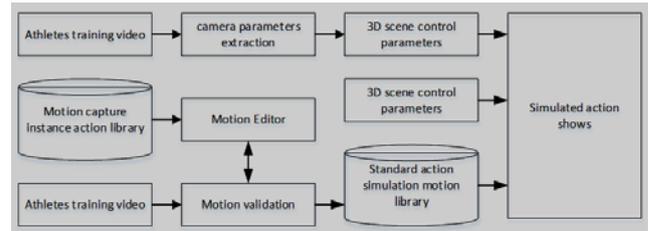

Figure 5. Comparison process between simulated and actual action

V. VIDEO-BASED SPORTS ANALYSIS APPLICATIONS

Including the realization of three-dimensional motion simulation, based on a comparison to the actual situation of sports video analysis system, action choreography action editor, kinematics analysis, video analysis and other six auxiliary training methods, the upgrade version behind, will join Dynamics. These methods can help athletes understand and master the basic action sports to help athletes understand the nature of sports action from physiological and physical laws, according to their own conditions, the development of appropriate training measures. Actual comparison module standard action motion video and motion simulation system virtual athlete will be the same screen contrast viewing angle display, intuitive and accurate comparison of the difference between the two, to help athletes improve athletic performance and training efficiency.

Three-dimensional motion analysis technology analysis including kinematic and dynamic analysis. As the rotation angle of the joint analysis of trends, analyzes different heights, athletes and other differences of the same length as the joint action, to quantify the state of image motion manner athletes displayed. We chose virtual athletes focus joint, the center of gravity of the visual display in a certain time trace shown in Figure 6.
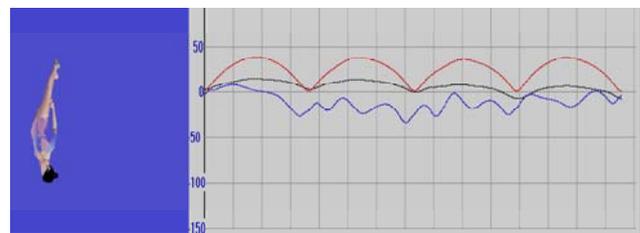

Figure 6. Video-based sports analysis application.

In order to achieve integrity and the independence movement database design needs, we need to realize that the correct classification of technical movements, but in order to

achieve common needs, we need to ensure that actions are scalable library. According to the motion operation of the technical action task decomposition model and classification methods, we propose a hierarchy Players libraries, from top to bottom can be divided into action unit layer, layer, layer, action elements and technical operations. The basic action elements layer: This layer contains only one basic motilin unit. The basic elements of a framework for action defines the basic action sports athletes, and describes some of the basic elements of relevant, including start-up operation cycle, pause, stop, and general motion parameters.

Technical action elements layer: Basic operating unit derived elements obtained technical action elements, and the basic semantic features of sports action, but the action can not be broken down semantics is human action sports most basic units. Sports action elements generally follow the model divided the human joints and freedom of movement. Action cell layer: technical action unit is composed of several technical action elements in accordance with certain semantic rules constitute a certain degree of semantic features, describes the technical operations knowledge semantic features, but does not include any specific operational semantics related activities.

Action base layer, we design based on finite state is a basic fundamental class action, behavior and action units of the parent class action element, responsible for implementing the technical movements round-robin scheduling; element layer movement, the movement of basic derived and packaging plane motion, attitude sports cell layer, according to the action from further action action elements with a specific semantic features;. The adjustment, unarmed, tools, and other dynamic operating element unit operation

VI. CONCLUSION

Computer vision image processing technology-based intelligent monitoring system is currently a hot item urgent needs of society, subject to various objective and subjective factors, constraints, the limited intelligent monitoring system with the intelligent modules for the environment, there is a certain distance from social requirements gap. Overall, the current intelligent monitoring system is still in the proof of concept stage of research. At present, for image classification algorithm based on static image library basically, there is no relationship between the images, and this article take advantage of the timing relationship between video sequences, analysis of sports information, classification given conclusion, improve intelligent video system sex. Based on the visual image processing and artificial intelligence techniques in-depth research and analysis on the basis of comprehensive consideration of motion detection and image segmentation and other visual aspects of the technical characteristics and problems, how to select the sports objective physical characteristics and behavioral characteristics using support vector machine design suitable image analyzer, at each stage using wide range of applications and algorithms robust high technology, we propose a method based on analysis of sports information video. Physical characteristics and behavior analysis features to some extent for the video stream sports information, sports

target extraction, the use of complete fusion of the two video monitor screen dynamic target analysis, including sports target classification and behavior judgment. In this paper, considering the application of platform restrictions, in the realization does not use image processing functions, but full use of C language programming, to facilitate porting to run on the front of the camera embedded platforms in the future. After extensive testing of experimental data, the intended target of work well done, to effectively improve the intelligence of video surveillance systems, and promote the intelligent monitoring system from concept phase to mass production stage, with some reference value and practical significance.

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