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A Study on Motion Capture Data Editing in Virtual Environment

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Abstract: Motion capture technology is very crucial in the computer games and animation development especially for interactively simulating 3-Dimensional (3D) human motion. The main purpose of motion capture is to produce realistic 3D humanoid character movement in virtual environment. This paper presents a study on motion capture data editing method used by researcher in 3D humanoid movement development. This study can contribute to other researchers on getting a better insight on motion capture data editing process, experimental hardware and challenges. The main purpose of this study is to give a brief idea to novice animators and researchers on the current motion capture technologies and techniques.

Key words: Motion Capture · Motion Data Editing · Virtual Environment

INTRODUCTION

Motion capture is a full human body recording and tracking technology that can be used to calculate human body position and orientation in virtual environments including 3-Dimensional animation and computer games. There is a lot of computer graphic companies that have used motion capture due to realistic output motion created by this technology. Generally, motion capture used by industry is very high cost with good quality. There are many differences between motion capture used by industry and university researcher [1]. A lot of university researchers used low-cost motion capture technology, producing the output motion that is not realistic as industry standard. Thus, motion editing method has been produced to overcome the weaknesses in low quality motion capture including inaccuracy data information.

Current motion capture technology has been developed referring to several traditional photography techniques and tools such as zoopraxiscope, rotoscoping and stroboscope. Eadward Muybridge (1872) invented zoopraxiscope; a moving image from a large quantity of photograph images [14]. In 1915, Max Fleischer created rotoscoping, a device that captures real-time cartoon characters over photographed frames. Rotoscoping methodology has been used by Walt Disney at that time for getting natural character movements in their cartoon production. An MIT Scientist, Harold Edgerton, has been exploring high speed photography technique named stroboscope to capture slow motion images. In 1980, computer graphics have been introduced in research lab and motion capture technology grows rapidly.

Motion capture technology uses a marker for recording and tracking human movement process. Nowadays, motion capture markers can be divided to three types namely active, passive and markerless markers. Figure 1 shows the types of motion capture markers. The types of marker in motion capture used by the animators will result in different motion capture device cost, editing time and quality of output motion [12]. Magnetical, inertial and optical methods are widely used by researchers and animators in recording and tracking human movements. Optical methodology uses camera to track the location of LED's or retroreflective marker located on actor's body. Meanwhile, magnetic sensor uses transmitter and receiver to track human body orientation. Inertial sensor can be a value added tool for accuracy tracking method by tracking physical movements of the human body. Magnetic sensor in motion capture can be used in real time at a cheaper price than optical motion capture. The quantity of sensors in

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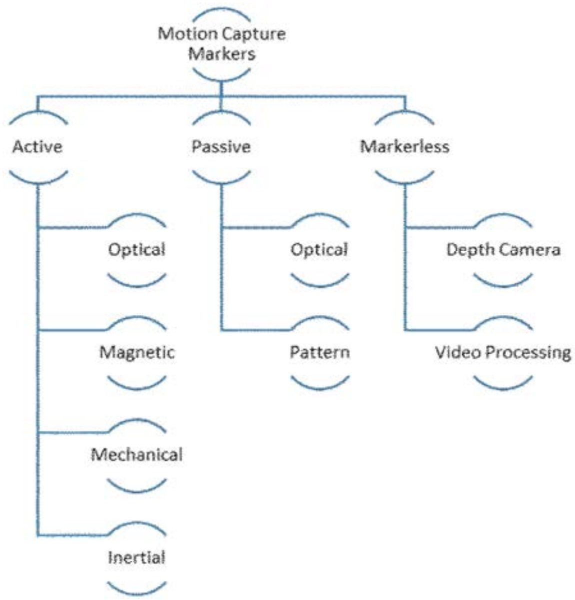

Fig. 1: Type of Motion Capture Markers

Fig. 2: Standard process in motion capture

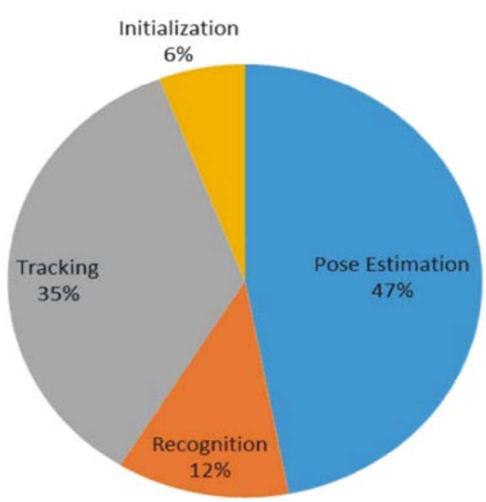

Fig. 3: Motion capture focus publication[2] from 1980 into 2000

magnetic motion capture is lower than optical motion capture. Usually, active and passive types of marker require the actor to wear a suit with markers or strap with sensors. On the other hand, markerless sensors does not require any suits or sensors since it can track and record human movements directly using depth cameras like kinect.

As discussed earlier, motion capture tools are very important in producing realistic movements in the virtual environment. However, all these types of motion capture marker have the same weaknesses [13] and limits such as noise and data error in the output motion especially those involving low cost and markerless types marker. Therefore, motion editing method has been created by this study to solve the addressed problems. Figure 2 shows a standard process in motion capture for recording and tracking real human movements. The recording phase involves capturing human movements using human actor and motion capture device. After the recording process, motion capture data is displayed using motion capture provided software. Normally, human skeleton is used in the display mode, making it easier for users to detect any defect in the motion produced. The process in cleaning motion data needs to get realistic human motion in virtual environment. After the noise data is cleaned, motion capture data is mapped with 3D humanoid characters in the computer games, animations or simulations with realistic movements.

Related Study: Early comprehensive survey and literature on motion capture technology from 1980 into 2000 [2] have been done by Moeslund (2001). The study has been divided into general structures to analyse human body motions to four main functions known as initial process, track process, pose estimation process and recognition process [2]. From the study, a lot of researchers at that time had focused on research publication in pose estimation process function [2] followed by tracking, recognition and initialisation as shown in Figure 3. Pose estimation is a postprocessing [2] step in motion capture to track the configuration of human body. There are three classes in pose estimation namely the free model to represent a pose, indirect model used to estimate pose and direct model for subject observation [2].

Tracking research focuses on recognition motion capture data with related human body joints. Object-based and image-based data have been represented. Another topic is recognition research, which is one of post processing study in motion capture [2]. This topic has been divided to two parts; static recognition and

Table 1: Capturing human body shapes and motion study [3]

Research Topic	Overview	Activity
Surface reconstruction	3D laser scanner	Capture data with high accuracy and precision
	Photometric stereo	Use multiple images
	Video-based	Record using video camera
	Depth cameras	Capture dynamic color an depth data
Motion Capture	Sensor-based	Use physical sensor such as pressure, magntometer, inertial or optical sensors in tracking data
	Image-based	Use color image based include multi-camera color image
	Depth image based	Use monocular and different depth images
	Hybrid sensor	Combination of depth camera and sensors in recording and tracking process
Motion synthesis	Motion graphs	Divide motion data into various fragments in database
	Motion Editing	Manipulate keyframe to achieve user's requirement motion
	Interpolation	Mix between two or more existing pose or motion sequences
	Statistical synthesis	Use machine learning and statistical model method
	Stylized	Generate different style for the same motion

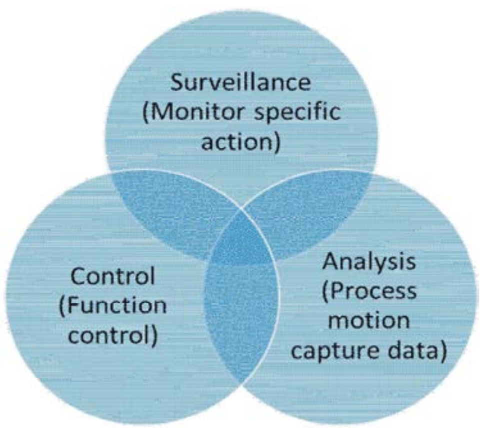

Fig. 4: Application areas [2] for human motion capture

dynamic recognition [2]. Besides, there are three major application areas related with motion capture as shown in Figure 4. For this major application, researcher had focused on characteristics of robustness of device in operation, accuracy between actual movement and captured motion, as well as speed processing in real-time and non real-time.

Meanwhile, [3] have conducted a survey on capturing human body shapes and motion as demonstrated in Table 1. The survey has been divided to three parts namely surface reconstruction, motion capture and motion synthesis [3]. In surface reconstruction, they explained on 3D data acquisition techniques for developing 3D humanoid character body such as 3D laser scanner, photometric stereo, video-based process and depth –camera tools. Motion capture and synthesis are the very important subjects for creating realistic 3D humanoid characters. Reseachers analysed motion capture tools such as image-based equipment, depth image based equipment and sensor based equipment. The last part in this literature is on motion synthesis techniques including motion graphs, motion manipulation, motion interpolation, statistical method and editing motion style.

Motion Capture Data Editing Method: One of the studies such as that done by Lee et al. [4] on motion editing for humanoid character has been carried out using hierarchical approach. They introduced the combination of inverse kinematic solver method and hierarchical curve fitting technique. The main purpose of their study is to solve retargetting motion problem. The motion editing algorithm was tested using SGI Indigo2 workstation (R1000 195 MHz processor) and compared at several viewpoints. Their comparison was made using different motions and environments including by walking on flat ground with rough terrain, climbing rope with different 3D humanoid characters, as well as morphing process and transition process between walking and sneaking. From their observation, the algorithm created has low maximum errors and good execute time [4]. The drawback of this hybrid algorithm is inter-frame constrant happened in multiple frames.

Zordan [5] applied motion editing control system by tracking the trajectory of motion capture data. They simulated hit and hit reaction from 3D humanoid characters. The study involved motion capture data for table tennis and boxing activities. Simulation was run using 400 Mhz R1200 SGI and for evaluating the experiment, they compared the result motion with real human video and recorded movement. Ismail et al. [6] used trajectory control techniques for controlling additional forces to produce new 3D humanoid movements from motion capture data. They combined the trajectory algorithm with key pose motion technique to produce different styles of realistic motion. They evaluated their experiment by observing and comparing the result with ground truth data and recorded motion using keyframe techniques.

Furthermore, Holden et al. [7] created 3D humanoid character motion editing and motion synthesis framework. They manipulated the realistic 3D humanoid movements by inventing a motion dataset for deep learning to generate space optimisation in the training network. They simulated the experiment using a NVIDIA GeForce GTX 660 GPU and evaluated the result by comparing the performances of produce motions with other network structures. For performance-based motion editing method, Ishigaki et. al [8] proposed a simple control interface to produce realistic 3D humanoid motion in virtual environment. They simulated the motion data using 3.4Ghz Pentium 4 CPU. Several real human movements have been recorded and tracked such as walk motion, jump motion and climb motions. They evaluated the result using observation method by comparing users' experience with minimal training instructions.

Other researchers involved in motion editing study are Sok et al. [9] using momentum and external forces approach. They recorded the real human movements using 120Hz motion capture input data. Their experimental result was validated by asking professional animators to test their system for editing 3D humanoid movement. Meanwhile, Ho et al. [10] came up with motion retargeting algorithm that solved close interaction motion problem. They tested the output using Core i7 2.67GHz CPU. The output result was compared with that of others researchers. Coros et. al [11] presented real-time physical transition algorithm to study transition between walking-standing and multi-step movement. They simulated the motions using 2.4 GHz 2 Core equipment and observed the output result as a validation process.

CONCLUSION

A lot of studies have been done for motion capture data editing process. Researchers continuously try to find the right balance between low cost motion capture and high quality output motion. The motion editing method is very important to produce realistic 3D humanoid movements in the virtual environment. From previous studies, a lot of researchers have done qualitative validation process for testing the experimental result. Normally, they invite professional animators to run their system and compare the result with ground truth data or output from other researchers.

This paper presented an introduction for motion capture editing method in the virtual environment. In the future, comprehensive study on motion editing method need to be done. Besides, experimental result from researchers in this area need to be collected and analysed. The main challenges in the motion editing method for motion capture data in the virtual environment are:

- Producing real-time motion capture data editing
- Synthesis different styles of motion pose
- Mapping different sizes of human body motion capture data

Hopefully, this simple study on motion capture data editing method can help others to understand related studies that have been done previously. The motion editing research method for 3D humanoid character is very crucial especially in the field of computer animations, computer games and mixed reality environment.

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