Review on Motion Capture Technology

By Rahul M

Abstract- In this paper we provide the reader with a overview of what is motion capture, its history and evolution so far and processes used in acquiring the tri-dimensional data of the recorded scene, take or animation. A brief look at the "mocap" process's (short for motion capture) structure is given followed by an extensive list of the technologies behind the most popular systems used today. We dive into the inner works of acoustical, mechanical, magnetic and optical mocap systems, also discussing the differences between active, passive and marker less optical systems, since these are the most popular of the above referred. Later on we also provide some insight into facial motion capture, right after we compare the data acquisition systems and quickly overview the generic data file structure. Finally we provide examples of real-world applications and some possible research fields in the area along with our conclusions.

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I. Introduction

Animation gave its first steps in the early 20th century, when in 1911, cartoonist Winsor McCay drew a character in multiple sheets of paper with slight changes between these and then sampled them at a constant rate to create the illusion of motion .

Animation processes did not witness considerable innovation until computers started to take place in the process. With the birth of keyframing, which reduced the amount of samples needed to create an animation animators saw their work a lot more simplified. This process was time consuming because, at the time, every artist was forced to individually animate each pose/frame. With the introduction of keyframing the artist specified the initial and ending frames of the animation and the intermediate frames of the movement where automatically generated. However some animations were still impossible to recreate due to their inherent complexity, for example the human walking animation, which is terrifyingly complex due to our articulations.

To speed up the animation process further, motion capture was invented, a means by which we capture the movements of objects in the real world and then insert the data of the captured movement in a tri-dimensional model of the world in a virtual environment. The process first evolved with mechanical systems that were quite cumbersome and limited the amount of freedom the actor could experience, limiting severely the animation spectrum that could be captured. This happened mainly because these were mechanical systems that resorted to very restrictive suits and large amounts of cable that hindered the actor's movements. They include acoustical, mechanical, optical and magnetic systems, further divided in marker and markerless systems.

[1] Today, motion capture is widely used in the gaming, movie and animation industry as a means to provide quick, budget adapting body and/or facial animations in order to animate one or various characters. We provide insight into these methods and processes, and also the data processing and data formats that most systems use. Lastly we introduce some future work and research in motion capture. Research we believe would be highly beneficial and would enable future developments and breakthroughs in the area.

II. Literature Survey

[1] *Freedman Y* presented a system for person-independent hand posture recognition against complex backgrounds cues. It has a specific color i.e. the color of skin and it moves in the image with a characteristic speed. There are many more high level cues, such as the form, texture or specific trajectory which characterize a moving hand. However, in order to be fast and robust, it sticks with the simplest approach that still does the job.

From the literature survey, it is observed that the reported work motion capture do not perform effectively because motion capture is done inside a room if you want to capture a motion in outdoors it is highly expensive and time consuming because of the climate condition, localization and is less efficient. The background subtraction technique is proposed to enhance the motion tracking and detection. Also, the hardware implementation on STM32 ARM processor is done. The correlation extractor integrates the human motion (video) as input and the correlated output samples are extracted using unsupervised trained weights. The use of Karhumen – Loeve Transform (KLT) is optimal in terms of compactness of representation. However, KLT requires more pre-processing stages and hence, as an alternative Discrete Cosine Transform (DCT) which helps images to transform into parts is preferred in this research. Also, DCT closely approximates KLT in the context of information packing.

[3] *Furniss, Maureen*, presented human face recognition that do not operate directly on the reflectance of light from a face (i.e. the pixel intensity values). Instead, the primate visual system extracts visual features that are in turn processed clearly. It

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inspired machine object recognition systems, Gabor filters have been used to simulate these human visual features. Similar texture features such as local binary patterns and histograms of orientation gradients serve the same function, but they are more in tune with the discrete nature of digital images.

III.   Techniques

There are different techniques in motion capture technology some of the frequently used techniques are Mechanical motion capture, Magnetic motion capture, Magnetic motion capture

a)   Mechanical Motion Capture

[3] This technique of motion capture is achieved through the use of an exoskeleton. Each joint is then connected to an angular encoder. The value of movement of each encoder (rotation) is recorded by a computer that by knowing the relative position encoders (joints) can rebuild these movements on the screen using software. An offset is applied to each encoder, because it is very difficult to match exactly their position with that of the real relationship. The below figure describes [3.4].

Fig. 3.1: Mechanical Motion Capture using Exo skeleton

Merits and Demrits of Mechanical Motion Capture

This technique offers high precision and it has the advantage of not being influenced by external factors (such as quality or the number of cameras for Optical MOCAP).

But the catch is limited by mechanical constraints related to the implementation of the encoders and the exoskeleton. It should be noted that the exoskeleton generally use wired connections to connect the encoders to the computer. For example, there is much more difficult to move with a fairly heavy exoskeleton and connected to a large number of simple son with small reflective sphere. The freedom of movement is rather limited.

The accuracy of reproduction of the movement depends on the position encoders and modelling of the skeleton. It must match the size of the exoskeleton at each morphology. The big disadvantage comes from the coders themselves because if they are of great

precision between them it cannot move the object to capture in a so true. In effect, then use the method of optical positioning to place the animation in a decor.

b)   Magnetic Motion Capture

Magnetic motion capture is done through a field of electro-Magenta is introduced in which sensors are coils of sensors electrics, Les son are represented on a place mark in 3 axes x,y,z. To determine their position on the capture field disturbance created by a son through an antenna then we can know its orientation. The below figure describes [5].
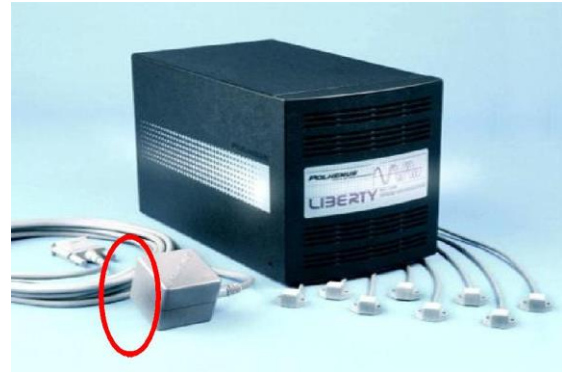

Fig. 3.2: Magnetic Field Transmitter Source

Merits and Demerits of Magnetic Motion Capture

1. The advantage of this method is that data captured is accurate and no further calculations excluding from the calculation of position is useful in handling.
2. But any metal object disturbs the magnetic field and distorts the data.

c)   Optical Motion Capture

The capture is based on optical shooting several synchronized cameras, the synthesis of coordinates (x, y) of the same object from different angles allows to deduce the coordinates (x, y, z). This method involves the consideration of complex problems such as optical parallax. Distortion lens used, etc. The signal thus undergoes many interpolations. However a correct calibration of these parameters will help in high accuracy of data collected. To determine their position on the capture field disturbance created by a son through an antenna then we can know its orientation. The above figure describes [3].
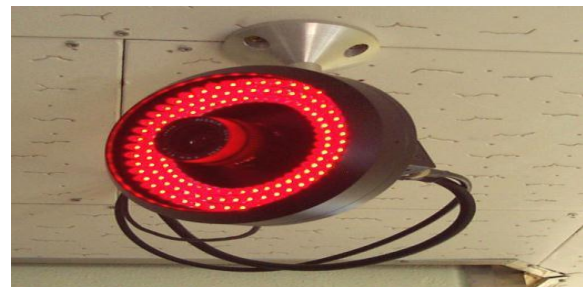

Fig. 3.3: Camera emitting Infrared Radiations

The operating principle is similar to radar: the cameras emit radiation usually infrared, reflected by the markers and then returned to the same cameras. Checking the information of each camera (minimum two cameras) to determine the position of markers in virtual space.

IV. Applications of Motion Capture

a) Advertising

There are many areas that can benefit from the use of motion capture. [1] In 1984, the first animation of a character using this technique was made in a publicity action commissioned by association of the largest producers of canned food of The United States. The animation turned into the ad called Brilliance, or Sexy Robot, which was broadcasted on the Super Bowl Championship, in 1985. The use of this technology, although impressive, even took some time to be used widely in the area of communication, gaining strength in the late 90's, when the technologies were more efficient and accessible.

b) Entertainment

[1] Between the mid to late 80's and early 90's, the technology was being enhanced and applied more often on entertainment projects, being widely used in real-time animations for television — in 1991, a French producer called Media lab, developed for a TV show the character "Mat, the ghost", which was daily broadcasted for more than three years in appearances of a minute. In that same year the Terminator II movie was launched, using the technique to animate the character T-1000, a robot made of liquid metal. Although this would not be the first use of the technique in the film, it was the first use of motion capture in a relevant character. Currently, the cinema is still one of the biggest industries that makes use of this technique. The videogames also had a representative role in using the motion capture. In the 90's this media was responsible for most of the use of motion capture for animation, keeping its current use for entertainment. Even today, many highly qualified technical and artistically games use motion capture, being also employed in digital games consoles such as Nintendo Wii, Xbox and Playstation EyeToy, carrying the players ' movements into the games.

c) Health

[5] This field is a largely benefited by motion capture processes. One of the main areas served by this technology is biomechanical analysis, which can be used to verify the conditions of a person requiring prosthesis. The motion capture can analyze how a person performs his movements and where he exerts more strength in order to identify points in the body where any workload is happening, thus providing data for the construction of custom prostheses for each person and an unprecedented analysis on the progress of rehabilitation work.

d) Sports

The motion capture can be used to analyze the performance of athletes, providing information about the way people move; allowing them to improve their performance by recognizing its gaps. The capture works out in a specific situation, analyzing a certain athlete, and in a general aspect, analyzing the performance data of all athletes involved in a match.

V. Conclusion

Mocap systems, as shown throughout the paper, have evolved from simple, highly restricting, user un-friendly systems (software wise), to very mobile and specialized ones. The types of system discussed clearly all have their optimal case scenarios for deployment. However, optical mocap has evolved much more than its brethren systems. This is, for the most part, due to its ability to adapt very well to the major requirements of the film and videogame industry, which have invested and thus aided in this technology's development. Despite its advantages, there are still improvements that can be done in this field (some of which proposed in the Future Research section). Other than these improvements, some mocap systems are still very limited in terms of the area where they can capture movements, being restricted to adapted warehouses or studios. These systems are also very high budget, which, in some cases, rules them out of question. They could benefit from lower budget versions, more accessible by the public and smaller companies.

a) Direction For Future Work

i. *Captured Movement Modification:* Since every data file represents a limited and closed data set of animations these cannot be manipulated after the caption process. An interesting field of research would be how to modify or derive new movements from an already captured movement. Captured Movement Fusion and Concatenation: As an extension to the research field one could try to create a fusion of any number of movements or concatenate them in order to create new movements from these original ones.

ii. *Improvements in Actual Tracking Techniques:* As discussed, marker occlusion in optical mocap systems is critical. Improved tracking techniques could be developed to eliminate this problem.

iii. *Marker Mapping Techniques for Non-Human Beings:* Sometimes we want to capture movements that don't belong to human beings. Studying how to position the markers in the most effective way in these beings could prove beneficial, especially if the procedure could adapt itself to every object, thus becoming general and optimal.

iv. *Transference of motion captured animations between models:* Although mocap is somewhat

transferable between models there are still a lot of limitations as to which animations can be transferred, given the source and destination model. For example, the animation of a normal person cannot be transferred to a giant, since by physical laws they move in a very different manner, or between models with very different body constitutions.

v. *Improvements in Actual Tracking Techniques:* As previously discussed, marker occlusion in optical mocap systems is critical. Improved tracking techniques could be developed to eliminate this problem.

Contribution

This paper explores the different motion capture techniques which are used in several field for the capture of motion. These techniques provide invisible patterns which can be used for capturing motions.

In the introduction section we are providing the information about what motion capture is, it's origin, history, and how motion capture can be used in different fields. In literature survey we highlight the research work done by various researchers on motion capture technology. We discuss different techniques that are used in motion capture, applications of motion capture and how motion capture is implemented in different fields. Motion capture techniques are effective approach to the latest and indefinite patterns in the data. The motion which is obtained can be used by animators which can be used in different filed to get better results. Finally we conclude various implications and significance and applications of using motion capture technology.

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