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THE OPTIONS OF MOTION TRACKING IN THE VIRTUAL REALITY SYSTEMS

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ABSTRACT
The article is focused on the area of virtual reality. Virtual reality provides us the chance to see, feel and really perceive the computer-simulated environment to enter with it into the interaction. In the introduction the virtual reality term is briefly described in general and then MOCAP. The modern technology has some ways to capture the movement of people or things. Some of these technologies are described. The main aim of this article is to familiarize with the options of motion tracking in the virtual reality system, their advantages and disadvantages.
Keywords: MOCAP, motion tracking, virtual reality

1. INTRODUCTION

Virtual reality technology has been known for some years, but in the public awareness has come recently, as a toy helmet - gloves. In today's advanced time people often need to simulate some natural events such as people walking or moving some things from one place to another. These simulated events are not perfect like the original, but effort of virtual reality is to advance towards to this, to know how to show three-dimensional models and environment and to manipulate with them. Virtual reality is simulation of the real or fictive environment which can be visual sensed to the all dimension of space: height, width and depth. Virtual reality provides us the chance to see, feel and really perceive the computer-simulated environment to enter with it into the interaction. Its perfection depends on the advance of used devices as a head-mounted display, data gloves or data suits. Virtual reality is the most used for entertainment, but not only there. Currently, virtual reality achieves rapid development. It is applied almost to the all areas of our lives. However, its use is high-priced, therefore only these companies and industries can afford this technology, for which it is budget-priced. [1, 2, 3, 4]

2. MOTION TRACKING

Motion capture, motion tracking or MOCAP are terms used for describing the process of the recording of movement and the interpretation of movement into the digital model. For motion capture the movement of one or more people is monitored several times a second.
Mocap offers several advantages over the traditional computer animation of 3D model: [6]

- faster obtain of results, even in the real time
- the quantity of obtained data within a certain time period is very large in comparison with traditional animation techniques. This also contributes to cost efficiency and the performance of production deadlines.

These systems have disadvantages like everything: [6]

- specific hardware and specific software are necessary for data obtaining and processing

- the cost of software, necessary equipment and personnel can be potentially unapproachable for small business
- the motion capture system can have special requirements for the space
- if problems are created, it is easier to recalibrate tracking area and start again than to try to manipulate with data
- if the animation model has different proportions from the user, collisions may arise. For example, if the user has large hands, these may intersect with model's hands or body if the user is not careful with their physical movie

The most systems allow track six degrees of freedom (6DOF). These are the object's position within the x, y and z coordinates of a space and the object's orientation - yaw, pitch and roll (Fig. 1).

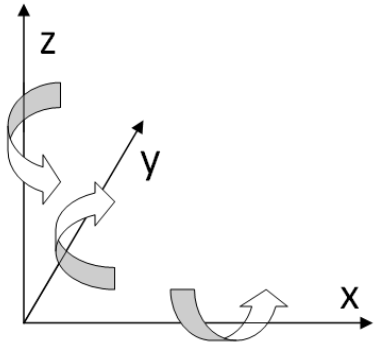

Figure 1. Six degrees of freedom

Every tracking system includes a device, a sensor and a control unit. The device generates a signal, the sensor detects this signal and the control unit processes the signal and sends information to the CPU. Some systems require the attaching of sensors to the user (or the user's equipment) and the signal emitters can be placed at fixed points in the space. Some systems have the emitters attached with the user wearing and the sensors are placed in the space. The signals sent from emitters to sensors can take many forms, for example electromagnetic signals, acoustic or optical signals. Each technology has advantages and disadvantages. [5, 6]

2.1. Acoustic motion tracking

This system emits and tracks ultrasonic sound waves to determine the position and orientation of a target. The most systems measure the time, while signals arrive to the sensors from the emitters. Usually the sensors are stationary in the space and the user wears the ultrasonic emitters. These acoustic systems have many disadvantages. The sound travels slowly, so the update rate of position and orientation is slow. The environment can negative affect the system's efficiency, because the speed of sound in air can be changed on the temperature, humidity or barometric pressure in the environment. [5]

2.2. Electromagnetic motion tracking

Electromagnetic tracking systems work on the basis of magnetic fields. These systems measure and calculate position and orientation by the relative intensity of voltage of three orthogonal coils of emitters to the sensors.

Electromagnetic systems use the sensors placed on the body of user to measure low-frequency magnetic field generated by a transmitter source. Mostly these sensors are attached with a helmet or the gloves and the transmitter is installed on the ceiling of the workspace. [5, 6]

Advantages of these systems [8]:

- precision and update rate is not highest in these systems, but it is effective solution for this price
- electromagnetic systems are cheaper like optical systems

Disadvantages [8]:

- high latency - the system that responds slowly to movements may be disturbing for the user

- the tracking of position on the edge of the monitored space is imprecise and the object in virtual environment is trembled
- the limiting of extremely powerful movements because of sensor cables.

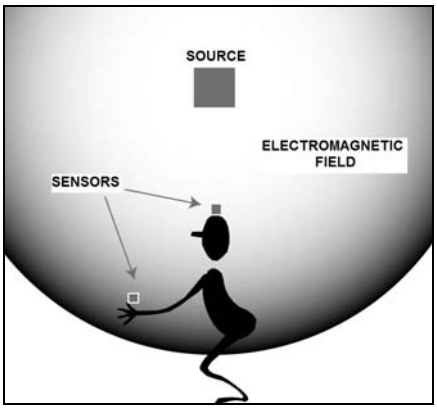

Figure 2. Electromagnetic motion tracking [8]

These systems use AC or DC current. AC (alternating current) flows into the larger distances without the loss of energy. DC (direct current) has very negative reactions to metal or magnetic fields in the environment, limited range and high latency, therefore AC systems are more used.

2.3. Mechanical motion tracking

Mechanical tracking systems are based on the physical connection between the target and a fixed reference point. These systems directly track body joint. Usually they are named as exo-skeleton motion capture systems, due to the way the sensors are attached to the user´s body. The users attach the skeletal structure to their body and as they move so do the articulated mechanical parts, measuring the performer's relative motion. The mechanical systems are real-time and relatively cheap.
A common example of a mechanical tracking system is the BOOM display. A BOOM display is an HMD (head mounted display) mounted on the end of a mechanical arm. The system detects the position and orientation by this arm. These systems have very high update rate, that is advantage, but systems have limited range of user´s motion and this is disadvantage. [5, 6]

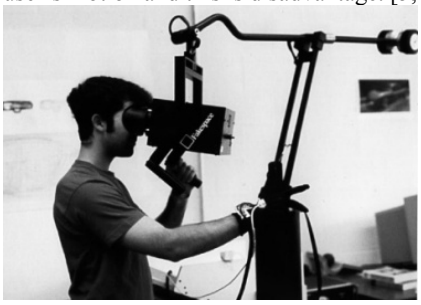

Figure 3. BOOM [7]

2.4. Optical motion tracking

These optical systems use light to measure and calculate a target's position and orientation. The signal emitter in these optical systems usually consists of a set of infrared LEDs. The sensors are cameras which track the emitted infrared light from the LEDs. The cameras record these signals and send information to the system's processing unit. The unit then extrapolate these data to calculate the position and orientation of the target. These optical systems have a fast update rate, therefore latency is minimized. The system's disadvantages are that the line of sight between a camera and an LED is

needed and it can be obscured and ambient light or infrared radiation can also make a system less effective.
The LED markers are attached on the body of user. The tracking of more people is possible we expand systems by other cameras. The typically system consists from 6 to 24 cameras. [5, 6]
Optical sensors mounted in the corners of a workspace track LED markers (Fig. 4). [10]

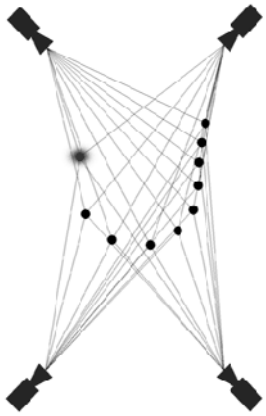

Figure 4. The principle of optical system [10]

The optical systems can use the active or passive markers. Active markers emit light and passive markers are coated retro-reflective material which reflects the light back. The light is generated near the camera lens.

3. CONCLUSION

Recently, the virtual reality technologies are increasingly applied in industry, especially in the automotive and aviation. These technologies of motion capture records only movements of the person or things, but not their appearance. The captured data is converted to a 3D model so that the model performs the same movements as the monitored people. In systems which allow user to move into the physical space, trackers detect where the user is, direction his movement and his speed. Signals from transmitters to the sensor may take many forms, for example electromagnetic signals, audio signals, optical signals or mechanical. Each technology has its advantages and disadvantages. In this time the optical motion tracking system is quite often used. It is very accurate technology for motion tracking and for applications in today´s industry is very useful.
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