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THE MOTION CAPTURE OVERVIEW

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Aim. The purpose of the present work is making an overview of the motion capture technology.
Objectives:

- Find historical information about motion capture prototypes before the invention of the computer.
- Retrace the main breakthroughs in development of motion tracking systems.
- Update on the current development of motion capture technology.

The object of this research – motion capture (sometimes referred to as mo-cap or mocap, for short) – is the process of recording the movement of objects or people. It is used in military, entertainment, sports, medical applications, and for validation of computer vision and robotics. In filmmaking and video game development, it refers to recording actions of human actors, and using that information to animate digital character models in 2D or 3D computer animation. When it includes face and fingers or captures subtle expressions, it is often referred to as performance capture. In many fields, motion capture is sometimes called motion tracking, but in filmmaking and games, motion tracking usually refers more to match moving. [1]

The practical significance of the present work is to highlight the development of motion capture and spark the academic interest to this technology. Despite the fact that researches in this direction have been conducted for few decade, such systems are rarely used outside the media industry and individual research projects.

Modern motion-capture systems are the product of a century of tinkering, innovation and computational advances. Mocap was born a lifetime before Gollum hit the big screen in The Lord of the Rings, and ages before the Cold War, Vietnam War or World War II. It was 1915, in the midst of the World War I, when animator Max Fleischer developed a technique called rotoscoping and laid the foundation for today's cutting-edge mocap technology.

Rotoscoping was a primitive and time-consuming process, but it was a necessary starting point for the industry. In the rotoscope method, animators stood at a glass-topped desk and traced over a projected live-action film frame-by-frame, copying actors' or animals' actions directly onto a hand-drawn world. The technique produced fluid, lifelike movements that animators couldn't achieve on their own.

The first full-length American film to use rotoscoping was Snow White and the Seven Dwarfs, which debuted in 1939, and Disney used the technique in subsequent films, including Alice in Wonderland, Sleeping Beauty and Peter Pan.

Two decades later, the United States were dragged in the Cold War, racing the Soviet Union to the moon, and animator Lee Harrison III was experimenting with analog circuits and cathode ray tubes. In 1959, Harrison lined a bodysuit (ANIMAC) with potentiometers (adjustable resistors) and was able to record and animate an actor's movements, in real time, on a CRT. This was a rudimentary rig – the animated actor was essentially a glowing stick figure – but it marked the first instance of real-time motion capture.

By the 1980s, animators were using bodysuits lined with active markers and a handful of large cameras to track actors' movements, resulting in digital images with much more detail and precision than Harrison's radioactive line drawings. But even in the 1990s, each mocap-ready

camera was roughly the size of a small refrigerator, and animators had to manually assign each marker, in each frame, for every scene. It was nearly as painstaking as rotoscoping.

Mocap saw a boom in the 1990s as developers took advantage of multithreading technology, higher processing speeds and the ability to use the GPU as a processor. These advances are still notable in today's mocap rigs and computers are only becoming faster and more powerful – but another boom is on the horizon. [2]

There are two main system kinds used for capturing motion data: optical systems and non-optical systems [3]:

- Optical systems:
  - Passive optical systems - use markers coated with a retroreflective material to reflect light that is generated near the cameras lens.
  - Active optical systems - triangulate positions by illuminating one LED at a time very quickly or multiple LEDs with software to identify them by their relative positions, somewhat akin to celestial navigation.
  - Markerless systems – special computer algorithms are designed to allow the system to analyze multiple streams of optical input and identify human forms, breaking them down into constituent parts for tracking.
- Non-optical systems:
  - Inertial motion capture systems – based on miniature inertial sensors, biomechanical models and sensor fusion algorithms.
  - Mechanical motion capture systems – directly track body joint angles and are often referred to as exoskeleton motion capture systems, due to the way the sensors are attached to the body.
  - Magnetic systems – calculate position and orientation by the relative magnetic flux of three orthogonal coils on both the transmitter and each receiver.

Conclusion. While film and gaming are two of the most consumer-facing uses of motion capture technology, the bulk of its usage is actually in biomechanics, helping track and treat patients with cerebral palsy, injuries affecting their movements and gait, and a broad range of other medical conditions [2]. About half of motion capture devices is dedicated to biomechanics, while a quarter is video games and movies, and the last quarter is robotics, including things like virtual reality and autonomous driving.

All of these industries are supporting each other, and therefore making good progress within the motion capture industry. That is especially true of the connection between films and video games.

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