網路與多媒體實驗　專題報告書面資料

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Topic: Computer Graphics

Outline

- ✓ History of Computer Graphics
- ✓ Computer Graphics Pipeline
- ✓ Introduction to Computer Animation

History

萌芽期	發展期	成熟期
(60's~mid 70's)	(late 70's~80's)	(90's~00's)

SAGE system, WWII

The Air Force in 1954 began the SAGE (Semi-Automatic Ground Environment) project at MIT (Massachusetts Institute of Technology) where Vannevar Bush had created a large research organization in WWII for his OSRD (Office of Scientific Research and Development).

Sketchpad invented by Dr. Ivan Sutherland, 1963

Ivan Edward Sutherland (born 1938 in Hastings, Nebraska) is a computer programmer and Internet pioneer.

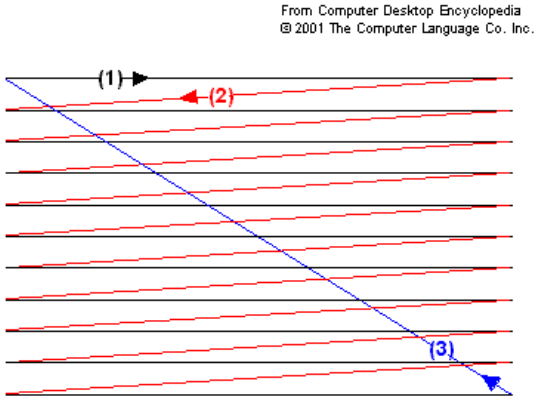
Sutherland earned his Bachelor's degree in electrical engineering from the Carnegie Institute of Technology (now Carnegie Mellon University), his Master's degree from Caltech, and his Ph.D. from MIT in EECS in 1963. He is a member of the National Academy of Engineering as well as the National Academy of Sciences.

He was the inventor of Sketchpad, an innovative program that influenced alternative forms of interaction with computers.

Sketchpad was a revolutionary computer program written by Ivan Sutherland in 1963 in the course of his PhD thesis. It helped change the way people interact with computers. Sketchpad is considered to be the ancestor of modern computer-aided drafting (CAD) programs as well as a major breakthrough in the development of computer graphics in general. Ivan Sutherland demonstrated with it that computer graphics could be utilized for both artistic and technical purposes in addition to showing a novel method of human-computer interaction.

Sketchpad was the first program ever to utilize a complete graphical user interface. Sketchpad used an x-y point plotter display as well as the then recently invented light pen. The clever way the program organized its geometric data pioneered the use of "objects" and "instances" in computing and pointed forward to object oriented programming. The main idea was to have master drawings which one could instantiate into many duplicates. If the user changed the master drawing all the instances would change as well. Another major invention in Sketchpad was to let the user easily constrain selected geometrical properties in the drawing.

First Raster Display, 1966



Principles of raster scan

Apple II, 1977

The Apple II (sometimes written as Apple][or Apple //) was the first popular microcomputer manufactured by Apple Computer. Its direct ancestor was the Apple I, a limited production circuit board computer for electronics hobbyists which pioneered many features that made the Apple II a commercial success. Introduced at the West Coast Computer Faire in 1977, the Apple II was one of the very first and most successful personal computers. A number of different models were sold, and the most popular model was manufactured with relatively minor changes into the 1990s. By the end of its production in 1993, two million Apple II series computers had been produced.

Throughout the 1980s and much of the 1990s, the Apple II was the de facto standard computer in American education; some of them are still operational in classrooms today. The Apple II was popular with business users as well as with families and schools, particularly after the release of the first-ever computer spreadsheet, VisiCalc, which initially ran only on the Apple II

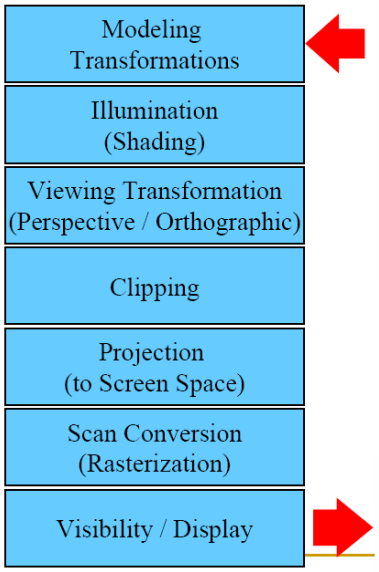
Tron by Disney, 1982

Tron is a 1982 Walt Disney Productions science fiction film starring Jeff Bridges as Kevin Flynn (and his counterpart inside the electronic world, Clu), Bruce Boxleitner as Alan Bradley (and Tron), Cindy Morgan as Lora Baines (and Yori) and Dan Shor as Ram. David Warner plays the villain, Ed Dillinger (and Sark), as well as providing the voice of the 'Master Control Program'. It was directed by Steven Lisberger. Being one of the first films from a major studio to use computer graphics extensively (developed by MAGI, Information International Inc. (Triple-I), and two others), Tron has a distinctive visual style.

Toy Story by Pixar, 1995

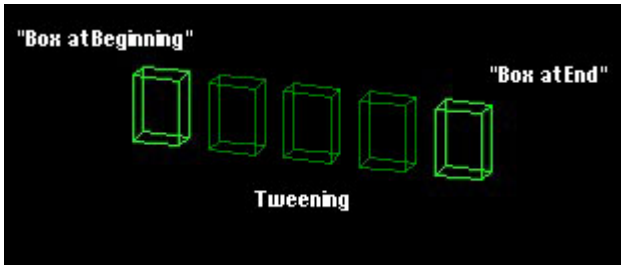
Toy Story was the first feature-length completely computer-animated movie released by Disney. At least one earlier attempt to create a computer animated feature had been tried before *Toy Story*, the announced movie *The Works*, which was never finished. *Toy Story* was also Pixar's first feature film. It grossed $191,773,049 in the United States and it took a grand total of $358,100,000 worldwide. The primary characters are toys in the room of the six-year-old boy Andy, and is mostly told from their point of view.

Computer Graphics Pipeline



Introduction to Computer Animation

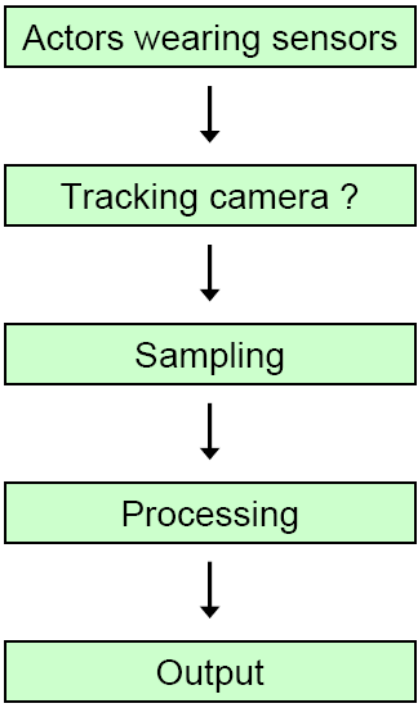
Keyframing



Keyframing is the simplest form of animating an object. Based on the notion that an object has a beginning state or condition and will be changing over time, in position, form, color, luminosity, or any other property, to some different final form. Keyframing takes the stance that we only need to show the "key" frames, or conditions, that desribe the transformation of this object, and that all other intermediate positions can be figured out from these. Take an object like the one shown at right - a simple box. The condition at the top is the starting position of motion. We might label this keyframe "Box at Beginning". The condition below that shows the final position of the box after it has been moved. This keyframe is "Box at End".

All of the intermediate stages of the box's motion from point A to point B can be calculated by breaking the distance traveled into the number of frames, 5 in thie case, that it takes to get there. Each intermediate frame then moves the box by that resultant distance. This process of figuring out the frames in between two keyframes is called "in-betweening" or simply "tweening". The frames played in succession yields a simple, though complete, keyframed animation.

Motion Capture



In the motion capture session, the movements of one or more actors are sampled many times per second. High resolution optical motion capture systems can be used to sample body, facial and finger movement at the same time. A motion capture session records only the movements of the actor, not his visual appearance. These movements are recorded as animation data which are mapped to a 3D model (human, giant robot, etc.) created by a computer artist, to move the model the same way. This is comparable to the older technique of rotoscope where the visual appearance of the motion of an actor was filmed, then the

film used as a guide for the frame by frame motion of a hand-drawn animated character.

If desired, a camera can pan, tilt, or dolly around the stage while the actor is performing and the motion capture system can capture the camera and props as well. This allows the computer generated characters, images and sets, to have the same perspective as the video images from the camera. A computer processes the data and displays the movements of the actor, as inferred from the 3D position of each marker. If desired, a virtual or real camera can be tracked as well, providing the desired camera positions in terms of objects in the set.

A related technique match moving can derive 3D camera movement from a single 2D image sequence without the use of photogrammetry, but is often ambiguous below centimeter resolution, due to the inability to distinguish pose and scale characteristics from a single vantage point. One might extrapolate that future technology might include full-frame imaging from many camera angles to record the exact position of every part of the actor's body, clothing, and hair for the entire duration of the session, resulting in a higher resolution of detail than is possible today.

After processing, the software exports animation data, which computer animators can associate with a 3D model and then manipulate using normal computer animation software. If the actor's performance was good and the software processing was accurate, this manipulation is limited to placing the actor in the scene that the animator has created and controlling the 3D model's interaction with objects.

Advantages:

- Mocap can take far fewer man-hours of work to animate a character for complex human movements.
- Mocap can capture secondary animation that traditional animators might not have had the skill, or time to create. For example, a quick movement of the head by the actor might cause his hip to twist slightly. This nuance might be understood by a traditional animator but be too time consuming and difficult to accurately represent, but it is captured accurately by mocap, which is why mocap animation often seems shockingly realistic compared with hand animated models. Incidentally, one of the hallmarks of rotoscope in traditional animation is just such secondary "business."
- Mocap can accurately capture difficult-to-model physical movement. For example, if the mocap actor does a backflip while holding nunchaku by the chain, both sticks of the nunchucks will be captured by the cameras moving in a realistic fashion. A traditional animator might not be able to physically simulate the movement of the sticks adequately due to other motions by the actor. Secondary motion such as the ripple of a body as an actor is punched or is

punching requires both higher speed and higher resolution as well as more markers.

- Mocap technology allows one actor to play multiple roles within a single film

Disadvantages:

- On the negative side, mocap data requires special programs and time to manipulate once captured and processed, and if the data is wrong, it is often easier to throw it away and reshoot the scene rather than trying to manipulate the data. Many systems allow real time viewing of the data to decide if the take needs to be redone.
- Another important point is that while it is common and comparatively easy to mocap a human actor in order to animate a biped model, applying motion capture to animals like horses can be difficult.
- Motion capture equipment costs from fifty thousand dollars for 8 camera active marker systems to millions of dollars for passive marker systems, for the digital video cameras, lights, software, and staff to run a mocap studio, and this technology investment can become obsolete every few years as better software and techniques are invented.
- Computer models that have a cartoony design will "break" when realistic human movement is applied to them unless the motion is correctly retargeted, which is an ongoing task in computer animation. For example, if a cartoony character has large, over-sized hands, these will intersect strangely with any other body part when the human actor brings them too close to his body.
- Although motion capture produces "realistic" movement, hand animation often allows for stronger applications of traditional techniques like squash and stretch, secondary motion, and anticipation, creating characters with greater impact and personality.

Reference

- ✓ John T. Demel and Michael J. Miller, *Introduction to computer graphics*, Brooks/Cole Engineering Division
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- ✓ Lecture notes from Dr. Michael McCool, University of Waterloo, Course No CS488
- ✓ Lecture notes from Dr. D. Brogan, University of Virginia, Course No CS551
- ✓ http://www.wikipedia.org