Unit 5
Computer Animation

Introduction

Although we tend to think of **animation** as implying object motions, the term computer animation generally refers to any time sequence of visual changes in a scene. In addition to changing object position with translations or rotations, a computer-generated animation could display time variations in object size, color, transparency, or surface texture.

Some typical applications of computer-generated animation are entertainment (motion pictures and cartoons), advertising, scientific and engineering studies, and training and education. Advertising animations often transition one object shape into another: for example, transforming a can of motor oil into an automobile engine.

Computer animations can also be generated by changing camera parameters, such as position, orientation, and focal length. And we can produce computer animations by charging lighting effects or other parameters and procedures associated with illumination and rendering.

Design of animation sequences

In general, an animation sequence is designed with the following steps:

1. Storyboard layout
2. Object definitions
3. Key-frame specifications
4. Generation of in-between frames

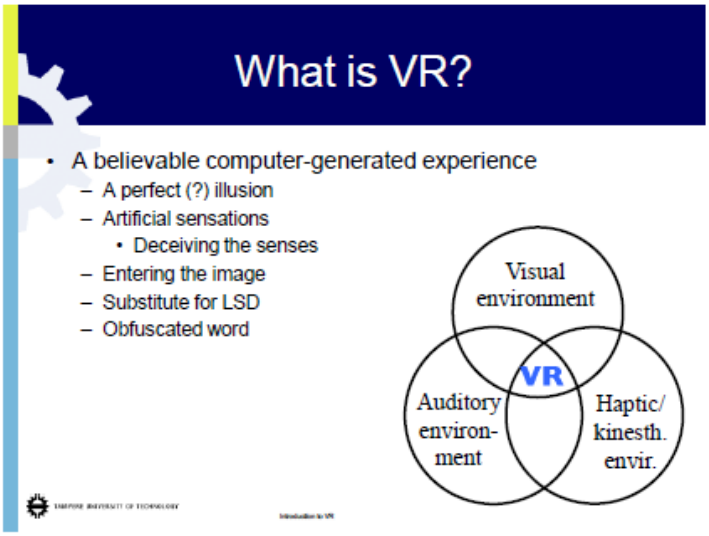
This standard approach for animated cartoons is applied to other animation applications as well, although there are many special applications that do not follow this sequence. Real-time computer animations produced by flight simulators, for instance, display motion sequences in response to settings on the aircraft controls. For frame-by-frame animation, each frame of the scene is separately generated and stored. Later, the frames can be recorded on film or they can be consecutively displayed in "real-time playback" mode.

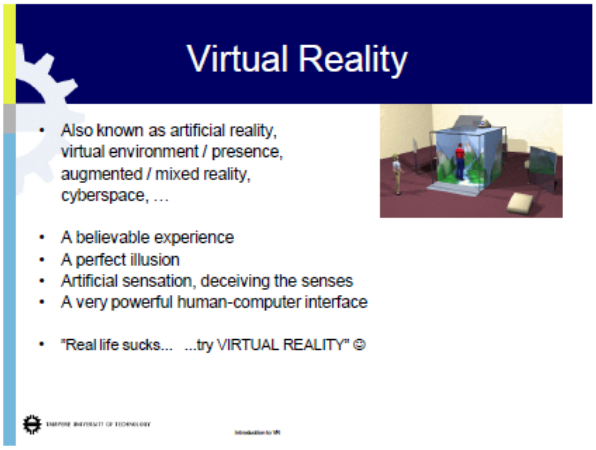
1. **Storyboard** is an outline of the action. It defines the motion sequence as a set of basic events that are to take place. Depending on the type of animation to be produced, the storyboard could consist of a set of rough sketches or it could be a list of the basic ideas for the motion.
2. An **object definition** is given for each participant in the action. Objects can be defined in terms of basic shapes, such as polygons or splines. In addition, the associated movements for each object are specified along with the shape.
3. A **key frame** is a detailed drawing of the scene at a certain time in the animation sequence. Within each key frame, each object is positioned according to the time for that frame. Some key frames are chosen at extreme positions in the action; others are spaced so that the time interval between key frames is not too great. More key frames are specified for intricate motions than for simple, slowly varying motions.
4. **In-betweens** are the intermediate frames between the key frames. The number of in-betweens needed is determined by the media to be used to display the animation. Film requires 24 frames per second, and graphics terminals are refreshed at the rate of 30 to 60 frames per second.

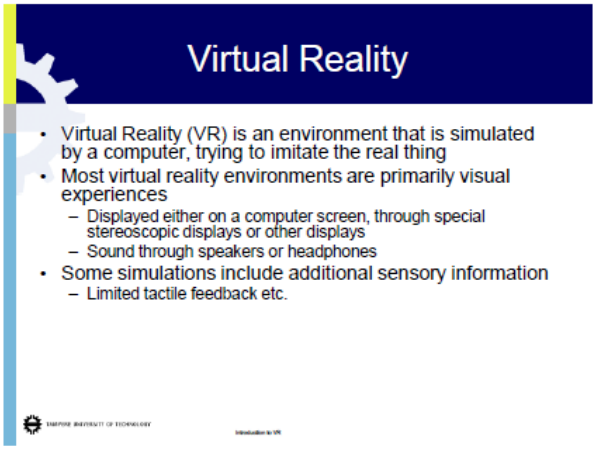
Typically, time intervals for the motion are set up so that there are from three to five in-betweens for each pair of key frames. Depending on the speed specified for the motion, some key frames can be duplicated. For a 1-minute film sequence with no duplication, we would need 1440 frames. With five in-betweens for each pair of key frames, we would need 288 key frames. If the motion is not too complicated, we could space the key frames a little farther apart.

There are several other tasks that may be required, depending on the application. They include motion verification, editing, and production and synchronization of a soundtrack. Many of the functions needed to produce general animations are now computer-generated.

Virtual Reality







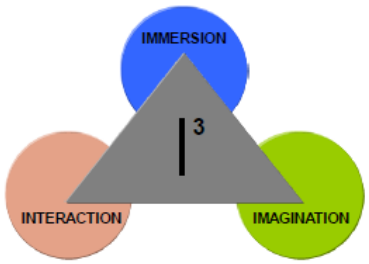
Virtual Reality

- "Virtual reality" originally denoted a fully immersive system
- It has since been used to describe non-orthodox systems lacking wired gloves etc.
- The most immersive experiences I have seen:
  - 3D IMAX (non-VR), Real-D movies (non-VR), CAVE (VR)
  - All of them are very impressive if well done
- In practice, it is very difficult to create a fully convincing virtual reality experience
  - Technical limitations on processing power and image resolution
  - Input/output-devices far from perfect
  - Perfectionism usually not even needed

VR definition

- A simulation in which computer graphics is used to create a realistic-looking world
- Can be a completely synthetic environment without any real counterpart
- Virtual Reality is a high-end user - computer interface that involves real-time simulation and interaction through multiple sensory channels
  - Sensory information may include visual, auditory, haptic, tactile, smell, taste…
  - Visual is dominating

Virtual Reality Triangle



The Three I's of Virtual Reality

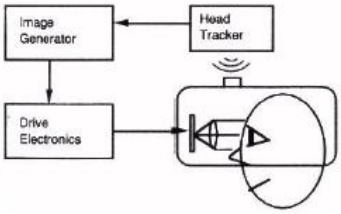
- **Immersion**
  - The feeling of presence, being there
  - The amount and quality of stimuli and sensations
  - Real time: very little latency accepted
    - around 50 ms is a threshold of visual noticability, but varies for all senses
- **Interaction**
  - Not just passive watching
  - Moving in the virtual world
  - Doing all kind of things there
- **Imagination**
  - The applications
  - The ideas
  - The virtual worlds

Properties of VR

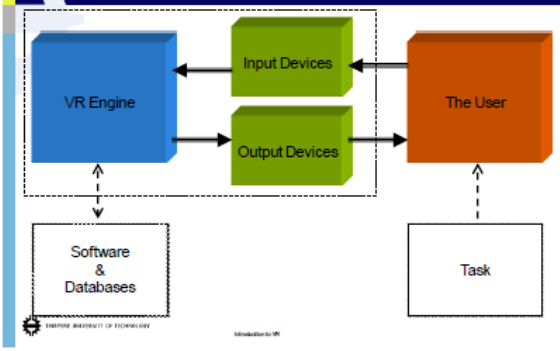
- Synthetically generated environment
  - Computers, 3D, real-time
- Sensory feedback
  - I/O devices
- Interaction, moving
  - In time
  - In space
  - In scale
- Immersion
  - Being there

The Basic Components of VR

- Computing
- Displays (visual, audio, haptics, etc)
- Tracking
- Input



The VR System Architecture



VR Input Devices

- **The ways to transfer information from the user to the computer**
- Mouse, keyboard
- Trackball, joystick, mouse, ...
- Position tracking
- Orientation tracking
- Datagloves
- Exoskeleton (external hardware on hands etc.)
- Data suit
- Motion capture (tracking of body)
- Eye tracking
- Videoanalysis
- Brainwaves (EEG), EMG, EOG
- …

VR Output Devices

- **Transfering data from the computer to the senses of the user**
- Fooling of ALL(?) senses?
  - Displays
    - Monitors, projectors, HMDs, etc.
  - Localized audio
    - Loudspeakers, headphones
  - Tactile & haptic
    - Force feedback
  - Smell, balance, etc.

Requirements for the System

- Real time, >25 frames/s
  - So the environment is smooth
- Latency < 50 ms
  - Processing power
  - Input devices
- Big data size
  - Enough memory & hard disk space
- 3D speed, as much polygon/s as possible
  - PC: new and powerful graphics cards
  - If not enough power in GPU, fps drops or details drop
- CPU processing power for other calculations & simulations
- Fast networking
- VR may be expensive, or low-cost…