Computer Animation

What is it?

- **Sequence of computer-generated images**
- **Objects, lights, and cameras may be moving and changing over time**
- **May be generated off-line (as opposed to real-time)**

What is it used for?

- **Fully computer-generated films (short or feature length)**
  - **entertainment**
  - **visualization of simulation data**
- **Special effects added to real camera footage**

Common Approaches

Key frame animation

Physically-based simulation

Motion capture

Key Frame Animation

Specify animation parameters at particular points in time

- **Positions and orientations of objects, lights, and cameras**
- **Non-rigid-body modifications in object geometry**
- **Non-geometric parameters, such as color and intensity of lights, focus of cameras, etc.**

Specify interpolation modes

- **None, linear, higher-order splines, etc.**

Hierarchical Specification

Hierarchical objects assigned parent/child relationships

- **Child object parameters specified relative to parent**
- **Interpolations performed on these relative parameters rather than absolute**

Often useful for articulated figures, such as humans or animals

Key Frame Advantages and Disadvantages

Advantages

- **Animator has total control of animation**

Disadvantages

- **Difficult to specify realistic interactions**
- **Difficult to specify large, dynamic environments**

Physically-based Simulation

Animator specifies physical parameters and initial conditions

Computer simulates object behaviors over time

Simulation Advantages and Disadvantages

Advantages

- **Interactions are automatically realistic**
- **Large dynamic environments are possible**
- **Systems with complex interrelationships are possible**

Disadvantages

- **Difficult to predict outcome based on initial conditions**
- **Difficult to achieve particular behaviors or events**

Motion Capture

Measure real physical systems in action

- **Attach sensors or markers to system**
- **Track system as it moves**

Often used to measure motion of articulated figures

Motion Capture Advantages and Disadvantages

Advantages

- **No need to model and simulate complex mechanical systems**
- **Good for generating natural-looking motions**

Disadvantages

- **Must have available and willing physical subject**
- **Tricky to adapt to different tasks and combine several independent motions**

Hybrid Approaches

Key frame some objects and simulate other objects independently

Set up minimal constraints using key frames then perform physical-like optimizations

Modify motion capture data to conform to key frame constraints

Video Examples

Drucker and Zeltzer, "CamDroid: A System for Implementing Intelligent Camera Control," ***Proceedings of 1995 Symposium on Interactive 3D Graphics*****.**

Mirtich and Canny, "Impulse-based Simulation of Rigid Bodies," ***Proceedings of 1995 Symposium on Interactive 3D Graphics*****.**

Grzeszczuk, "NeuroAnimator: Fast Neural Network Emulation and Control of Physics-Based Models," ***Proceedings of SIGGRAPH 98.***

Gleicher, "Retargeting Motion to New Characters," ***Proceedings of SIGGRAPH 98*****.**