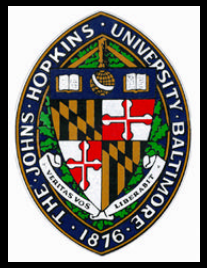
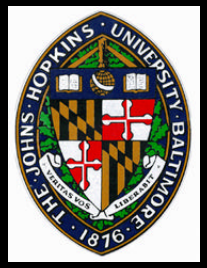
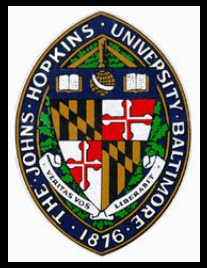


Computer Animation



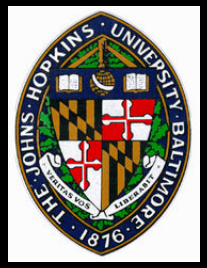
What is it?

- 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

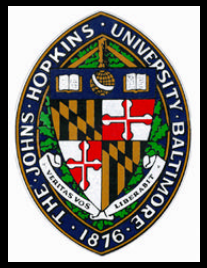


Common Approaches

Key frame animation

Physically-based simulation

Motion capture



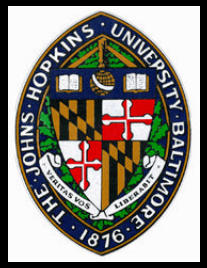
Key Frame Animation

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.**

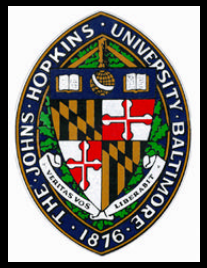


Hierarchical Specification

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



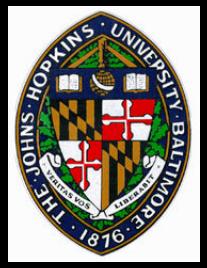
Key Frame Advantages and Disadvantages

Advantages

- Animator has total control of animation

Disadvantages

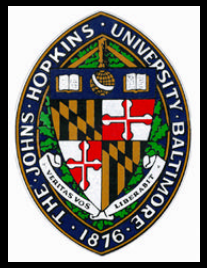
- Difficult to specify realistic interactions
- Difficult to specify large, dynamic environments



Physically-based Simulation

Animator specifies physical parameters and initial conditions

Computer simulates object behaviors over time



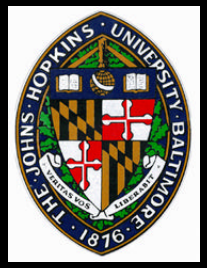
Simulation Advantages and Disadvantages

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

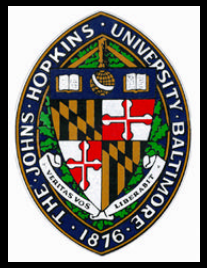


Motion Capture

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



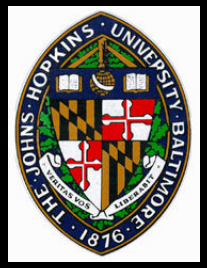
Motion Capture Advantages and Disadvantages

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

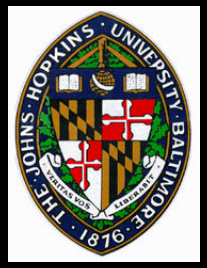


Hybrid Approaches

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*****.**