Animation in Interactive Computer Graphics

CS 248: Interactive Computer Graphics
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General Approaches

Playback of animation created off-line

- Play back animation created off-line, either by animator, or through motion capture, or through simulation
- Challenge: Responsiveness

Simulation

- Calculate physical forces acting on (and within) objects, numerically integrate
- Challenge: Performance, stability, not always easy to set up (e.g., characters, faces)

Model reduction

- Combine exhaustive precomputation and online simulation
- New direction, rapid progress
- Challenge: Difficult precomputation, doesn’t adapt beyond precomputed domain
We’re highly attuned to human and animal motion.

Major challenge: Reconcile high quality and detail with responsiveness and controllability

Techniques: Kinematics and dynamics

Active research topic. Significant advances almost every year.

Image from Safonova and Hodgins, “Construction and optimal search of interpolated motion graphs”
Faces

Extremely hard to do well.

Techniques: Blend shapes (morph targets). Some muscle simulation, but generally not in real-time applications.

Warning: Uncanny valley

Image from Cao et al., “Expressive speech-driven facial animation”, 2005
Uncanny Valley

Possibly triggered by evolved mechanism for pathogen avoidance. (Defects indicate disease or pathology.)

Possibly related to the mirror system in the brain that leads us to instinctively simulate the subjective experience of a humanoid character based on their appearance. Leads to dissonance if animation is subtly incongruent with cohesive subjective experience.

Cloth

Basic problems solved, increasing use in games, integrated in commercial physics engines (Havoc, PhysX)

- Mass-spring systems, numerical integration
- Advanced issues: Cloth-cloth interactions, tearing

Image from Baraff and Witkin, “Large steps in cloth simulation”, 1998
Largely solved problem, widespread use in games

Packages available: ODE, Bullet, Havoc, PhysX

- Basic Newtonian physics, numerical integration
- Slight challenges: Rotational dynamics, surface contact, friction
Fracture, deformation

Still challenging to do in real time. Increasing use in games, integrated in commercial physics engines (Havoc, PhysX)

Fluids, smoke, fire, explosions, etc.

Physically accurate simulation extremely challenging in real time. Model reduction techniques under active research.

Images from Ron Fedkiw et al.
Principles of animation

The famous half-filled flour sack, guide to maintaining volume in any animatable shape, and proof that attitudes can be achieved with the simplest of shapes.
Example of great animation

“Luxo Jr.”, (c) Pixar Animation Studios, 1986
Some principles for animation in interactive computer graphics

Squash and stretch
Timing
Slow in and slow out
Arcs
Exaggeration
Secondary action

Images from Lasseter, “Principles of traditional animation applied to 3D computer animation”, 1987