1 **Computer Animation, Computer Graphics, and Special Effects**

Stan Sclaroff

2 **Introduction**

- Computer Graphics = Simulation
- Simulaton = Approximation
- Everything must be expressed mathematically and in terms of computer programs
- Computationally intensive
- Storage intensive

3 **Special Effects**

- Roots in traditional animation and special effects
- Special challenges
  - realism
  - merging original footage with computer graphics
  - integrated with story
  - image and model manipulation
- Example: The Mask

4 **The Mask**

- Mix of character animation and human characters:
  - Mask grasps to face
  - Spins round apartment
  - Alarm clock bounces around
  - Wooden mallet
  - Eyes pop out
  - Character “peels” off sidewalk
  - Horn blast
- Matched computer shots with regular film footage

5 **Computer Graphics**

- Rendering
- Modeling
- Animation
- User Interface

6 **Rendering**

- Simulating the physics of light and its interaction with materials in the world:
  - Surface properties
  - Textures

Lighting, light placement
Inter-reflection, optics
Camera modeling

7 ❑ Modeling

- Simulating geometry, structure, and form:
  - Surface geometry
  - Details: skin, fur, scales
  - Putting things together: joints and hierarchy of parts
  - Natural forms: trees, mountains, plants, liquids

8 ❑ Animation

- Motion control:
  - Human expressions
  - Deformation: trees bending
  - Morphing
  - Animal motion: joints, gait, grasp
  - Collision detection
  - Natural phenomena: explosions, wind, water, fire, fireworks

9 ❑ User Interface

- Defining and refining animation sequences:
  - create models
  - control models
  - display intermediate results
  - feedback and redisplay
  - output to film recorder

10 ❑ Research Clips

- Plants: growth and form
- Church: subtle lighting
- Wind blowing leaves
- Model building (digitization)
- Animation controls:
  - sliders
  - skeleton
  - morphing
  - camera controls
  - running
  - snake slither, human gait
  - collision detection

11 ❑ Animation

- Character and story development
- Story board
- Motion studies
- Character and object definition
- Keyframe specification
- In-between frames
- Editing and production

12 **Special Effects**

- Character and story development
- Story board
- Motion and camera specification
- Film and sound recording
- Digitization
- Computer animation
- Merge animation with film
  match:camera, lighting, motion
  synchronization
  image manipulation

13 **Jurassic Park**

- Dinosaur bones and skeleton modeled on computer
- Preliminary motion and behavior studies: elephants, alligators, ostriches, and lions.
- Model skin, wobble of body using physical simulation
- Challenge: natural movement
- Also challenging: lighting

14 **Jurassic Park Video Clips**

- Clip 1: note motion of legs, neck, and swaying belly
- Clip 2: note roughness of walk (shown w/o sound)
- Clip 3: herd motion, computer controlled

Remember: issues of control, realism, and synchronization.

15 **Terminator2**

- T1000: can change from amorphous metal blob into any shape (including human)
- Live action footage filmed and scanned into computer
- Chrome human forms modeled based on motion studies of real actors
- Model reflections of real scene on computer-generated metal
- Digital composite

16 **T2 Video Clips**

- Walking out of fire
  reflection of fire on computer model
  computer stunt person
  transformation from virtual to real
- Morphing out of floor
  floor checkers move
  reflections
- Helicopter scene
  character melts and spills into cabin
  reflection of real character on T1000

17 **Computer-Assisted Animation**

- Animation by hand (Simpsons)

- Computer models driven by animators
- Computer models driven by actors
- Computer actors driven entirely by computer:
  - behavior, direction, and goals
  - expression
  - motion
  - sensing and interaction

18 Toy Story

- First completely computer-animated feature film
- 79 minutes of animation
  - 114,240 frames
  - 800,000 machine hours
  - 25,000 drawings for story boards
- Modeling
  - 712 animation controls for Woody
  - Number of hairs on head of Sid: 15,977
  - Houses, furniture, cars
  - trees; 1,200,000 leaves
  - dirt, holes, spills, spray, rust, etc.

19 Toy Story

- 4.5 million lines of code (270MB)
- Over 10 person/years to complete
- No motion capture; everything animated by hand
- Number of animated cameras: 620
- Smallest staff for Disney animation feature

20 Are synthetic actors a threat to human actors?

21 Summary

- Computer Graphics = Simulation
- Simulaton = Approximation
- Everything must be expressed mathematically and in terms of computer programs
- 4 areas of computer animation:
  - Rendering
  - Modeling
  - Animation Control
  - User interface