Computer Animation

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Computer Animation

• What is animation?
  ◦ Make objects change over time according to scripted actions

• What is simulation?
  ◦ Predict how objects change over time according to physical laws

Outline

• Principles of animation
• Articulated figures
• Keyframe animation

Principles of Traditional Animation

• Squash and stretch
• Slow In and out
• Anticipation
• Exaggeration
• Follow through and overlapping action
• Timing
• Staging
• Straight ahead action and pose-to-pose action
• Arcs
• Secondary action
• Appeal

Angel Plate 1

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Disney

Lasseter '87
**Principles of Traditional Animation**

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Diary

**Principles of Traditional Animation**

- Slow In and Out

Watt Figure 13.5

**Principles of Traditional Animation**

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Diary

**Principles of Traditional Animation**

- Anticipation (and squash & stretch)

Lasseter ‘87

**Example: Roadrunner**

Warner Brothers
Computer Animation

- Animation pipeline
  - 3D modeling
  - Motion specification
  - Motion simulation
  - Shading, lighting, & rendering
  - Postprocessing

Example: Luxo Jr.

Outline

- Principles of animation
- Articulated figures
- Keyframe animation

Articulated Figures

- Character poses described by set of rigid bodies connected by "joints"

Articulated Figures

- Well-suited for humanoid characters

Articulated Figures

- Joints provide handles for moving articulated figure
Example: Robot

Articulated Figures

• Inbetweening
  ◦ Compute joint angles between keyframes

Outline

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Keyframe Animation

• Define character poses at specific time steps called “keyframes”

Keyframe Animation

• Interpolate variables describing keyframes to determine poses for character in between

Keyframe Animation

• Inbetweening:
  ◦ Linear interpolation - usually not enough continuity
Keyframe Animation

- Inbetweening:
  - Spline interpolation - maybe good enough

H&B Figure 16.11

Keyframe Animation

- Inbetweening:
  - Cubic spline interpolation - maybe good enough
    - May not follow physical laws

Lasseter '87

Keyframe Animation

- Inbetweening:
  - Cubic spline interpolation - maybe good enough
    - May not follow physical laws

Lasseter '87

Keyframe Animation

- Inbetweening:
  - Inverse kinematics or dynamics

Rose et al. '96

Example: Walk Cycle

- Articulated figure:

Watt & Watt

Example: Walk Cycle

- Hip joint orientation:

Watt & Watt
Example: Walk Cycle

- Knee joint orientation:

(Watt & Watt)

Example: Walk Cycle

- Ankle joint orientation:

(Watt & Watt)

Example: Robot

(Mihai Parparita, COS 426, Princeton University, 2003)

Example: Ice Skating

(Mao Chen, Zaijin Guan, Zhiyan Liu, Xiaohu Qu, CS426, Fall98, Princeton University)

Example: Red’s Dream

(Pixar)

Challenges of Animation

- Temporal aliasing
- Motion blur
Temporal Aliasing

- Artifacts due to limited temporal resolution
  - Strobing
  - Flickering

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Motion Blur

- Composite weighted images of adjacent frames
  - Remove parts of signal under-sampled in time

Summary

- Animation requires ...
  - Modeling
  - Scripting
  - Inbetweening
  - Lighting, shading
  - Rendering
  - Image processing