Lecture 17 of 41

Animation 1 of 3: Basics, Keyframing
Sample Exam Review

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Readings:
Today: §5.1 – 5.2, Eberly
Next class: no new reading – review Chapters 1 – 4, 20
Lecture 18 reading (two class days from today): §4.4 – 4.7, Eberly

Optional review session during next class period; evening exam time TBD

Reading for Last Class: §2.6, 20.1, Eberly
Reading for Today: §5.1 – 5.2, Eberly
Reading for Next Lecture (Two Classes from Now): §4.4 – 4.7, Eberly

Last Time: Shading and Transparency in OpenGL

Today: Introduction to Animation
What is it and how does it work?
Brief history
Principles of traditional animation
Keyframe animation
Articulated figures: Inbetweening

Where We Are

Review:
Painter’s Algorithm vs. z-Buffering

Acknowledgements:
Computer Animation Intro

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Overview

• Some early animation history
  - http://web.inter.nl.net/users/anima/index.htm
  - http://www.public.la.state.edu/~rllew/chmear.html

• Computer animation

Thaumatrope

• Why does animation work?
• Persistence of vision
• 1824 John Ayrton invents the thaumatrope
• Or, 1828 Paul Roget invents the thaumatrope

Phenakistoscope

• Invented independently by 2 people in 1832
• Disc mounted on spindle
• Viewed through slots with images facing mirror
• Turning disc animates images

Zoetrope (1834)

• Images arranged on paper band inside a drum
• Slits cut in the upper half of the drum
• Opposite side viewed as drum rapidly spun
• Praxinoscope is a variation on this

Animation History

• Animation and technology have always gone together!
• Animation popular even before movies
• Movies were big step forward!
• “Humorous Phases of Funny Faces” (1906)
Key Developments [2]:
Rotoscoping (1921)

- Max Fleischer invents roto-scopying (1921)

Fleischer's Rotoscope

Key Developments [4]:
Using Rotoscopy

- Max Fleischer invents roto-scopying (1921)

Key Developments [5]:
Color

- "Flowers and Trees" (1932) uses color!
- "Snow White" (aka "Disney's Folly") released 1937

“Flowers and Trees”
Walt Disney

“Snow White”
Walt Disney

Overview

- Some early animation history
  - http://web.inter.nl.net/users/anima/index.htm
  - http://www.public.iastate.edu/~rltew/chmearl.html

- Computer animation

Animation, Simulation, & Visualization

- 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
2-D & 3-D Animation

Homer 2-D
http://youtu.be/TKQ8Ilr6PgU
Homer 3-D

© 1989 - 2011 Fox Broadcasting Company, Inc.

Traditional Animation [1]:
Lasseter’s List of Principles (1987)

- Squash and Stretch
- Timing
- Anticipation
- Staging
- Follow Through and Overlapping Action
- Straight Ahead Action and Pose-to-Pose Action
- Slow In and Out
- Arcs
- Exaggeration
- Secondary action
- Appeal

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Traditional Animation [2]:
Squash & Stretch

- Defining the rigidity and mass of an object by distorting its shape during an action.

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Traditional Animation [3]:
Timing

- Spacing actions to define the weight and size of objects and the personality of characters.
  - Heavier objects accelerate slower
  - Lethargic characters move slower
  - Etc.

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Traditional Animation [4]:
Anticipation

- The preparation for an action.
  - Muscle contraction prior to extension
  - Bending over to lift a heavy object
  - Luxo’s dad responds to Luxo Jr. off screen before Luxo Jr. appears.

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Traditional Animation [5]:
Staging

- Presenting an idea so that it is unmistakably clear.
  - Keeping the viewer’s attention focused on a specific part of the scene.
  - Luxo Jr. moves faster than his dad, and so we focus on him.

Traditional Animation [6]:
Follow Through & Overlapping Action

- The termination of an action and establishing its relationship to the next action.
  - Loose clothing will “drag” and continue moving after the character has stopped moving.
  - The way in which an object slows down indicates its weight/mood.

Traditional Animation [7]:
Straight-Ahead vs. Pose-to-Pose Action

- The two contrasting approaches to the creation of movement.
  - Straight Ahead Action:
    - Action is drawn from the first frame through to the last one.
    - Wild, scrambling actions where spontaneity is important.
  - Pose-to-Pose Action:
    - Poses are pre-conceived and animator fills in the in-betweens.
    - Good acting, where the poses and timing are all important.

Traditional Animation [8]:
Slow In-And-Out

- The spacing of in-between frames to achieve subtlety of timing and movements.

Traditional Animation [9]:
Arcs

- The visual path of action for natural movement.
  - Make animation much smoother and less stiff than a straight line for the path of action

Traditional Animation [10]:
Exaggeration

- Accentuating the essence of an idea via the design and the action.
Traditional Animation [11]: Secondary Action

- The Action of an object resulting from another action.
  - The rippling of Luxo Jr.’s cord as he bounces around the scene.

Traditional Animation [12]: Appeal

- Creating a design or an action that the audience enjoys watching.
  - Charm
  - Pleasing design
  - Simplicity
  - Communication
  - Magnetism
  - Etc.

Outline

- Principles of animation
  - Keyframe animation
  - Articulated figures

Keyframe Animation [1]: Keyframes

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

Keyframe Animation [2]: Interpolation (aka Inbetweening)

- Interpolate variables describing keyframes to determine poses for character “in-between”

Keyframe Animation [3]: Linear Interpolation aka Lerping

- Inbetweening:
  - Linear interpolation - usually not enough continuity
Keyframe Animation [4]:
Cubic Curve (Spline) Interpolation

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

Keyframe Animation [5]:
Dynamics & Kinematics

- Inbetweening:
  - Kinematics or dynamics

Outline

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- Keyframe animation
  - Articulated figures

Articulated Figures [1]:
Definition

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

Articulated Figures [2]:
Character Modeling

- Well-suited for humanoid characters

Articulated Figures [3]:
Angular Interpolation

- Inbetweening
  - Interpolate angles, not positions, between keyframes
Articulated Figures [4]: Bones & Joints

- Articulated figure:
  - Hip
  - Upper leg
  - Knee
  - Lower leg
  - Ankle
  - Foot

Articulated Figures [5]: Example – Walk Cycle 1

- Hip joint orientation:
  - Hip rotate
  - Lower leg (knee rot)
  - Hip rotate + knee rot

Articulated Figures [6]: Example – Walk Cycle 2

- Knee joint orientation:

Articulated Figures [7]: Example – Walk Cycle 3

- Ankle joint orientation:

Looking Ahead:
Scene Graph Traversal

© 2002 D. M. Murillo
Looking Ahead: Scene Graph Rendering

Problem Set 3: Hour Exam 1 Review

Summary

- Reading for Last Class: §2.6, 20.1, Eberly 2e; OpenGL primer material
- Reading for Today: §5.1 – 5.2, Eberly 2e
- Reading for Next Lecture (Two Classes from Now): §4.4 – 4.7, Eberly 2e
- Last Time: Shading and Transparency in OpenGL
  - Alpha blending
  - Painter’s algorithm – less efficient, can handle non-opaque objects
  - Depth buffering (z-buffering) – in hardware, fast, opaque only
- Today: Introduction to Animation
  - What is it and how does it work?
  - Brief history
  - Principles of traditional animation
  - Keyframe animation
  - Articulated figures: Inbetweening

Terminology

- Shading and Transparency in OpenGL: Alpha, Painter’s, z-buffering
- Animation – Bringing Still Objects “to Life” (Change Over Time)
- Early Animation
  - Thaumatrope (c. 1824) – early Victorian toy prefiguring flipbooks
  - Flipbook – simple paper-based animation technique
- Action in Traditional Animation
  - Before: squash & stretch, timing, anticipation, staging
  - During: exaggeration, secondary
  - After: follow-through & overlapping action
- Design: straight-ahead vs. pose-to-pose
- Keyframe Animation
  - Inbetweening – interpolation technique
    - Lerp – linear interpolation
    - Splines & other cubic curves
  - Articulated figures: singular interpolation