Lecture 17 of 41

Animation 1 of 3: Basics, Keyframing

Sample Exam Review

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Public mirror web site: http://www.kddresearch.org/Courses/CIS636
Instructor home page: http://www.cis.ksu.edu/~bhsu

Readings:
Next class: no new reading – review Chapters 1 – 4, 20
Optional review session during next class period; evening exam time TBD
Lecture 18 reading (two class days from today): §4.4 – 4.7, Eberly 2e

Lecture Outline
• 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
  • Transparency revisited
  • OpenGL how-to: http://bit.ly/hRaQgk
    ➢ Alpha blending (15.020, 15.040)
    ➢ Screen-door transparency (15.030)
  • Painter’s algorithm & depth buffering (z-buffering)
• 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

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Lightly shaded entries denote the due dates of a written problem set, heavily shaded entries that of a machine problem (programming assignment), blue shaded entries that of a paper review, and the green shaded entity, that of the term project.

Green, blue and red letters denote exam review, exam, and exam solution review dates.

Review:
Painter’s Algorithm vs. z-Buffering

© 2004 – 2009 Wikipedia, Painter’s Algorithm

© 2009 Wikipedia, Z-buffering
http://bit.ly/gGRFMA
Transparency in OpenGL:
Final Note

15.00 I want to use blending but can’t get destination alpha to work. Can I blend or create a transparency effect without destination alpha?

Many OpenGL devices don’t support destination alpha. In particular, the OpenGL 1.1 software rendering libraries from Microsoft don’t support it. The OpenGL specification doesn’t require it.

If you have a system that supports destination alpha, using it is a simple matter of asking for it when you create your window. For example, pass GLUT_ALPHA to glutInitDisplayMode(), then set up a blending function that uses destination alpha, such as:

```c
glBlendFunc(GL_ONE_MINUS_DST_ALPHA, GL_DST_ALPHA);
```

Often this question is asked under the mistaken assumption that destination alpha is required to do blending. It’s not. You can use blending in many ways to obtain a transparency effect that uses source alpha instead of destination alpha. The fact that you might be on a platform without destination alpha shouldn’t prevent you from obtaining a transparency effect. See the OpenGL Programming Guide chapter 6 for ways to use blending to achieve transparency.

© 1997 – 2011 Khronos Group

http://bit.ly/hRaQgk

Acknowledgements:
Computer Animation Intro

Jason Lawrence
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Department of Computer Science
University of Virginia
http://www.cs.virginia.edu/~jdl/

Acknowledgment: slides by Misha Kazhdan, Allison Klein, Tom Funkhouser, Adam Finkelstein and David Dobkin

Thomas A. Funkhouser
Professor
Department of Computer Science
Computer Graphics Group
Princeton University
http://www.cs.princeton.edu/~funk/
Overview

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

Thaumatrope

- Why does animation work?
- Persistence of vision
- 1824 John Ayerton 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

Phenakistoscope of couple (1893)
© 2007 Wikipedia, Phenakistoscope

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

Tarzan © 2000 Disney
http://youtu.be/3MnoS99Hw
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 [1]:
Storytelling & Cel Animation

- Plot
- Creation of animation studios
- Getting rid of “rubber-hose” bodies
- Inking on cels

“Steamboat Willie”
Walt Disney (1928)

“Felix the Cat”
Pat Sullivan (1919)

“Gertie the Dinosaur”
Windsor McCay (1914)
Key Developments [2]:
Rotoscoping (1921)

- Max Fleischer invents roto-ensing (1921)

Key Developments [4]:
Fleischer's Rotoscope
Key Developments [5]:
Using Rotoscoping

- Max Fleischer invents rotoscoping (1921)

Key Developments [6]:
Color

- “Flowers and Trees” (1932) uses color!
- “Snow White” (aka “Disney’s Folly”) released 1937
Overview

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

Adapted from slides © 2010 J. Lawrence, University of Virginia
2-D & 3-D Animation

Homer 2-D

Homer 3-D

http://youtu.be/TKQ8t69FaU (Making Of)


Outline

- Principles of animation
- Keyframe animation
- Articulated figures

Angel Plate 1
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

Traditional Animation [2]:
Squash & Stretch

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

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.

Luxo Jr. © 1986 Pixar
http://www.pixar.com/shorts/ljr/
http://youtu.be/qGxoui3IFS0

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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.

![Luxo Jr.](http://www.pixar.com/shorts/ljr/)

© 2010 J. Lawrence, University of Virginia

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.
  o The rippling of Luxo Jr.’s cord as he bounces around the scene.

Luxo Jr. © 1986 Pixar
http://www.pixar.com/shorts/ljr/
http://www.youtube.com/watch?v=65DP55

Traditional Animation [12]: Appeal

• Creating a design or an action that the audience enjoys watching.
  o Charm
  o Pleasing design
  o Simplicity
  o Communication
  o Magnetism
  o 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”

Lasseter '87

Keyframe Animation [3]: Linear Interpolation aka Lerping

- Inbetweening:
  - Linear interpolation - usually not enough continuity

H&B Figure 16.16
Keyframe Animation [4]:
Cubic Curve (Spline) Interpolation

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

Lasseter ‘87

Keyframe Animation [5]:
Dynamics & Kinematics

- Inbetweening:
  - Kinematics or dynamics

Rose et al. ‘96
Outline

- Principles of animation
- Keyframe animation
  - Articulated figures

Articulated Figures [1]: Definition

- Character poses described by set of rigid bodies connected by “joints”

Scene Graph

© 2010 J. Lawrence, University of Virginia
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
  Upper leg (hip rot)
  Hip rotate
  Lower leg (knee rot)
  Hip rotate + knee rot
  Foot (ankle rot)

Watt & Watt

Articulated Figures [5]:
Example – Walk Cycle 1

- Hip joint orientation:

  1  2  3  4  5

  45°
  -35°

Watt & Watt
Articulated Figures [6]:
Example – Walk Cycle 2

- Knee joint orientation:

Articulated Figures [7]:
Example – Walk Cycle 3

- Ankle joint orientation:
Articulated Figures [7]: Example – Walk Cycle 4

© 2002 D. M. Murillo

Looking Ahead:
Scene Graph Traversal

© 2002 – 2005 Virtools
http://bit.ly/eM1gz8
Looking Ahead:
Scene Graph Rendering

Problem Set 3:
Hour Exam 1Review
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
    - Lerping – linear interpolation
    - Splines & other cubic curves
  - Articulated figures: angular interpolation