Course Overview

Administrative Issues
Modeling
Animation
Rendering
OpenGL Programming

January 10, 2011
Jernej Barbic
University of Southern California
http://www-bcf.usc.edu/~jbarbic/cs480-s11/

Course Information On-Line
http://www-bcf.usc.edu/~jbarbic/cs480-s11/

– Schedule (slides, readings)
– Assignments (details, due dates)
– Software (libraries, hints)
– Resources (books, tutorials, links)

Blackboard:
– Forum
– Submit assignments

About me
Assistant professor in CS
Post-doc at MIT
PhD, Carnegie Mellon University
jnb@usc.edu
Wed 3:30-5:00, SAL 230

About the teacher
Background:
BSc Mathematics
PhD Computer Science

Research interests:
graphics, animation, real-time physics,
control, sound, haptics

Teaching Assistant
Fun Shing Sin
Mon 4:00-5:00
Thu 4:00-5:00
SAL 112

Prerequisites
• CSCI 102 Data Structures
• Basic familiarity with calculus and linear algebra
• C/C++ programming skills
• See me if you are missing any and we haven’t discussed it
Textbooks

• Interactive Computer Graphics
  A top-down approach with OpenGL, Fifth Edition
  Edward Angel, Addison-Wesley

• OpenGL Programming Guide (“Red Book”)
  Basic version also available on-line (see Resources)

Grading

• 51% Programming Assignments (3x 17%)
• 19% Midterm (one sheet of notes only, in class)
• 30% Final (open book)
• No collaboration!

Assignment Policies

• Programming assignments
  - Hand in via Blackboard by end of due date
  - Functionality and features
  - Style and documentation
  - Artistic impression

• 3 late days, usable any time during semester
• Academic integrity policy applied rigorously

Course Overview

The computer graphics trinity
  - Modeling: how to represent objects
  - Animation: how to control and represent motion
  - Rendering: how to create images

OpenGL graphics library

Not in this course:
  - Human-computer interaction
  - Graphic design
  - DirectX API

Computer Graphics Disciplines

Rendering

Geometry (Modeling)

Animation

Image Processing

Computer Graphics Goals

• Synthetic images indistinguishable from reality
• Practical, scientifically sound, in real time
Example: Ray Tracing

Barbic, James,
SIGGRAPH 2010

Example: Physics + Computational Geometry + Animation + Ray Tracing

Barbic, James,
SIGGRAPH 2010

Example: Radiosity


Computer Graphics Goals II

• Creating a new reality
• Practical, aesthetically pleasing, in real time

Example: Illustrating Smooth Surfaces

A. Hertzmann, D. Zorin,
SIGGRAPH 2000

Example: Scene Completion

J. Hays, A. Efros,
SIGGRAPH 2007
SIGGRAPH

• Main computer graphics event in the world
• Once per year
• 30,000 attendees
• Academia, industry

1. Course Overview

• Administrative Issues
• Topics Outline (next)

2. OpenGL Basics

• Primitives and attributes
• Color
• Viewing
• Control functions
• [Angel, Ch. 2]

3. Input and Interaction

• Clients and servers
• Event driven programming
• Text and fonts
• [Angel, Ch. 3]

4. Objects & Transformations

• Linear algebra review
• Coordinate systems and frames
• Rotation, translation, scaling
• Homogeneous coordinates
• OpenGL transformation matrices
• [Angel, Ch. 4]

5. Viewing and Projection

• Orthographic projection
• Perspective projection
• Camera positioning
• Projections in OpenGL
• Hidden surface removal
• [Angel, Ch. 5]
6. Hierarchical Models
- Graphical objects
- Animations
- OpenGL routines
- Parameters and transformations
- [Angel, Ch. 10]

7. Light and Shading
- Light sources
- Ambient, diffuse, and specular reflection
- Normal vectors
- Material properties in OpenGL
- Radiosity
- [Angel, Ch. 6]

8. Curves and Surfaces
- Review of 3D-calculus
- Explicit representations
- Implicit representations
- Parametric curves and surfaces
- Hermite curves and surfaces
- Bezier curves and surfaces
- Splines
- Curves and surfaces in OpenGL
- [Angel, Ch. 12]

9. Rendering
- Clipping
- Bounding boxes
- Hidden-surface removal
- Line drawing
- Scan conversion
- Antialiasing
- [Angel, Ch. 7,8]

10. Textures and Pixels
- Texture mapping
- OpenGL texture primitives
- Bump maps
- Environment maps
- Opacity and blending
- Image filtering
- [Angel, Ch. 8]

11. Ray Tracing
- Basic ray tracing [Angel, Ch. 13]
- Spatial data structures [Angel, Ch. 10]
- Motion Blur
- Soft Shadows
12. Radiosity
- Local vs global illumination model
- Interreflection between surfaces
- Radiosity equation
- Solution methods
- [Angel Ch. 13.4-5]

13. Physically Based Models
- Particle systems
- Spring forces
- Cloth
- Collisions
- Constraints
- Fractals
- [Angel, Ch. 11]

14. Scientific Visualization
- Height fields and contours
- Isosurfaces
- Volume rendering
- Texture mapping of volumes
- [Angel Ch. 2.11]

Guest Lecture:
Doug Roble, Digital Domain

“Wildcard” Lectures:
- Graphics hardware
- More on animation
- Motion capture
- Virtual reality and interaction
- Special effects in movies
- Video game programming
- Non-photo-realistic rendering

Hot Application Areas
- Special effects
- Feature animation
- PC graphics boards
- Video games
- Visualization (science, architecture, space)

Hot Research Topics
- Modeling
  - getting models from the real world
  - multi-resolution
- Animation
  - physically based simulation
  - motion capture
- Rendering:
  - more realistic: image-based modeling
  - less realistic: impressionist, pen & ink
Acknowledgments

- Jessica Hodgins (CMU)
- Frank Pfenning (CMU)
- Paul Heckbert (Nvidia)