CSCI 480 Computer Graphics
Lecture 1

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
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

Source: Jensen

Geometry (Modeling)

Source: Botsch et al.

Animation

Source: Baraff and Witkin

Image Processing

Source: Durand
Computer Graphics Goals I

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

Barbic, James, SIGGRAPH 2010

Thurey, Wojtan, Gross, Turk, SIGGRAPH 2010
Example: Physics + Computational Geometry + Animation + Ray Tracing
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

Non-photorealistic rendering (NPR)
Example: Scene Completion

Original

Input

Scene Matches

Output

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)