Course Overview

Administrative Issues
Modeling
Animation
Rendering
OpenGL Programming
[Angel Ch. 1]

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Course Information On-Line

http://www-bcf.usc.edu/~jbarbic/cs420-s15/

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

Blackboard:
– Forum
– Submit assignments

Course slides

http://www-bcf.usc.edu/~jbarbic/cs420-s15/

• Full-color version
• 6-slides-per-page B&W version
  – good for printing
• Posted in advance of lectures
  – bring to class & annotate
• Color viewing in Acrobat Reader:
  Disable "Replace Document Colors" in Preferences.Accessibility (if enabled)

About me

Assistant professor in CS
Post-doc at MIT
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Mon 3:45-4:45, SAL 240

About the teacher

Background:
BSc Mathematics
PhD Computer Science

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

Prerequisites

• CSCI 104 (Data Structures and Object-Oriented Design)
• MATH 225 (Linear Algebra and Differential Equations)
• Familiarity with calculus and linear algebra
• 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 (one sheet of notes only)

Academic integrity

- No collaboration!
- Do not copy any parts of any of the assignments from anyone
- Do not look at other students' code, papers, assignments or exams
- USC Office of Student Judicial Affairs and Community Standards will be notified

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

Computer Graphics

One of the “core” computer science disciplines:

- Algorithms and Theory
- Artificial Intelligence
- Computer Architecture
- Computer Graphics and Visualization
- Computer Security
- Computer Systems
- Databases
- Networks
- Programming Languages
- Software Engineering

Course Overview

Theory: Computer graphics disciplines:
- Modeling: how to represent objects
- Animation: how to control and represent motion
- Rendering: how to create images of objects
- Image Processing: how to edit images

Practice: OpenGL graphics library

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

- Rendering
- Geometry (Modeling)
- Animation
- Image Processing

Source:
- Jensen
- Botsch et al.
- Baraff and Witkin
- Durand

Computer Graphics Goals I

- 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 (not necessarily scientific)
- Practical, aesthetically pleasing, in real time
Example: Illustrating Smooth Surfaces
A. Hertzmann, D. Zorin, SIGGRAPH 2000
Non-photorealistic rendering (NPR)

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
   - Re-using 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

Guest Lecture:
TBA

“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

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