Course Overview

Administrative Issues
Modeling
Animation
Rendering
OpenGL Programming

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Course Information On-Line

- http://www.cs.cmu.edu/~fp/courses/graphics/
  - Schedule (slides, readings)
  - Assignments (details, due dates)
  - Software (libraries, hints)
  - Resources (books, tutorials, links)
- news:cmu.cs.class.cs462

About Me

- **Research:** Programming Languages & Logic
- **Teaching:** Anything
- [http://www.cs.cmu.edu/~fp/](http://www.cs.cmu.edu/~fp/)
- **Office Hours**
  - Wed 2:30-3:30, WeH 8117
  - Right after class
  - By appointment

Teaching Assistants

- Chris Twigg (Thu 3:00-5:00)
- Ian Graham (Wed, Fri 10:30-11:30)
- Sriram Vaidhyanathan (Mon 6:00-8:00)
- David Kitchin (O'Caml wizard)
- TAs available in graphics lab, WeH 5336
- Card reader for access (email me if denied)
- Instructions for account setup on web page

Prerequisites

- 15-213 Intro to Computer Systems
- 21-241 Matrix Algebra
- 21-259 Calculus in 3D
- See me if you are missing any and we haven’t discussed it

Some Follow-On Courses

- 53-831 Building Virtual Worlds (Pausch, F’03)
- 15-493 Game Programming (Kuffner, F’03)?
- ? (James, F’03)
- 15-497 Computer Animation (Hodgins, S’04)
- 53-609 Game Design (Schell, S’04, F’03?)
- Also: research opportunities in graphics group!
Textbook

- **Interactive Computer Graphics**
  A top-down approach with OpenGL, 3rd edition
  Edward Angel, Addison-Wesley, 2002
- Supplementary texts:
  - OpenGL Programming Guide (“Red Book”)
    Also available on-line (see Resources)
  - Real-Time Rendering
    Tomas Akenine-Möller and Eric Haines
    2nd edition, AK Peters, 2002
    On reserve soon

Grading

- 45% Programming Assignments (4)
- 20% Written Assignments (4)
- 10% Midterm (one sheet of notes only, in class)
- 25% Final (open book)
- Alternating assignments
  - Programming (2 weeks)
  - Written (1 week)
- No collaboration!

Assignment Policies

- Programming assignments
  - Hand in via AFS by end of due date
  - Functionality and features
  - Style and documentation
  - Artistic impression
- Written assignments
  - Hand in on paper before lecture
  - Correctness is central
  - Show your reasoning
- 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
  - Graphics hardware
  - DirectX API

Computer Graphics Goals I

- Synthetic images indistinguishable from reality
- Practical, scientifically sound, in real time

Example: Ray Tracing

- 2001 Internet ray tracing competition, N. Kern
Example: Radiosity
- Lightscape by Autodesk

Computer Graphics Goals II
- Creating a new reality
- Practical, aesthetically pleasing, in real time

Example: Illustrating Smooth Surfaces
- SIGGRAPH 2000 Conference, A. Hertzmann, D. Zorin

Example: Image Analogies

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. 9]

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. 10]
9. Rendering
• Clipping
• Bounding boxes
• Hidden-surface removal
• Line drawing
• Scan conversion
• Antialiasing
• [Angel, Ch. 8]

10. Textures and Pixels
• Texture mapping
• OpenGL texture primitives
• Bump maps
• Environment maps
• Opacity and blending
• Image filtering
• [Angel, Ch. 7]

11. Ray Tracing
• Basic ray tracing [Angel, Ch. 13.2]
• Spatial data structures [Angel, Ch. 9.10]
• Motion Blur
• Soft Shadows

12. Radiosity
• Local vs global illumination model
• Interreflection between surfaces
• Radiosity equation
• Solution methods
• [Angel Ch. 13.5]

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. 12]
Wildcards & Possible Guest Lectures

- Graphics hardware
- More on animation
- Motion capture
- Virtual reality and interaction
- Special effects in movies
- Video game programming
- Non-photo-realistic rendering
  (last year’s additional lectures highlighted)

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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  Movies!