15-462 Computer Graphics I
Lecture 1

Course Overview

<table>
<thead>
<tr>
<th>Administrative Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modeling</td>
</tr>
<tr>
<td>Animation</td>
</tr>
<tr>
<td>Rendering</td>
</tr>
<tr>
<td>OpenGL Programming</td>
</tr>
</tbody>
</table>

January 14, 2003
Frank Pfenning
Carnegie Mellon University

http://www.cs.cmu.edu/~fp/courses/graphics/

Course Information On-Line

- [http://www.cs.cmu.edu/~fp/courses/graphics/](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

Acknowledgments

• Jessica Hodgins
• Paul Heckbert
• Joel Welling
• Students and TAs in Spring’02 Version
  Movies!