

15-462 Computer Graphics I

Lecture 1

Course Overview

Administrative Issues
Modeling
Animation
Rendering
OpenGL Programming

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/>
 - 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/>
- 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'CamI 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

- SIGGRAPH 2001 Conference, A. Hertzmann, C. Jacobs, N. Oliver, B. Curless, D. Salesin



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!