15-462 Computer Graphics I
Lecture 1

Course Overview

| Administrative Issues |
| Modeling |
| Animation |
| Rendering |
| OpenGL Programming |

January 14, 2003
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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'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
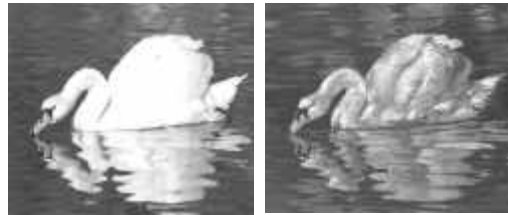
Example: Image Analogies

• 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!