CS4620/5620: Introduction to Computer Graphics

Professor: Steve Marschner
Computer graphics: The study of creating, manipulating, and using visual images in the computer.
Or, to paraphrase Ken Perlin...

**Computer graphics:** What you need to show other people your dreams.
Graphics Applications

• Entertainment
  – film production
  – film effects
  – games
• Science and engineering
  – computer-aided design
  – visualization (scientific, information)
• Virtual Prototyping
• Cultural Heritage
• Training & Simulation
• Graphic Arts, Fine Art
Graphics Applications

• Entertainment
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Pixar—*The Blue Umbrella* (2013)
The Hobbit: An Unexpected Journey (New Line Cinema, 2012)—visual effects by Weta Digital
Crytek—Crysis 3 (2013)
Quantic Dream—*_Two Souls* (2013)
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U. of Utah—Alpha 1
Simulated deformation of citrate synthase during substrate binding
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Autodesk® 360 Rendering

Create photorealistic images and panoramas using our Rendering cloud services with your Autodesk® 360
Digital Michelangelo Project
Marc Levoy, Stanford
Digital Michelangelo Project
Marc Levoy, Stanford
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Computer aided sculptures
Ergun Akleman
What is graphics about?
3D Modeling

- representing 3D shapes
- polygons, curved surfaces, …
- procedural modeling

Headus — Cysurf

[Hoppe et al. 1993]

[Prusinkiewicz et al. 2001]
3D Modeling

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- polygons, curved surfaces, …
- procedural modeling
3D Rendering

- 2D views of 3D geometry
- projection and perspective
- removing hidden surfaces
- lighting simulation
3D Rendering

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Animation

• keyframe animation
• physical simulation

Avengers (2012)
Animation

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Pixar
Cornell CS4620/5620 Fall 2014 • Lecture 1
Animation

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- physical simulation

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Animation

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Avengers (2012)

INTERPOLATION

Differential Equations
Images

• 2D imaging
  – compositing and layering
  – digital filtering
  – color transformations

• 2D drawing
  – illustration, drafting
  – text, GUIs
Images

- 2D imaging
  - compositing and layering
  - digital filtering
  - color transformations
- 2D drawing
  - illustration, drafting
  - text, GUIs
User Interaction

- 2D graphical user interfaces
- 3D modeling interfaces
- virtual reality
User Interaction

• 2D graphical user interfaces
• 3D modeling interfaces
• virtual reality
Graphics Hardware
Computer graphics: Mathematics made visible.
Introductions...
Translucent materials

Diffuse "milk"
Translucent materials

Diffuse “milk”  Skim milk
Translucent materials

Diffuse “milk”  Skim milk  Whole milk
Digital characters

Gollum from *The Lord of the Rings*: hair and skin are two major rendering challenges in film effects
Rendering hair

\[ a = 1.0 \]
a = 1.2

Rendering hair
Rendering hair

\[ a = 1.5 \]
Modeling knit cloth

[Yuksel et al. 2012]
High-quality woven cloth appearance

[Zhao et al. 2012]
Course Overview
Course mechanics

Web http://www.cs.cornell.edu/Courses/cs4620

Teaching Assistants (6 PhD/MS/MEng, ≥6 ugrad)
Eston Schweickart, Ph.D. TA emeritus
Rundong Wu, grad TA
Balazs Kovacs, grad TA
Nicolas Savva, grad TA
Deedy Das, grad TA
Jack Hessel, grad TA
Cristian Zaloj, software architect
and many more…

Piazza: Please sign up!
In CS4620/5620

• You will:
  – explore fundamental ideas
  – learn math essential to graphics
  – implement key algorithms
  – write cool programs
  – learn the basics of OpenGL

• You will not:
  – write very big programs
Topics

• Images, image processing, color science
• Modeling in 2D and 3D
• Rendering 3D scenes
  (using ray tracing and using the GPU)
• Geometric transformations
• The graphics pipeline
• Animation
CS4620 Prerequisites

• Programming
  – ability to read, write, and debug small Java programs (10s of classes)
  – understanding of very basic data structures
  – no serious software design required

• Mathematics
  – vector geometry (dot/cross products, etc.)
  – linear algebra (just basic matrices in 2-4D)
  – basic calculus (simple derivatives)
  – graphics is a good place to pick up some, but not all, of this
In CS4621

• You will also:
  – implement a modeling, rendering, animation system
    • in groups
  – learn a lot about
    • architecting good-sized interactive programs
    • OpenGL
    • programmable shaders, textures, animation
Workload

• CS 4620/5620
  – 7 assignments (written + programming)
  – 1 free late assignment (up to 1 week), else 10% per day
  – 2 exams (midterm + final)

• CS 4621/5621
  – one open-ended project
Textbook

Shirley & Marschner
Fundamentals of Computer Graphics
third edition
More books

Steven Gortler

**Foundations of Computer Graphics**
first edition

**OpenGL Programming Guide**
(a.k.a. the "Red Book")
Older version available online:
http://www.opengl.org/documentation/red_book/

**GLSL Shading Language**
(a.k.a. the "Orange Book")
Academic Integrity
Course mechanics

Web  http://www.cs.cornell.edu/Courses/cs4620

Schedule, handouts, etc. all on the web page

Practicum
  • See schedule on website
  • Not this Friday
  • First planned meeting Sept 9