Image Synthesis: Overview and Goals

cs348b
Matt Pharr
Goals and Applications

- **Goals**
  - Realistic image synthesis

- **Problems**
  - Modeling reality: light, materials, shapes
  - Simulating physics
  - Managing complexity

- **Applications**
  - Movies
  - Interactive entertainment
  - Lighting design
State of the art
Versus photos of reality

Ansel Adams
Modeling & Simulating Appearance

- Light sources
- Geometric shapes
- Materials
  - Surfaces
  - Participating media
- Cameras and film
- Perception & the human visual system
Early challenges in graphics

- Projection to the screen
- Visibility: hidden surface removal
- Basic shading
  - Gouraud
  - Phong
  - Texture mapping
  - Bump mapping
- ~What graphics hardware does today
Physically-Based Image Synthesis

- Surface reflection
  - The BRDF
- Participating media
  - Absorption, attenuation, the phase function
- Light transport algorithms
  - Ray tracing
  - The rendering equation / equation of transfer
Lighting Simulation

• The Rendering Equation
  • Given a scene consisting of geometric primitives with material properties and a set of light sources, compute the illumination at each point on each surface

• Challenges
  • Primitives complex: lights, materials, shapes
  • Exponential number of paths, dense coupling

• How to solve it?
  • Radiosity: Finite element
  • Ray tracing: Monte Carlo
Radiosity: Cornell Experiment

Measured

Simulated

Program of Computer Graphics
Cornell University
Early Radiosity
Early, Early Radiosity

Parry Moon and Domina Spencer (MIT), Lighting Design, 1948
Early Diffuse+Glossy

Tribute to Vermeer
Program of Computer Graphics, Cornell
Steel Mill
Camera Simulation
Difficult Light Paths

Eric Veach
Lighting Effects

Hard Shadows

Soft Shadows

Caustics

Indirect Illumination
Complex Indirect Illumination

Modeling: Stephen Duck; Rendering: Henrik Wann Jensen
Shadows on Rough Surfaces
Translucency

Surface Reflection

Subsurface Reflection
Water Flows on the Venus
Virtual Actors: Faces

Jensen, Marschner, Levoy, Hanrahan
Coupling Modeling & Rendering

Fedkiw, Stam, Jensen 2001
Past Final Projects
Orchid

Menelaos Levas
Zippo Lighter

Greg Hutchins and Yu Ping Hu
Glass Vase

by Georg Petschnigg and Inam Ur-Rahman Malik
Glass Vase

by Georg Petschnigg and Inam Ur-Rahman Malik
Digital Sculpture

by Robert Bridson
Igloo

by Farhan Zaidi and Irfan Zaidi
Grand Central

by Pradyumna Siddhartha and Erick Armbrust
Martinis

by Khai Weyn Ong
Hourglass

by Brad Johanson and Jeremy Johnson
Hourglass
Iridescence

by Steve Bennett and Arthur Amezquita
Class Details

• http://cs348b.stanford.edu
• T, Th, 9:30-10:45, here
  • Readings for each class meeting
• Lecturer: Matt Pharr
• TA: Ian Buck
Class Details

- Prereqs: cs248b, cs348a
  - Calculus, probability, signal processing
- 3 problem sets + final project
- No exams
- Texts
  - Matt Pharr and Greg Humphreys, *Physically Based Image Synthesis: Design and Implementation of a Rendering System*
  - Andrew Glassner, *An Introduction to Ray Tracing*
To Do

• Send mail to ianbuck@graphics
  • Name and home page
  • e-mail address
  • Est. probability of taking this class
  • Do you want a bound copy of *Physically Based Image Synthesis*? (Approx $25)

• Readings for Thursday