CS 419: Production Rendering

Eric Shaffer

Some Slides Adapted From Pat Hanrahan, Stanford University
CS345b Image Synthesis
Great Moments in Computer Graphics...

- Guardians of the Galaxy Rocket Racoon
- Academy Award for Physcially-Based Rendering
What drives CG technology

- Movie Industry
  - Production rendering...non-interactive
What drives CG technology

- Video Game Industry
  - Higher revenue than movies ($13B vs $12.9B in 2013)
What drives CG technology

- Medical Imaging and Scientific Visualization
  - Imaging one of the biggest advances in medicine
  - Sci Vis allows people to see previously hidden phenomena
What drives CG technology

- Computer Aided Design
- Engineering, Architecture, the Maker movement
General Goals of Rendering

- Increase quality
  - More accurate modeling of the physics of light
  - Better models of materials

- Reduce time
  - More efficient algorithms (numerical or otherwise)
  - Better data structures
  - Parallelism
Managing Geometric Complexity

PantaRay: Fast Ray-Traced Occlusion Caching of Massive Scenes
Pantaleoni et al., SIGGRAPH 2010
Rendering through 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
- Infinite number of light paths

How to solve it?

- Radiosity $\rightarrow$ Finite element
- Ray tracing $\rightarrow$ Monte Carlo
Photorealistic Rendering Effects

- Diffuse Reflection
- Specular Reflection
- Point and Area Lights
- Hard and Soft Shadows
- Transparency and Translucency
- Mirroring
- Materials (skin, etc.)
- Atmospheric Effects
- And more....
Lighting: Diffuse Reflection

Surface Color

Diffuse Shading Point Light Source
Lighting: Soft Shadows

Hard Shadows
Point Light Source

Soft Shadows
Area Light Source
Radiosity

Assumptions: Diffuse reflection and polygonal shapes
Diffuse and Glossy
Glossy and Curved Surfaces

Inter-Reflection, Curved Surfaces
Area Light Source

Inter-Reflection, Glossy & Curved Surfaces
Area Light Source
Tranlucency

Surface Reflection

Subsurface Reflection
Skin and Faces

Square USA
The digital heroine of the Final Fantasy film.

Final Fantasy
Square USA

Jensen, Marschner, Levoy, Hanrahan
Clouds and Atmospheric Phenomena

Hogum Mountain
Sunrise and sunset

7am

Modeling:
Simon Premoze
William Thompson

Rendering:
Henrik Wann Jensen

9am
Modeling Surfaces

Ray-Based Reflectance Model for Diffraction Cuypers et al., SIGGRAPH 2012

Building Volumetric Appearance Models of Fabric using Micro CT Imaging Zhao et al., SIGGRAPH 2011
Modeling Surfaces

Structure-aware Synthesis for Predictive Woven Fabric Appearance Zhao et al., SIGGRAPH 2012
Virtual Ray Lights for Rendering Scenes with Participating Media
Novak et al., SIGGRAPH 2012
Citrus Marmalade
Some Stuff about the Class

- Syllabus is on course website:
  https://courses.engr.illinois.edu/cs419/index.html

- We’ll use Piazza...hopefully a lot
Some Stuff about the Class

- Grades probably on usual scale:
  - 97 to 93: A
  - 93 to 90: A-
  - 90 to 87: B+
  - 87 to 83: B
  - 83 to 80: B-
  - ...etc.

- won’t be any tighter

- Two exams (each 20% of course grade)
- Four programming assignments (in total worth 60% of grade)
Some Stuff about the Class

Required text:
Some Stuff about the Class

- In addition to the book, we’ll try to cover a few of the following topics
  - High-Dynamic Range Images
  - BRDFs and material modeling in greater detail
  - Photon Mapping
  - Irradiance Caching
  - Monte Carlo Methods
  - Geometric data structures
  - Texture synthesis
  - Geometric modeling
  - Animation
Some Stuff about Coding

- Use whatever programming languages you want
- Use whatever libraries you want
- Help each other out on Piazza

- You can use other people’s code.
  - You have to document your use
  - Failure to do so results in a 0 on the assignment