Computer Graphics

Lecture 12
Advanced Ray Tracing
Announcements

• Feedback survey - respond by Thursday night (10pm)

• Now is a good time to start thinking about final projects - proposals will be due in about 3 weeks.

• Friday's class in CF 420

• For Friday:
  • Find a partner (different from your A1 partner)
  • Read the A2 handout
  • Accept the GH classroom invite to create your repo
Today

- A high-level overview of what comes next in ray tracing.
- Useful for A2 extensions and/or final project ideas.
- Not getting into gory detail - see the book references on the slides.
Ok, what can't we do?

• Render transparent things - *transmission and refraction* (Ch 13.1)

• Rotate, scale, shear objects - *transformations* (more on this next week, and in 13.2)

• Intersect more kinds of objects - *Constructive Solid Geometry* (Ch 13.3)

• Area light sources, soft shadows, depth of field - *distribution ray tracing* (Ch 13.4)

• Global illumination (Ch. 23)

• More realistic surfaces (Ch. 24)
Transparency and Refraction

Our framework assumes surfaces (only) reflect light.

What if that's wrong?
Basically, physics

Laws of physics govern how light transmits through *dielectric* surfaces. Snell's law:

\[ n \sin \theta = n_t \sin \phi. \]

**Similar to mirror reflection:**
When light hits a special kind of surface, shoot a new ray in new direction.
Transformations and Instancing

Next week we'll talk about how to transform objects:
Transformations and Instancing

Next week we'll talk about how to transform objects:

When ray tracing, we can alternatively transform the rays:

Same idea allows us to include multiple *instances* of the same object in a scene.
Constructive Solid Geometry

Compose objects from other objects using set operations:

- \( C \cup S \) (union)
- \( S - C \) (difference)
- \( C - S \) (difference)
- \( C \cap S \) (intersection)
Constructive Solid Geometry

- Intersections yield intervals of $t$
- Perform the set operations on those intervals to determine overall intersection.
Distribution Ray Tracing

Problem: X

Solution: Compute multiple rays per pixel, (randomly) sampling property Y for each one.
Distribution Ray Tracing

Problem: jagged object and shadow edges
Distribution Ray Tracing

Problem: jagged object and shadow edges
we have this

we want this

we have this

Idea: **supersample** rays within each pixel.
Regular, Random, and Stratified Sampling
Distribution Ray Tracing

Problem: area light sources

global illumination

soft shadows
Distribution Ray Tracing

Problem: area light sources
Distribution Ray Tracing

Problem: area light sources

This one's trickier..

Ch 23

global illumination

soft shadows
Distribution Ray Tracing

Problem: glossy reflection

Mirror

Glossy Mirror

Images: Kevin Suffern http://www.raytracegroundup.com/
Distribution Ray Tracing

Problem: glossy reflection
Distribution Ray Tracing

Problem: Defocus Blur
Distribution Ray Tracing

Problem: Defocus Blur
Distribution Ray Tracing

Problem: Motion Blur

Plot twist: sample from a 1D interval, not a rectangle!
Up Next

• Today was: slowing down ray tracing

• Friday is: implementing ray tracing (A2)

• Monday is: speeding up ray tracing

• Thereafter: Transformations - positioning, scaling, rotating, shearing, etc. of objects and cameras in the scene.

• Intro to object-order rendering.