CSI 4341, Computer Graphics

Lecture 21ish: Ray Tracing, Radiosity

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1 Ray Tracing

Follows light from a point source to the camera.

- Can account from reflection and transmission.
- Should be able to handle all physical interactions.

To parallelize computation, we need all the data of everywhere. Most rays, however, don't affect what we see. Scattering produces many (infinite) additional rays, creating a high computational cost.

Works best with perfectly specular surfaces.

1.1 Ray Casting

Ray casting is a great alternative to ray tracing. Cast rays (at least one per pixel) and follow to see if it reaches a light source.

We can also cast shadow rays. Since we follow these off reflecting or transmitting surfaces, we do it recursively. After x steps, cut off the computation and make it black.

1.2 Building a Ray Tracer

- Can remove recursion.
- Ignore rays that go off to infinity.
- Some light is absorbed at each intersection.
- Worry about outside/inside testing.

1.2.1 Outside/Inside testing

If a ray enters an object it must enter a front-facing polygon and exit through a back-facing polygon.

Create a polyhedron using the intersections of planes (don't need to keep the size). If a ray enters then exits, there is a collision. If it exits then enters, it passes by the polygon.

2 Radiosity

- Solves the rendering equation for perfectly diffuse surfaces.
- Only need to account for amount of light, its angle, and color.

Energy density $\phi = \int \int$ I dA dω

2.1 Rendering equation

- Integrate over all incoming light.
- Account for foreshortening of incoming light.

Energy in = Energy out

2.2 Fredholm integral equation

In general, cannot be solved analytically
Radiosity objects broken up into flat patches. Assume patches are perfectly diffuse reflectors.

Radiosity = flux * energy / area
a_i = area
b_i = radiosity
$a_i b_i$ = intensity
$e_i a_i$ = emitted intensity
ρ_i = reflectivity
f_{ij} = fraction of energy leaving j that reaches i

Energy balance: $b_i a_i = e_i a_i + \rho_i \Sigma f_{ji} b_j a_j$
Reciprocity: $f_{ij} a_i = f_{ji} a_j$

From these two equations,
Radiosity Equation: $b_i = e_i + \rho_i \Sigma f_{ij} b_j$

Rendered Images look awesome.