Monte Carlo IV: The Rendering Equation (Continued)

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Overview

- Irradiance caching
  - Another biased MC method
- Metropolis sampling
  - Generating samples from arbitrary functions
- Metropolis light transport

Irradiance Caching

- Separate out indirect illumination from direct
- Assumptions:
  - It changes relatively slowly
  - Directional distribution is relatively unimportant
- Approach:
  - Compute indirect illumination at sparse set of points, interpolate it to use at nearby points
- Advantages:
  - Low memory, efficient,...

Irradiance Caching

- Definition of irradiance

$$E(x) = \int_{\Omega} L_i(x, \omega) \cos \theta_i d\omega$$

- Estimate this integral with standard MC techniques

Irradiance Caching

- Estimate irradiance from nearby samples
- For Lambertian surface,

$$f_r(\omega_i \to \omega_o) = c$$

- Rendering equation:

$$\begin{aligned} L(x,\omega) &= L_e(x,\omega) + \int_\Omega f(\omega_i \to \omega) L_i(x,\omega_i) \cos\theta_i d\omega_i \\ &= L_e(x,\omega) + c \times E(x) \end{aligned}$$

Irradiance Caching

- What if surface isn't Lambertian?
- Two possible approaches:
  - Use irradiance estimate for Lambertian component of BSDF, handle the rest with different technique
  - Assume that incident radiance is same from all directions

$$L(x, \omega) = E(x)/\pi$$

- Error depends on specularity of BRDF, variation in illumination...

Irradiance Caching

- When is re-use error prone?
  - Sample is from far away
  - N is substantially different
  - Nearby objects
- Better interpolation
  - Ward & Heckbert: Irradiance gradients
- Other compact representations of incident radiance?
  - If more directional variation can be preserved, can be applied to directionally-varying BRDFs

Examples

- Under-sampled irradiance caching vs under-sampled path tracing