Radiance Estimation

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What’s wrong with this image?
What’s wrong with this one?
HW3: a special case

- Lens flare = a special case of a caustic
- Only works for point lights
- Only works for camera lens / spherical refraction
- And we didn’t give you much guidance on reconstruction
Trouble...

What if we needed to render this bizarre image of hundreds of stacked wineglasses?

HW3 could not handle this.
Quiz

Name this celebrity
Photon mapping to the rescue

*Image credit: Acquiring Scattering Properties of Participating Media by Dilution. Narasimhan, Jensen et al*
Photon mapping is not so different

- Simulate photon emission from light sources
- Trace photons through the scene
- Store a photon at each diffuse bounce
- **WHEN DOES THIS END??**
Non-Russian Non-Roulette

• You could scale down photon power by reflectance
• But eventually photons become very weak
• Simply eliminate photons below certain threshold? Your image is no longer unbiased
• And now some photons are more equal than others (i.e. they have vastly unequal power)
Russian Roulette

- Suppose surface absorbs 60% of power (i.e. probability of reflection is 40%)

- Choose a random number $x$ in $[0,1]$

- if $x < 0.4$, reflect photon with $\Phi/0.4$

- else absorb
Skipping ahead...

- Topics we are NOT covering today:
  - photon map data structure
  - kd-tree
  - nearest-neighbor search
Radiance estimation

- Here’s an idea:
  - divide up your meshes in little regions
  - each region keeps a histogram
  - each time photon hits region, add it to histogram
  - now you know photon density => irradiance!
  - sounds like ImageFilm::Splat()?
Radiance estimation

• Why is this idea not so great?
As Jensen writes:

• “...a histogram-based approach will risk getting zero photons in small polygons, resulting in no illumination, which can result in black pixels in the rendered image...”

• “...for high-quality image synthesis this is not acceptable.”

source: *Realistic Image Synthesis Using Photon Mapping*, pg. 76
“...for high-quality image synthesis this is not acceptable.”
Kernel density estimation

• Insight: let’s store the photons

• Need the irradiance for an arbitrary point?
  • Take a small spherical neighborhood
  • Count the power of the photons inside
  • Compute enclosed surface area

• power / area = density
Can you think of a potential problem?
Filtering: Motivation

Image credit: Phillip Ho, CS348b Rendering Competition, 2011
Filtering

- Motivation: to preserve sharp edges of caustics
- Weight of photons should be proportional to distance
- For regular photon mapping, 2D filter is fine
- What about volumetric?
- Jensen proposes cone filter or Gaussian filter