

# Progressive Photon Mapping

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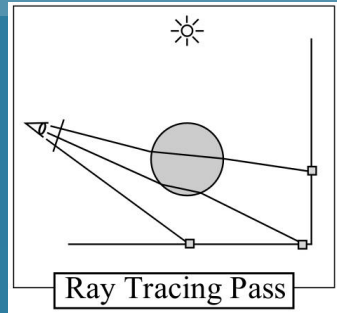
CM50245: Computer Animation and Games II

- Solve the rendering equation
- $L_o(x, \omega_o) =$   
 $L_e(x, \omega_o) + \int_{\Omega} f(x, \omega_o, \omega_i) L_i(x, \omega_i) |\cos\theta_i| d\omega_i$

- Photon mapping as an approximation
- Two passes
  1. Ray tracing in a photon map
  2. Photon rendering
- $$L_r(x, \omega_o) \approx \sum_{p=1}^N \frac{f(x, \omega_o, \omega_i) \phi_i(x_p, \omega_i)}{\pi r^2}$$

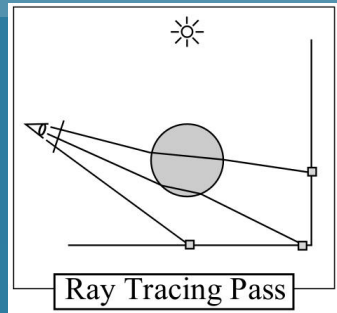
- Ray tracing pass 1

- Ray tracing to find visible surfaces
- Each ray includes all specular bounces
- Stop when non-specular surface is found



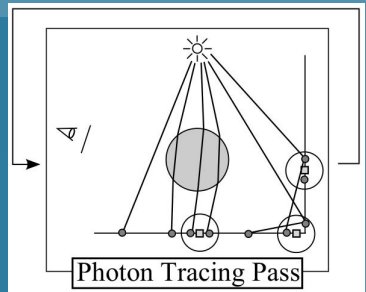
- Ray tracing pass 2

- Struct hitPoint
  - $x$  hit position
  - $i,j$  pixel location
  - $R$  current radius
  - $N$  acum photon count
  - $\tau$  acum reflected flux



- Photon tracing pass

- Accumulate photon flux in hit points
- Newly added photon improve the quality
- $d(x) = \frac{n}{\pi r^2}$ ,  $d'(x) = \frac{n'}{\pi r^2}$



- Radius reduction

- Radius reduces with each pass to increase quality
- Compute new photons  $\hat{N}(x) = N(x) + \alpha M(x)$
- New radius  $\hat{R}(x) = R(x) \left( \frac{N(x) + \alpha M(x)}{N(x) + M(x)} \right)^{\frac{1}{2}}$
- There has to be a gain in total number of photons

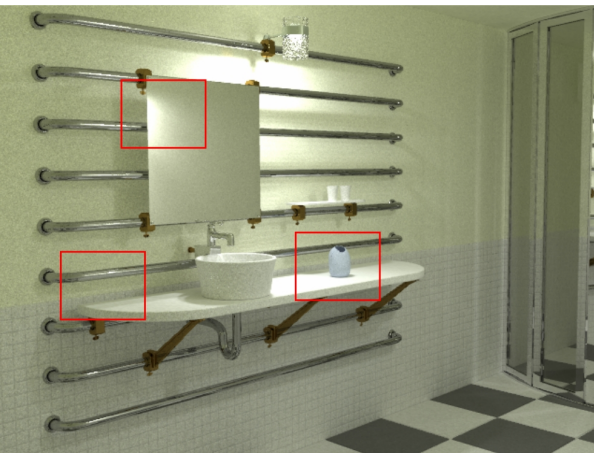
- Flux correction

- Flux from new pass has to be normalized
- $\tau_N(x, \omega_o) = \sum_{p=1}^{N(x)} f(x, \omega_o, \omega_i) \phi'_p(x_p, \omega_i)$
- $\tau_{\hat{N}}(x, \omega_o) = (\tau_N(x, \omega_o) + \tau_M(x, \omega_o)) \frac{N(x) + \alpha M(x)}{N(x) + M(x)}$

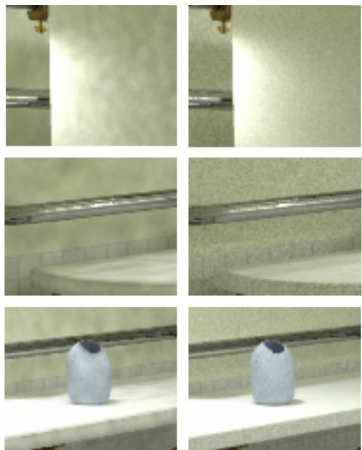


- Radiance evaluation

- Sum the contribution of all photons in the hit point
- $L(x, \omega_o) = \frac{\tau(x, \omega_o)}{\pi R(x)^2 N_{em}}$



Progressive photon mapping

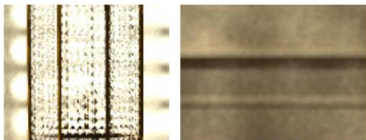
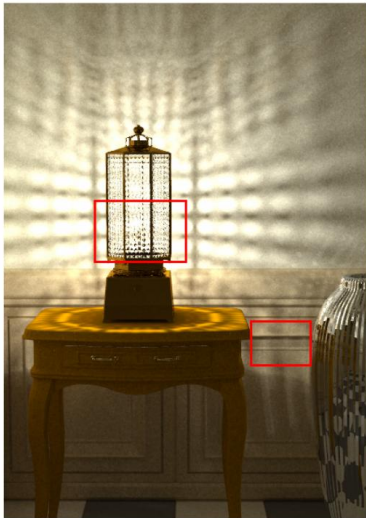


PM

PPM



Photon mapping



Progressive photon mapping

Questions?