

Progressive Photon Mapping

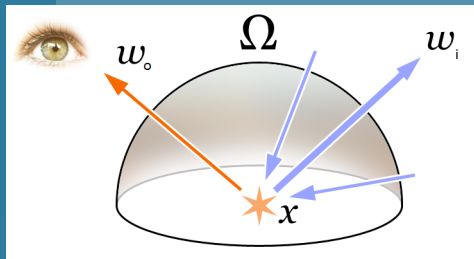
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CM50245: Computer Animation and Games II

- 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

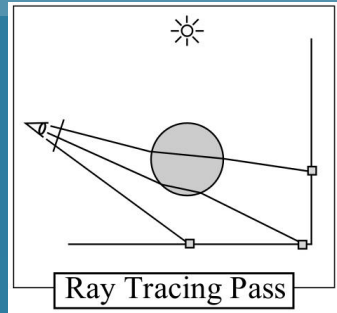
- Two passes

1. Ray tracing in a photon map
2. Photon rendering

- $$L_r(x, \omega_o) \approx \sum_{p=1}^N \frac{f(x, \omega_o, \omega_i) \phi_p(x_p, \omega_i)}{\pi r^2}$$

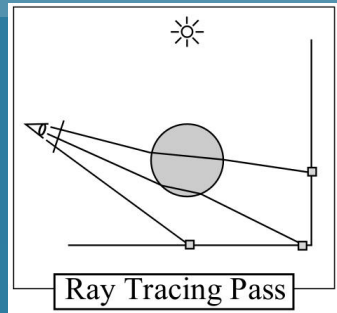
- Ray tracing pass 1

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



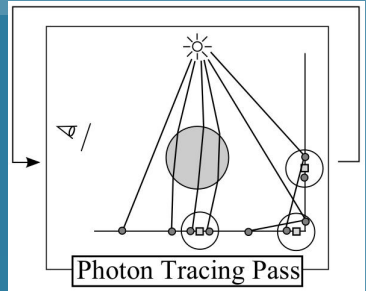
- Ray tracing pass 2

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



- Photon tracing pass

- Accumulate photon flux in hit points
- New photons 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
- There has to be a gain in total number of photons
- Keep fraction of new photons $\hat{N}(x) = N(x) + \alpha M(x)$
- New radius $\hat{R}(x) = R(x) \left(\frac{N(x) + \alpha M(x)}{N(x) + M(x)} \right)^{\frac{1}{2}}$

- Flux correction

- Reduced radius = incorrect accumulated flux

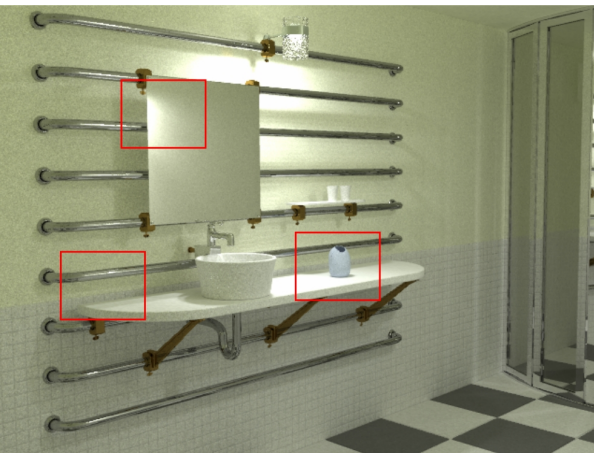
- $\tau_N(x, \omega_o) = \sum_{p=1}^{N(x)} f(x, \omega_o, \omega_i) \phi'_p(x_p, \omega_i)$

- $\tau_{\hat{N}}(x, \omega_o) = (\tau_N(x, \omega_o) + \tau_M(x, \omega_o)) \frac{N(x) + \alpha M(x)}{N(x) + M(x)}$

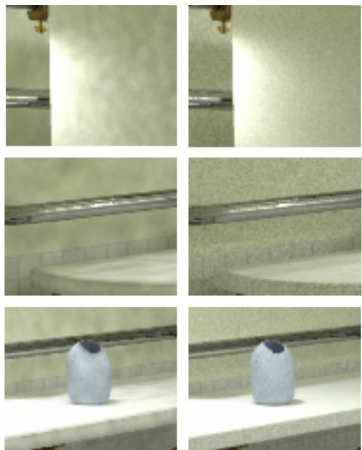
- Radiance evaluation

- 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

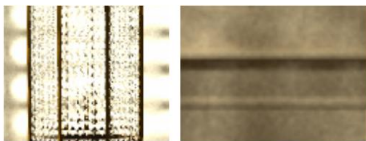
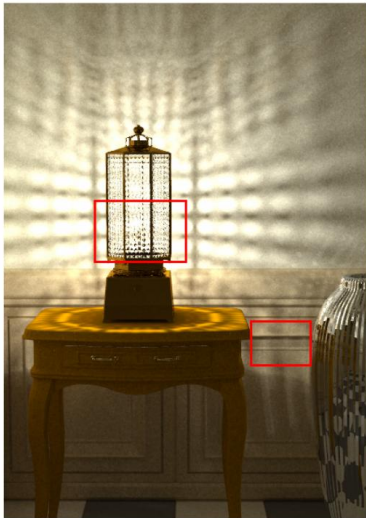


PM

PPM



Photon mapping



Progressive photon mapping

- Possible improvements

- Locally adaptive
- Optimal number of total photons
- Optimal direction to shoot photons
- Optimal photon intensity

Questions?