Progressive Photon Mapping

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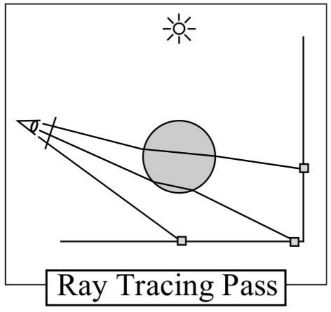
- Solve the rendering equation
- $L_o(x, \omega_o) = L_e(x, \omega_o) + \int_\Omega f(x, \omega_o, \omega_i) L_i(x, \omega_i) |cos\theta_i| d\omega_i$

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

- Ray tracing pass 1

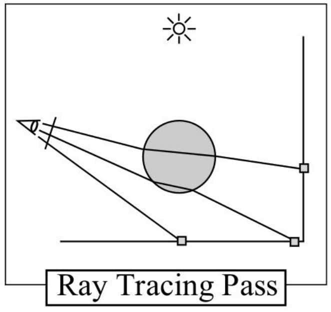
  - Ray tracing to find visible surfaces
  - Each ray includes all specular bounces
  - Stop when non-specular surface is found



- Ray tracing pass 2

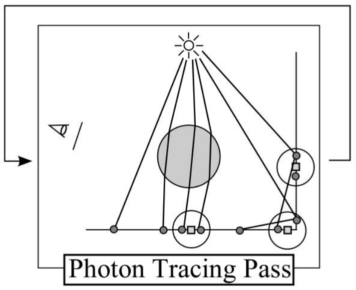
  - Struct hitPoint

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



- Photon tracing pass

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



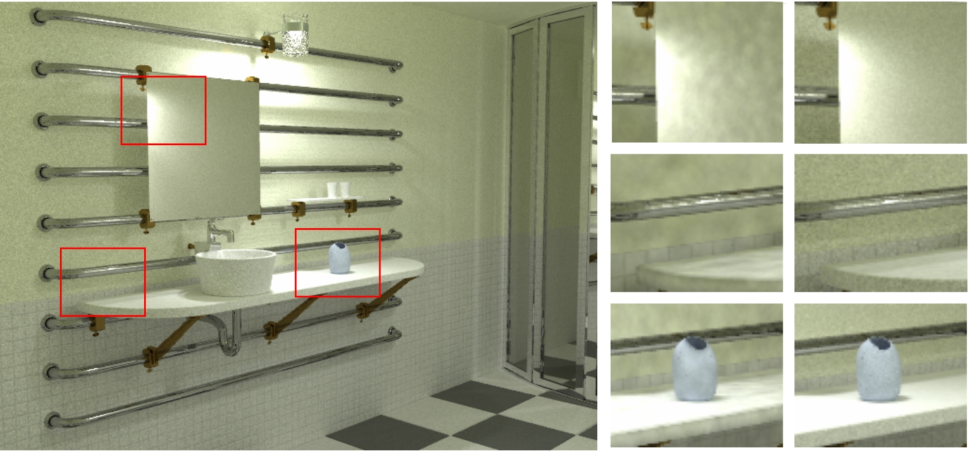
- Radius reduction

  - 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
  - $\tau_N(x, \omega_o) = \sum_{p=1}^{N(x)} f(x, \omega_o, \omega_i)\phi'_p(x_p, \omega_i)$
  - $\tau_{\hat{N}}(x, \omega_o) = (\tau_N(x, \omega_o) + \tau_M(x, \omega_o)) \frac{N(x)+\alpha M(x)}{N(x)+M(x)}$

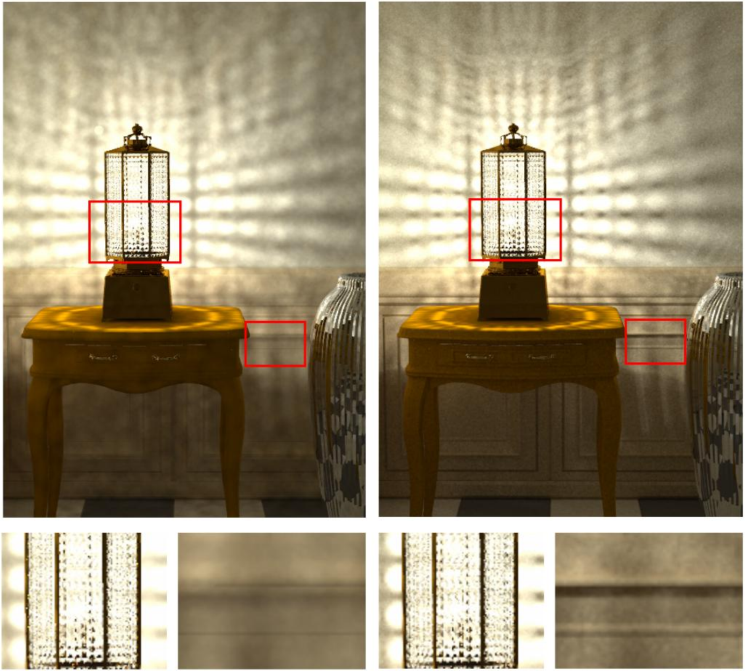
- Radiance evaluation

  - 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

- Possible improvements

  - Locally adaptive
  - Optimal number of total photon
  - Optimal direction direction
  - Optimal intensity

Questions?