Progressive Photon Mapping

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ACM Honored Class

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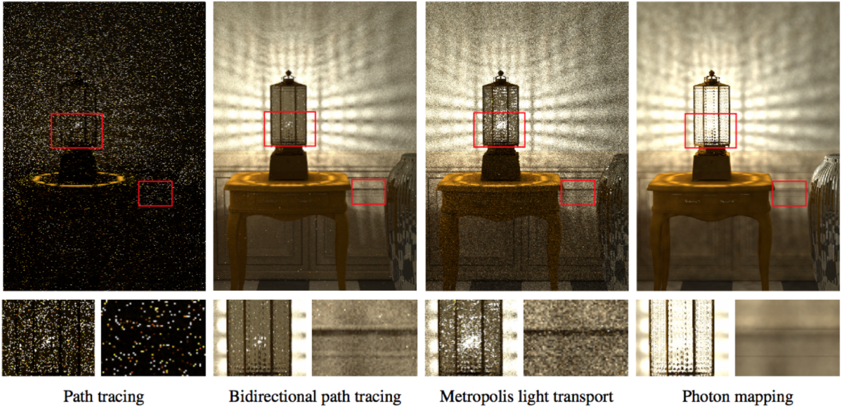
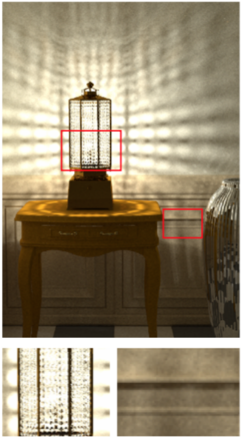
Traditional rendering algorithm for simulating caustics.





Progressive photon mapping

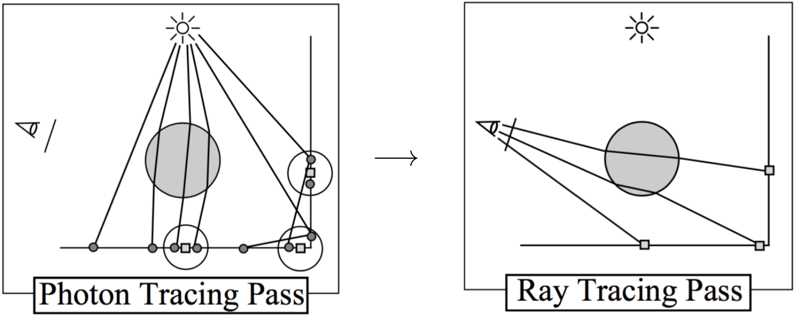
- More efficient
- More adaptive

‘Progressive’

There are two meanings of the work ‘progressive’ in the title.

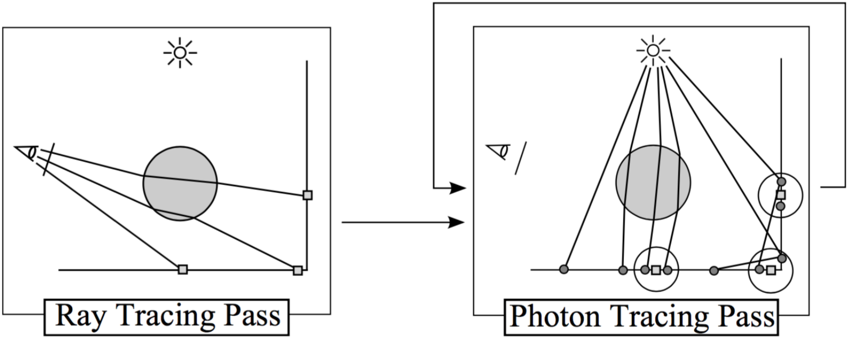
- Make progress on old algorithm
- Make progress on every iteration

Recall the traditional algorithm



A two-pass algorithm, trace the photons first, and then collect radiation of photons by ray tracing.

Author's algorithm



A multi-pass algorithm, run raytracing pass first, and then run phonton tracing pass iteratively.

$$L(x,\omega) = \sum_{p=1}^{n} \frac{f_r(x,\vec{\omega},\vec{\omega}_p)\phi_p(x_p,\omega_p)}{\pi r^2}$$

where f is BRDF, ϕ is a given parameter of photons certain property.

Why r is square rather than cube?

It only care about the number of photons, and the radius r is a constant, which means the picture rendered cannot be more detailed than r.

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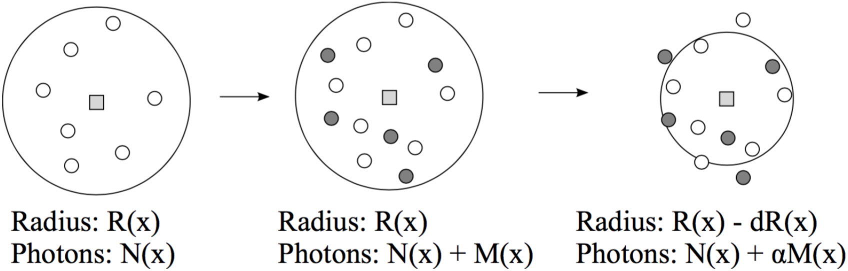

Calculate the contribution of photons adaptively.

At the very beginning, suppose we have N photons in the radius, R. Then M photons comes, we want still keep the density of the photons in the neighborhood. What should the new R be?
Suppose $N + \alpha M$ photons in the radius $\hat{R} = R - dR$.
I draw the conculsion first:

$$\hat{R} = R \cdot \sqrt{\frac{N + \alpha M}{N + M}}$$

This equation will be justified in the next page.

First, introduce a density function d

$$d = \frac{N + M}{\pi R^2}$$

We want to keep it with $\hat{R}$ and $N + \alpha M$, so it should be

$$\frac{N + \alpha M}{\hat{R}^2} = \frac{N + M}{R^2}$$

Resolve the equation above, we get

$$\hat{R} = \frac{N + \alpha M}{N + M} R$$

Both radius and weight of flux are adjusted by the term $\frac{N+\alpha M}{N+M}$