Global Illumination using Photon Maps[1]

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Abstract

Current state of the art techniques in global illumination are two-pass methods in which the first pass is a radiosity like algorithm that creates an approximate global illumination solution. In the second pass this approximation is visualized using an optimized Monte Carlo ray tracer. This scheme works very well in most scenes but as models become increasingly complex having millions of primitives, procedural objects and glossy reflection the cost of using radiosity becomes prohibitive. This is mainly due to the fact that storing illumination within a tessellated representation of the geometry uses too much memory.

In this talk a two-pass global illumination method is presented which uses the photon map to represent illumination within a model. The photon map is created by emitting a large number of photons (packets of energy) from the light sources into the scene. Each photon is traced through the scene using photon tracing (similar to path tracing). Every time a photon hits a non-specular surface it is stored in the photon map. The result is a large number of photons stored within the model approximating the incoming flux at the surfaces. The photon map can be used to provide radiance estimates at any given surface position, to generate optimized sampling direction in a Monte Carlo ray tracer, to reduce the number of shadow rays (using shadow photons) and to provide improved control variates.

The method presented uses two photon maps: One high resolution photon map representing caustics that are visualized directly and one lower resolution global photon map which is used to reduce the number of reflections traced and to generate optimized sampling directions in the Monte Carlo ray tracer.

Results are presented which demonstrate global illumination in scenes containing procedural objects and surfaces with diffuse and glossy reflection models. The implementation is also compared with the Radiance program.

Key words: Global Illumination, Photon Maps, Monte Carlo Ray Tracing

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