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Photon Mapping

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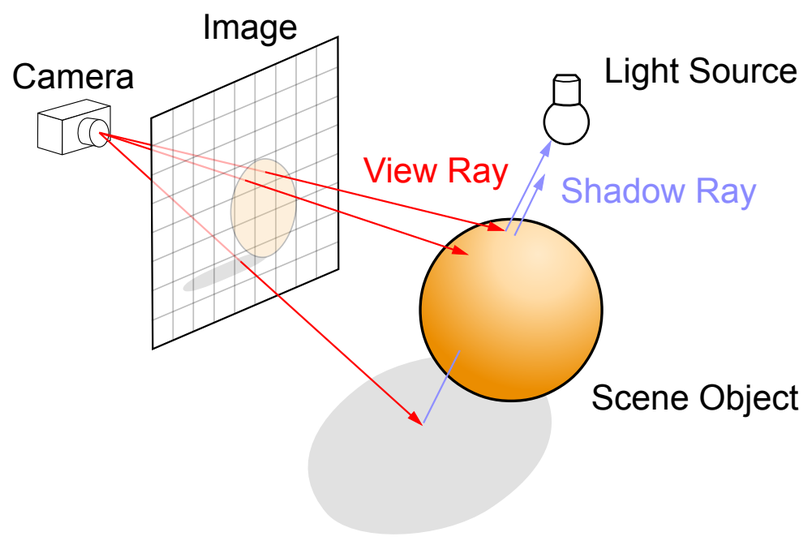
Abstract

Global Illumination (GI) techniques allow us to add realism to a rendering of a scene, one such technique, photon-mapping has been shown to improve the efficiency of GI calculations. The aim of this project is to create a photon mapping system that includes a novel modification to the standard algorithm.

Introduction

For many applications realistic rendering is required, as a result many algorithms have been developed that aim to simulate the light-transfer of a scene, one such algorithm is photon mapping, an extention of traditional raytracing that precomputes radiance for indirect illumination that is used to estimate the glocal illumination.



Traditional Raytracing

Background

Raytracing

Introduced by Whitted [1] as a method of synthesising images of a scene ny tracing rays from the viewer into the scene for each pixel in the output image and shade the pixel with the colour of the object that intersects the traced ray.

Global Illumination

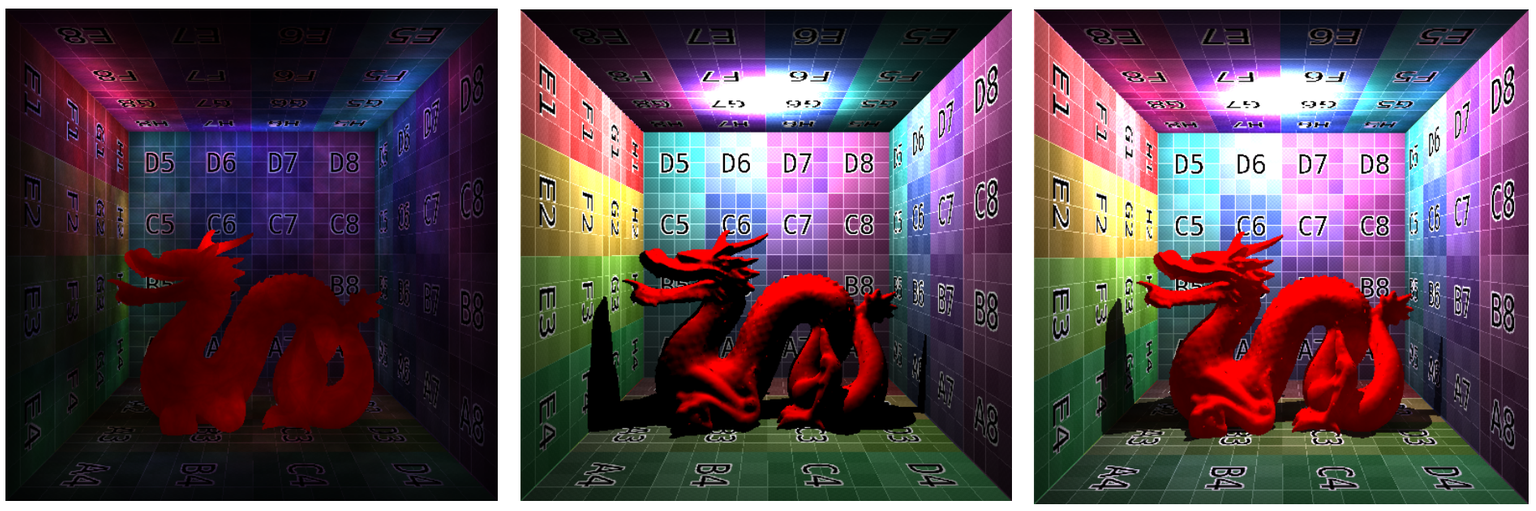
Describes illumination of a scene that accounts for intereflection of light with the scene, formalised by Kajiya [2] in the rendering equation.

Photon Mapping

Introduced by Jensen [3], aims to approximate the global illumination of a scene by storing photons in a spacial data structur that can be queried to estimate the radiance at a point on the scene geometry.

Photon Mapping

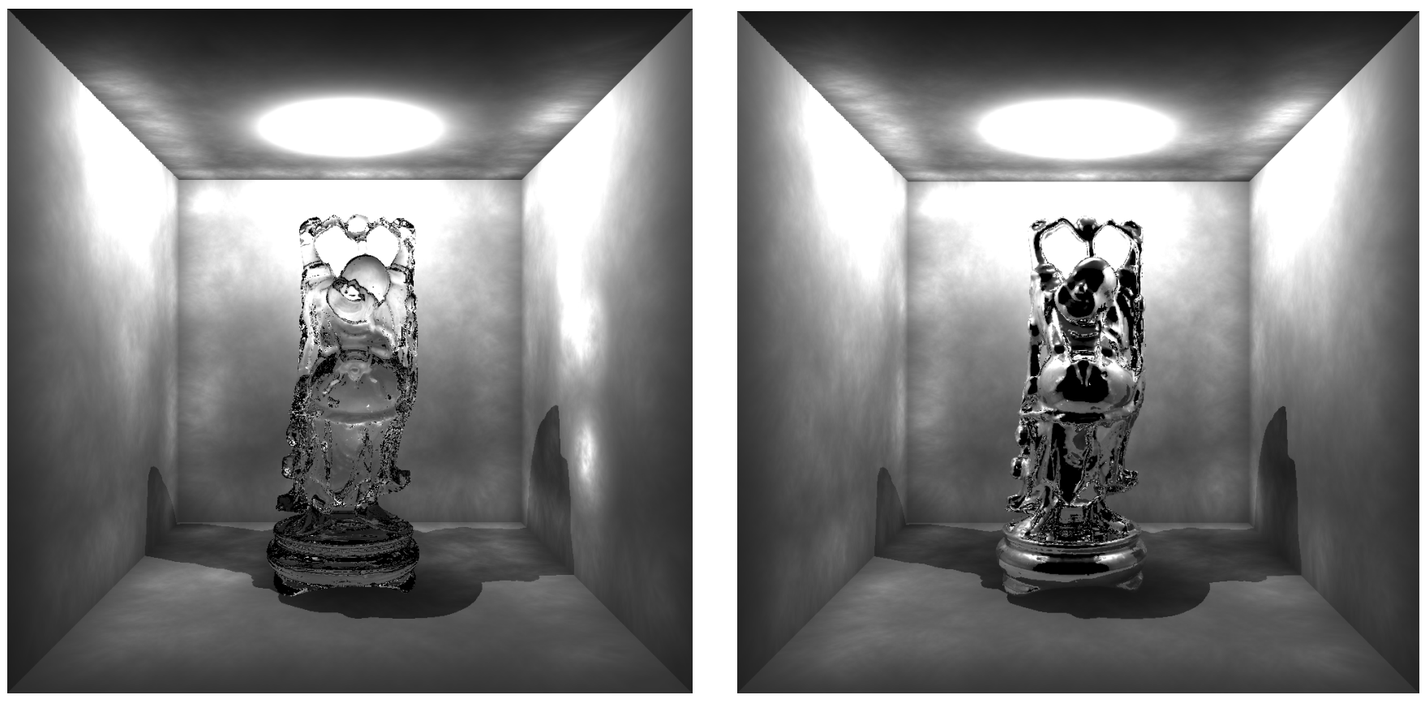
The key insight of the photon mapping algorithm is that radiance (in the form of photons) from a light source can be traced through a scene and stored in a spatial data structure that can be used to estimate the indirect illumination of a scene, this is done by calculating the density of photons at a point on the surface of an object. This method of global illumination is able to estimate the light transfer of a scene more efficiently that methods such as path tracing and is more flexible than radiosity methods [3].



Indirect (left), direct (middle) and combined (right) lighting.

Modification to Photon Mapping

This project includes a novel modification to the photon mapping algorithm, the modification is to store an extra photon map for light that is monochromatic and highly coherent (laser light) with the aim of reducing the number of photons used in the radiance estimation for the contribution from these light sources. Once implemented I will compare the performance of this method with that of traditional photon mapping.



Rendering with different material properties (glass and mirror)

Design

The system has been designed in a modular fashon to decouple the input/output from the image synthesis, the image synthesis is performed in parrallel and able to utilise multiple cores on a given machine, future work may include extending the system to utilise GPGPU if avaiable on a machine.

References

[1] Whitted, T. (1979), An improved illumination model for shaded display, Vol. 13, pp. 1–14.

[2] Kajiya, J. T. (1986), The rendering equation, in ‘Proceedings of Siggraph ’86’, pp. 143–150.

[3] Jensen, H. W. (1996), Global illumination using photon maps, in ‘7th Eurographics Workshop on Rendering’, pp. 22–31.