Ambient Light Caching via Approximate Photon Mapping

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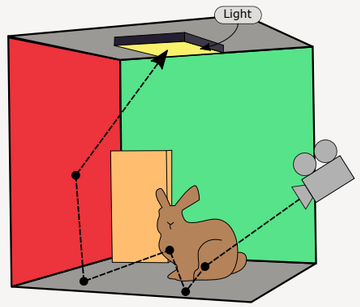
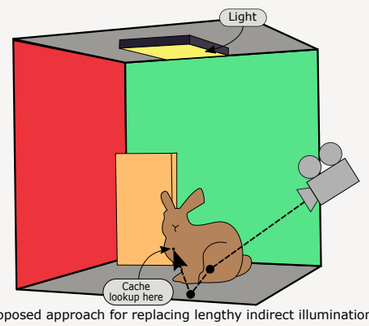
1 Introduction

Indirect illumination is an essential ingredient for adding realism to computer-generated imagery. Unfortunately, however, calculating indirect illumination accurately is computationally expensive as it involves following how rays cast from the camera scatter through the scene. This process is shown in the image below.



An example of calculating indirect illumination.

Although effective, this method can make rendering costs proliferate in scenes with challenging light paths. To minimise these costs, we propose using a precomputed ambient light cache to replace the lengthy indirect illumination paths. We build the cache using ideas from photon mapping [1]. Our method is shown in the figure below.



Our proposed approach for replacing lengthy indirect illumination paths.

2 Goal

Minimise costs of calculating indirect illumination by replacing lengthy light paths with queries to an ambient light cache.

References:
[1] Jensen H. W., Christensen N. J.: Photon maps in bidirectional monte carlo ray tracing of complex objects. *Computers & Graphics 19,* 2 (1995), 215–224

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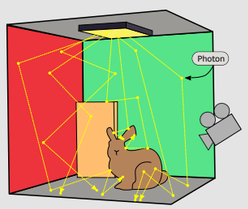
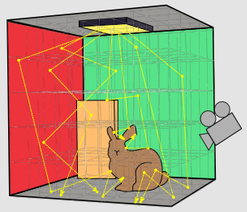
3 Method

Preprocessing

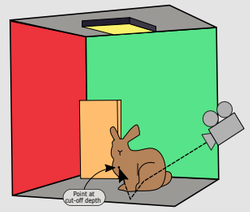


Step 1: Trace photons by casting rays from light sources

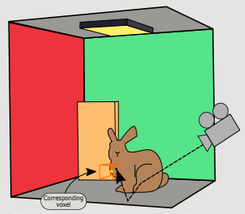


Step 2: Store photons in a spatial hash voxel grid

Rendering process



Step 3: Accurately calculate light scatterings until a defined cut-off path depth has been reached



Step 4: Place the last intersection point in the corresponding voxel of the grid. Use the photons of that voxel to estimate indirect illumination

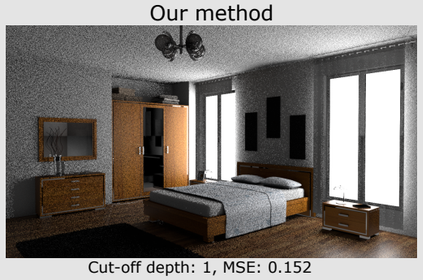
5 Conclusions

Our method is effective at improving convergence behaviour for indirect illumination. It is particularly practical in scenes with costly intersection tests. To improve it, a more accurate data structure, such as a kd-tree, can be used to store the photons, while a more advanced light leakage fix could increase performance. Potentially a progressive reformulation of our method can make it unbiased.

4 Results

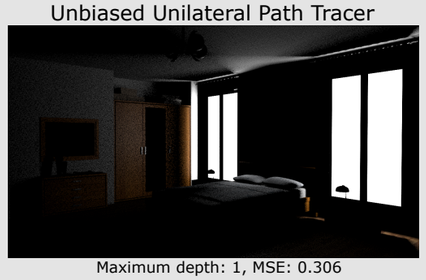
Reference

Our method



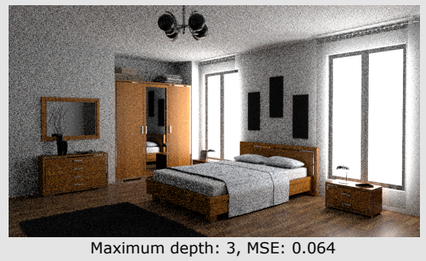
Cut-off depth: 1, MSE: 0.152

Unbiased Unilateral Path Tracer

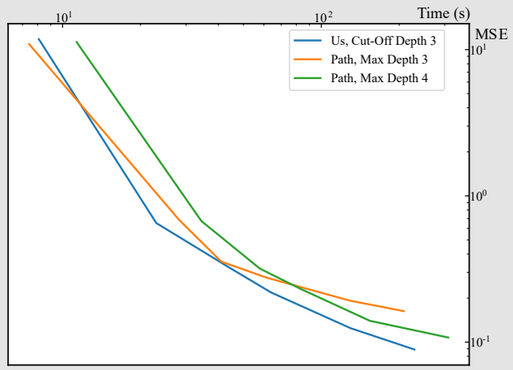


Maximum depth: 1, MSE: 0.306

Cut-off depth: 3, MSE: 0.041



Maximum depth: 3, MSE: 0.064



Convergence behaviour of our method compared to that of a path tracer at the same depth and of a path tracer that is allowed one additional bounce.

The values of our cache directly visualized