Efficient direct lighting calculations for area lights with light portals

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1 INTRODUCTION

Physically-based Monte Carlo light transport algorithms such as **path tracing** allow for the creation of photorealistic imagery with accurate direct and indirect illumination, however they are limited by their high computational demands.

For efficiency reasons, most rendering algorithms separate the calculation of **direct** and **indirect** illumination, where direct illumination is calculated by sampling directions towards the light sources.

Fig 1a: path traced

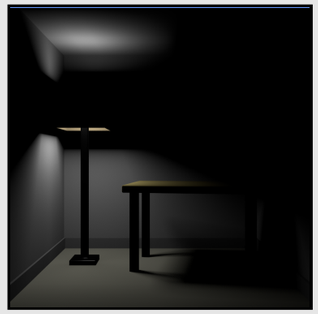


Fig 1b: direct lighting

Existing direct light estimation methods converge slowly when the **light source is largely occluded** such as a bulb in a lampshade, as a large amount of shadow rays are occluded.

2 METHOD OVERVIEW

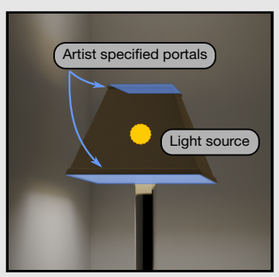


Fig 2: portal and light locations

We include **manually specified** openings to the light source in the scene description as **portals**.

During rendering, this visibility information is used to **importance sample according to the directions visible through the portal.**

3 EFFECTIVELY SAMPLING THE PORTAL

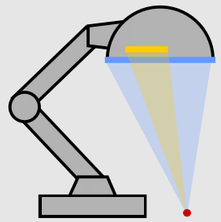


Fig 3: With naive portal sampling, it may be more suitable to sample the light directly

Uniform portal sampling is not a robust strategy, as many of the directions facing the portal may not face the light.

A more robust strategy is to sample the **projection of the light onto the portal**, but this introduces overhead in scenes where there is no additional benefit over just sampling the light itself.

4 ANTISHADOW BASED SAMPLING

The key observation is to consider the **shadow that the portal would cast if we were to replace it with an occluder**. Since the portal represents the precise opposite of an occluder, this imaginary shadow volume is the region lit through the portal. We call this volume the **antishadow**.

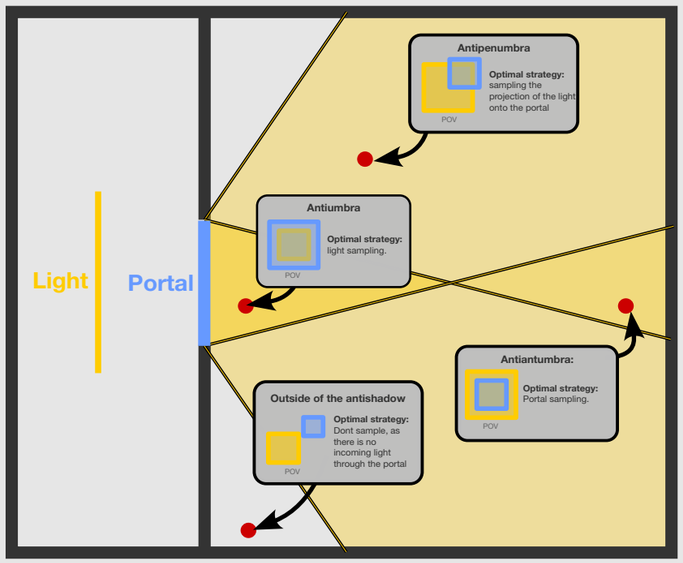
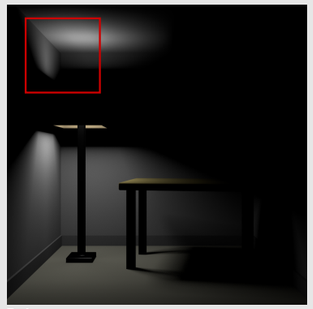
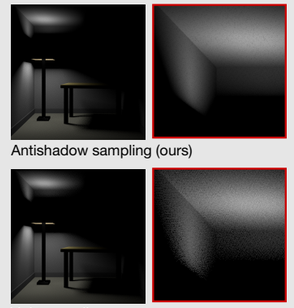


Fig 4: Simple scene shown in 2D with a light and a portal. The area in front of the potal can be subdivided into antishadow volumes. Each volume has a different optimal sampling strategy.

RESULTS

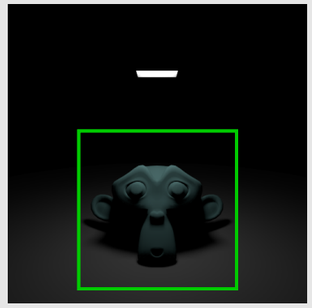


Reference



Antishadow sampling (ours)

Light sampling



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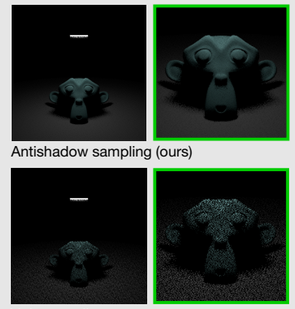

Antishadow sampling (ours)

Light sampling

Fig 5: equal time renders with both sampling techinques

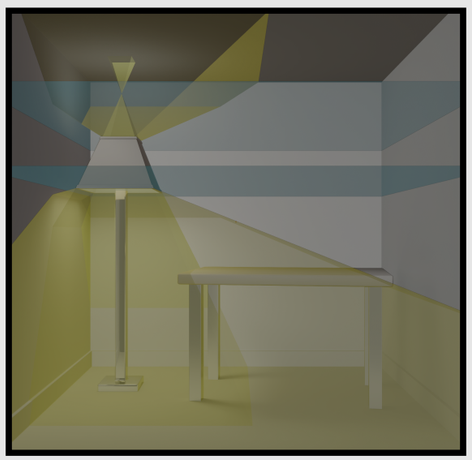

Fig 6: visualization of antishadow volumes in the lamp scene