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Multi-Image Based Photon Tracing for Interactive Global Illumination of Dynamic Scenes

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Introduction

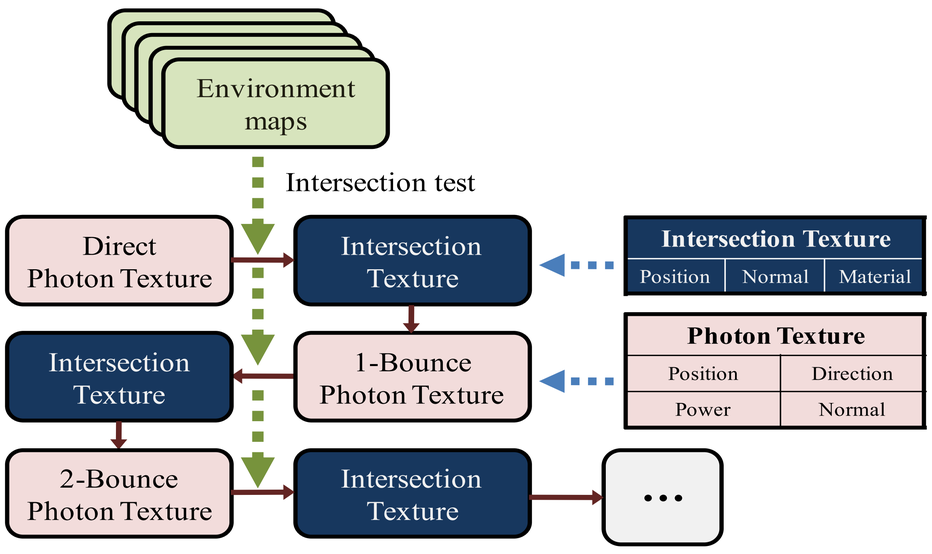
Photon mapping is a good choice for high quality global illumination. Existing interactive methods requires spatial acceleration structure, such as a KD-tree, either on CPU or on GPU. We implement photon tracing in image space of multiple environment maps. The scene is represented by a set of depth images. This approach has the advantage of simple implementation on GPU without pre-computation of complex acceleration structures. The two key problems are solved effectively:

1. Selecting the images to ensure adequate scene coverage;
2. Reliably computing ray-geometry intersections with multiple images.

Characteristics of the proposed method:

- ✓ All frequency GI effects with indirect visibility;
- ✓ Dynamic scenes without any preprocessing;
- ✓ Easy to implement on GPU with conventional shaders;

Algorithm Overview



Photon rays are stored in Photon Textures. With the help of multiple environment maps, intersections of these photon rays can be found and stored in Intersection Textures. Then new photon rays are generated by the geometry and material property of the intersections. This process is repeated until the required level of light bounces is reached.

Selecting Environment Map Centers

Environment map centers are selected by a heuristic method that yields an approximate yet satisfactory results and is efficient enough for interactive rendering.

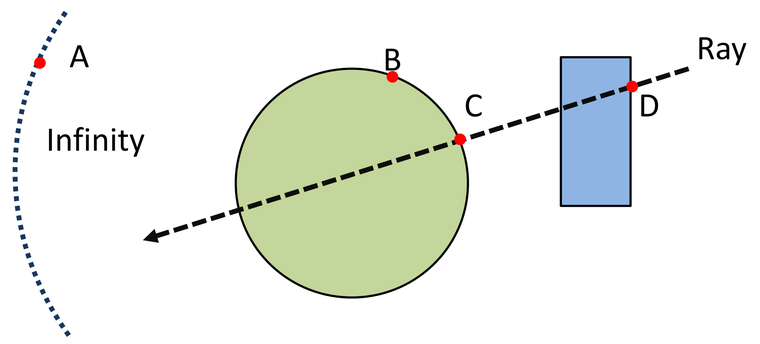
The selection algorithm:

1. Generating candidate points set inside the bounding box;
2. Computed new covered area of all unselected points;
3. Select the point with maximum new covered area to the selected set;
4. Go to step 2 until enough points has been selected.

Multi-Image Intersection Estimation

Classification of the intersections of single image results:

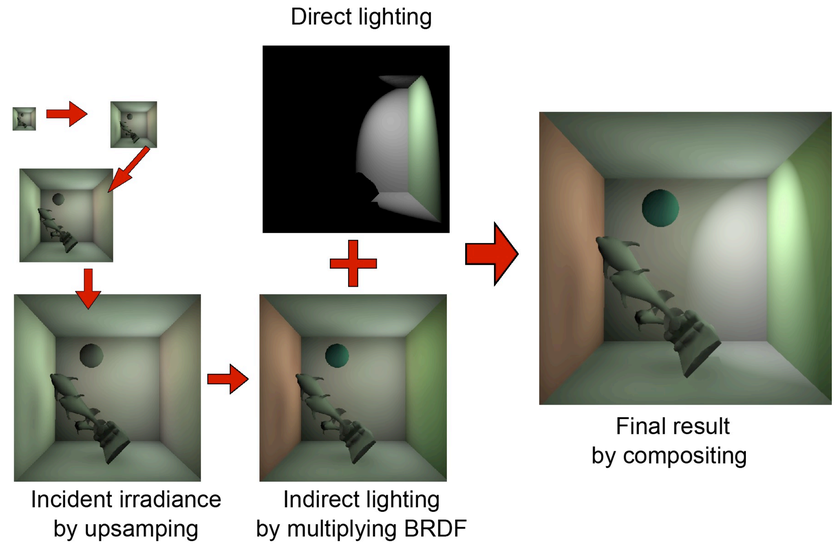
- **Type A:** A point at infinity, means no intersection
- **Type B:** A point on the surface but not on the ray
- **Type C:** An intersection point but not the first
- **Type D:** A proper intersection.



Reject type A and B, and then choose the first intersection by distance comparison.

Radiance Reconstruction

Radiance of indirect illumination is reconstructed by photon splatting in screen space with variable bandwidth and multi-level upsampling.

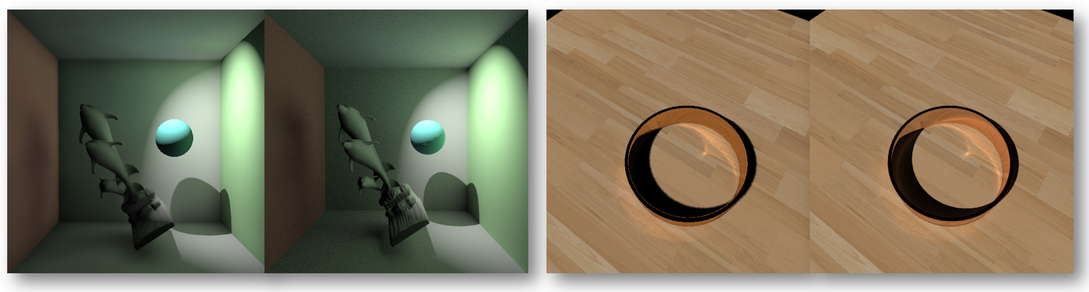


Results

On NVIDIA GeForce 260 GTX, 1024 x 1024.

diffuse (11FPS) glossy (8FPS) caustics (12FPS)

Comparison with ground truth.



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