Imperfect Ray-Bundle Tracing for Interactive Multi-Bounce Global Illumination

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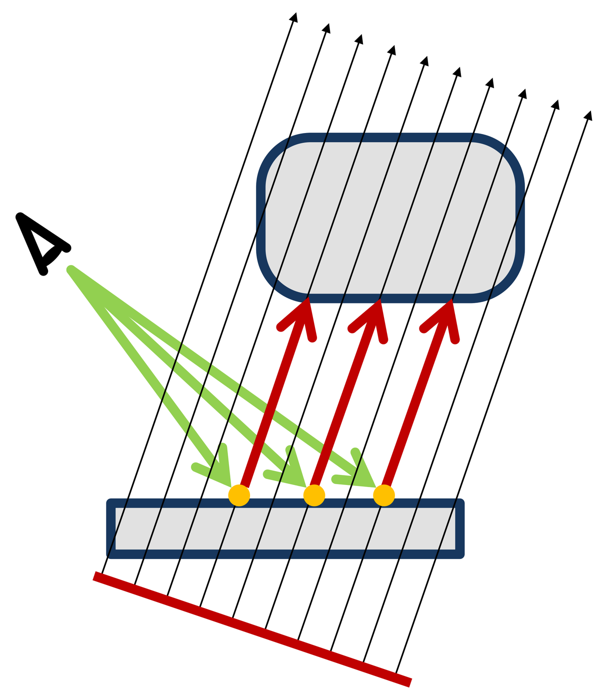
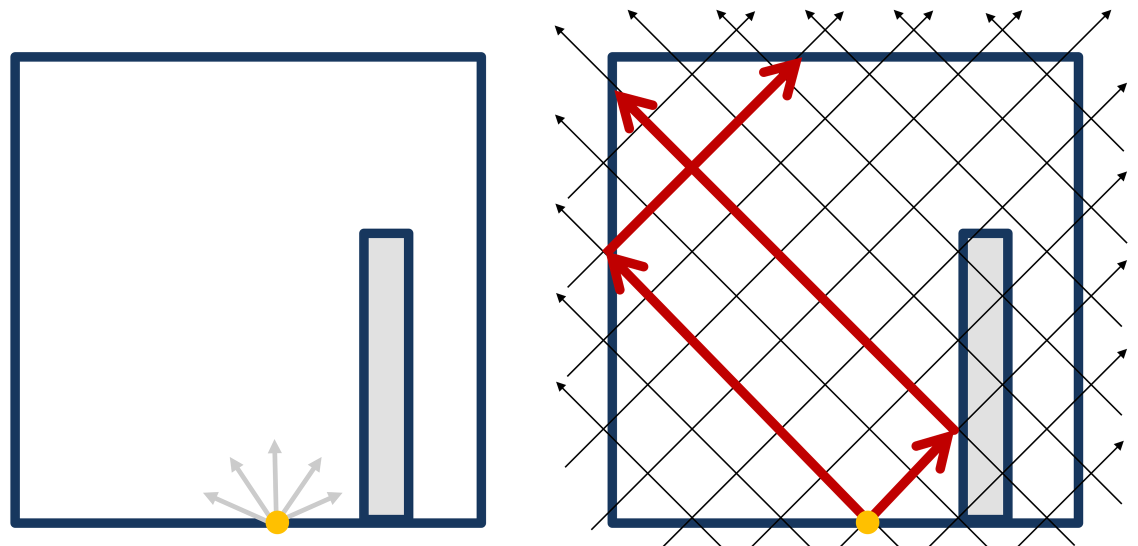
1. Introduction

A bidirectional sampling method with ray-bundles [TO12] enables high-quality global illumination, but computation time of ray-bundles depends on the number of sample directions and the number of primitives. This poster proposes an approximate ray-bundle tracing based on imperfect shadow maps (ISMs) [RGK*08]. ISMs accelerate light path visibility tests using a point-based rendering. In this poster, we accelerate ray-bundle based eye path generation using this point-based technique. Our technique computes multi-bounce global illumination at interactive frame rates.

2. Ray-Bundle Tracing



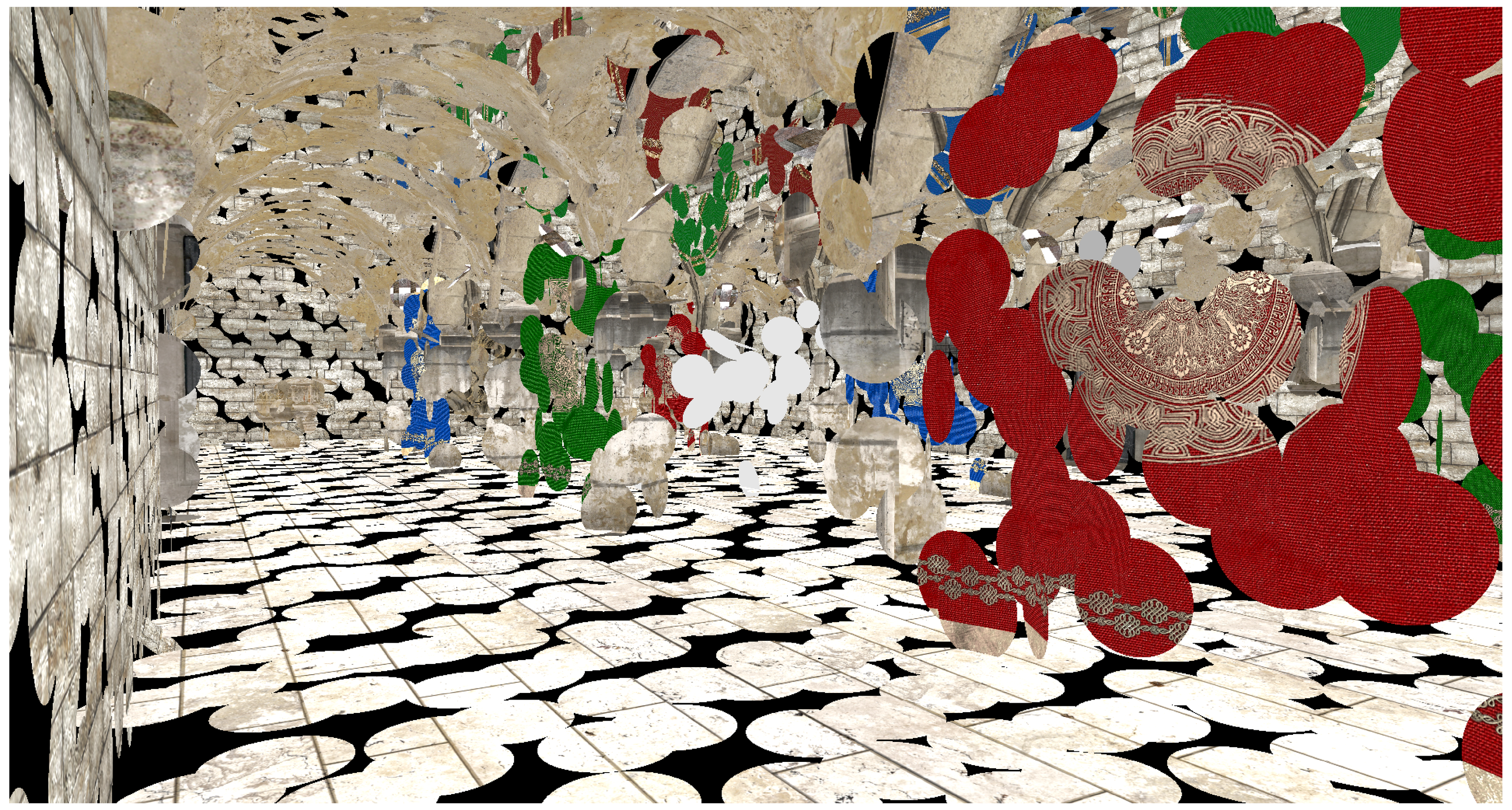
Ray-bundle tracing is a technique to trace paths from an eye using rasterization. This is done by rendering the scene from sample direction using parallel projection. Multiple fragments in a single pixel can be handled by per pixel linked-list.



If the ray-bundles contain an entire scene, we can randomly select a single ray-bundle and reuse it for the next bounce. This approach computes an arbitrary number of interreflections without additional visibility tests.

However, generating many ray-bundles requires expensive computation which increases according to the number of sample directions and the number of primitives.

3. Point-Based Approximation



Direct visualization of our point-based approximation (16384 points)

ISMs

ISMs avoid the same problems as ray-bundles in shadow maps by a point-based approximation of the scenes surface. This method renders hundreds of ISMs in a single pass, and their rendering cost is only loosely dependent on the number of the points.

ISM algorithm:

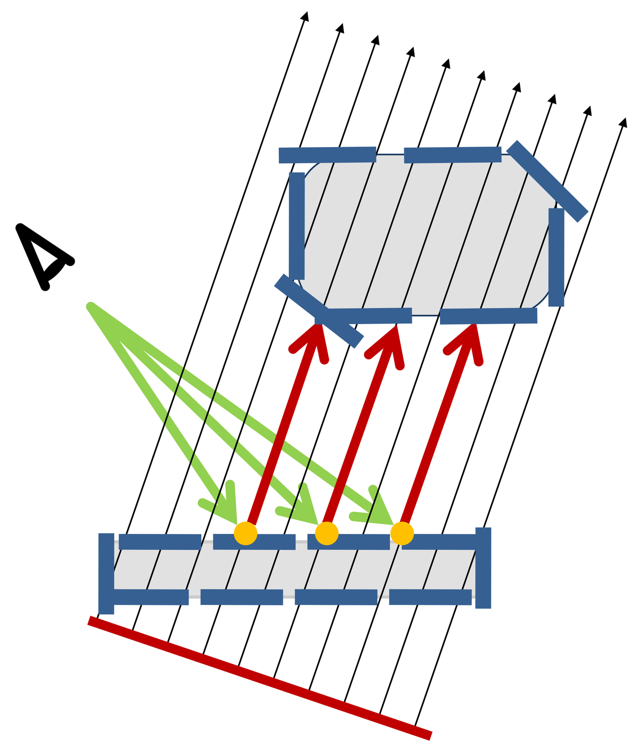
1. The point sprites are splatted into the shadow maps as billboards.
2. Every shadow map uses a different point set to reduce the error.
3. Holes can be filled in a pull-push postprocessing.

Imperfect Ray-Bundle Tracing

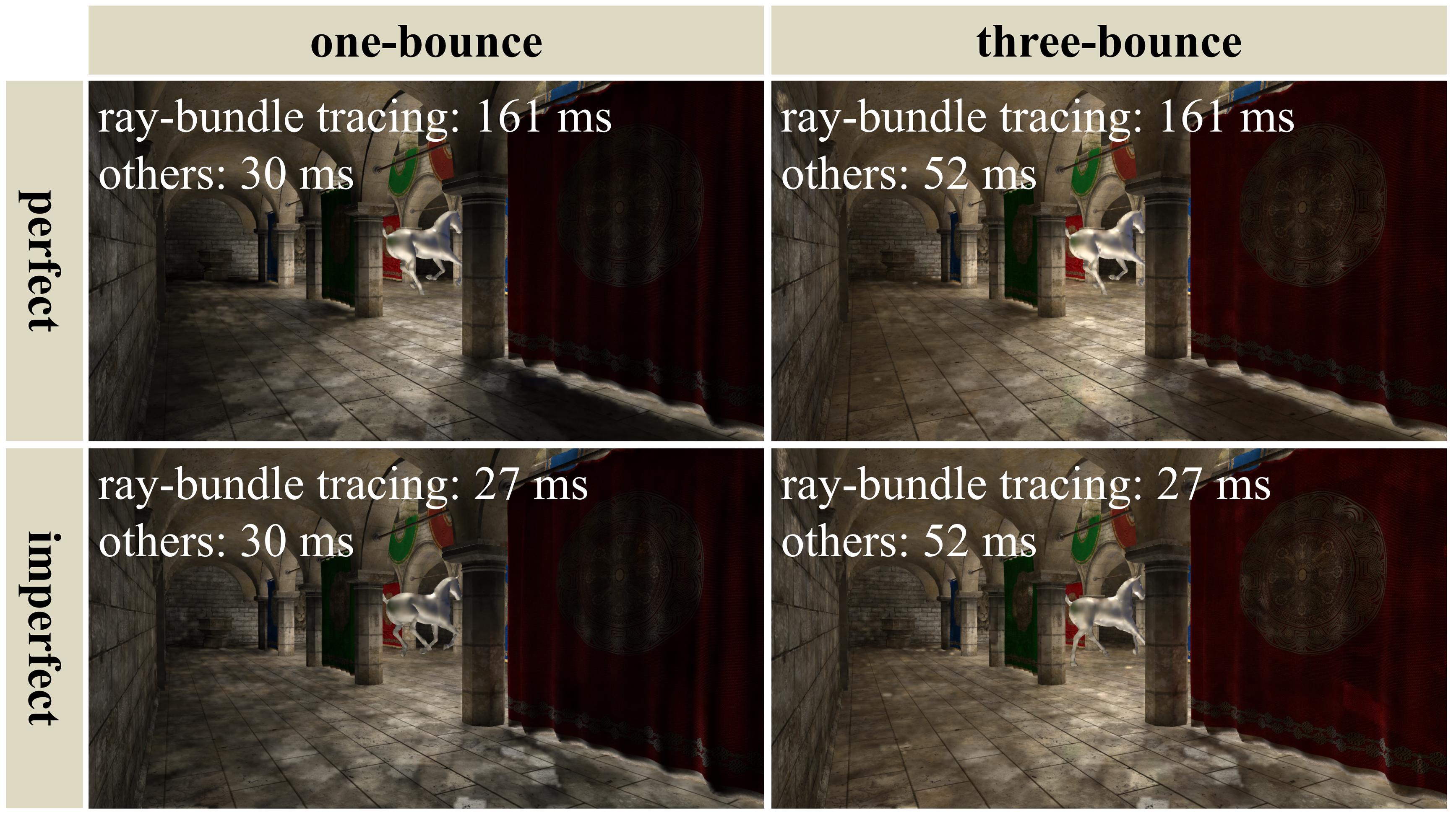
This poster approximates visibilities of ray-bundles using a point-based rendering inspired by ISMs. However, it is difficult to fill holes with pull-push, because ray-bundles are represented by per pixel linked-list. Therefore, we render point splats more accurately than original ISMs.

Our Splatting:

1. A triangle splat is defined in tangent space of the point sample.
2. Texture coordinates are computed at each corner vertex to preserve meso-scale representation.
3. Pixel shader cuts out a circle from the triangle in order to reduce overlap of the splats which causes an increase of redundant nodes of the linked-list.



4. Results and Future Work



Rendered indirect illumination

1920x1024 resolution, 2x2 super sampling, 128x128 ray-bundle resolution, 256 directions, 16384 points/direction, and 1GB node buffer. GPU: AMD Radeon HD 6990 830 MHz.

This figure shows the rendered indirect illumination of an animated scene. We compute three-bounce indirect illumination without additional visibility tests. Imperfect ray-bundle tracing is about 6 times faster than the perfect solution. Though our point-based rendering still produces holes, we can reduce them by enlarging the splat size at the expense of increasing the redundant nodes.

In this experiment, artifacts occur due to the sampling strategy of tracing paths from only an eye. In future work, we would like to investigate the effectiveness of a bidirectional sampling method with ISMs and imperfect ray-bundles.

Acknowledgements

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References

[RGK*08] RITSCHEL T., GROSCH T., KIM M. H., SEIDEL H.-P., DACHSBACHER C., KAUTZ J.: Imperfect shadow maps for efficient computation of indirect illumination. *ACM Trans. Graph. 27* (2008), 129:1–129:8.
[TO12] TOKUYOSHI Y., OGAKI S.: Real-time bidirectional path tracing via rasterization. In *Proc. of I3D 2012* (2012), pp. 183–190.