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

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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.

Method 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.

ISMs avoid the same problems in shadow maps by a point-based approximation of the scenes surface. The point sprites are splatted into the shadow maps as billboards. Every shadow map uses a different point set to reduce the error. Although this representation often produces holes, they can be filled in a pull-push postprocessing. This method renders hundreds of ISMs in a single pass, and their rendering cost is only loosely dependent on the number of the points.

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. Instead of using billboards, we define the triangle splat in tangent space of the point sample. In addition, texture coordinates are computed at each corner vertex to preserve meso-scale representation. We use pixel shader to cut 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.

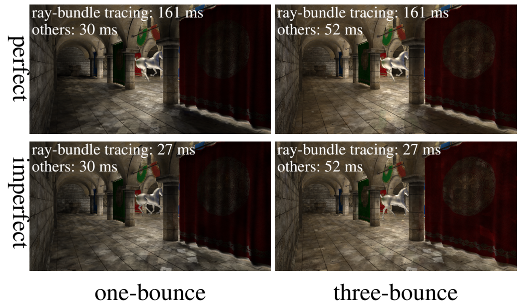

Figure 1: *Indirect illumination images rendered at 1920×1024 resolution, 2×2 super sampling, 128×128 ray-bundle resolution, 256 directions, 16384 points/direction, and 1GB node buffer (GPU: AMD Radeon HD 6990).*

Results and Future Work Figure 1 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 the future, we would like to investigate the effectiveness of a bidirectional sampling method with ISMs and imperfect ray-bundles.

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. 1

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