

iRT: An Interactive Ray Tracer for the CELL Processor

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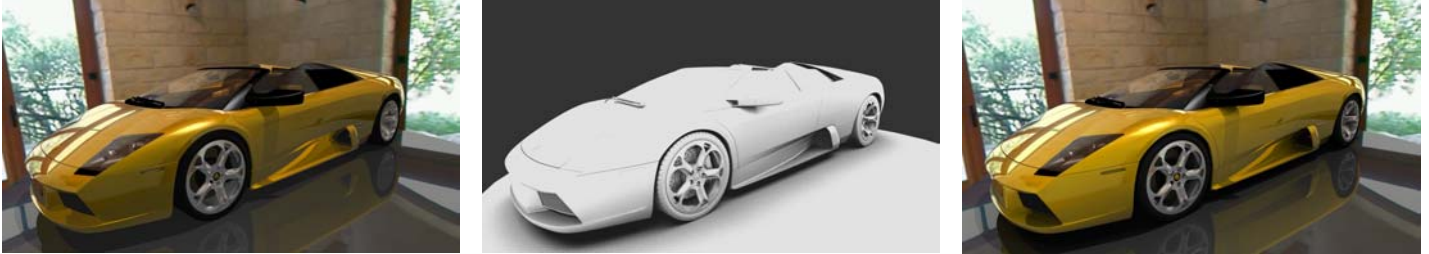


Figure 1: Left: Ray traced car with up to four levels of reflection and transparency, detailed shadows, and 4x4 jittered multi-sampling, totaling up to 96 rays per pixel. Middle: Ambient occlusion estimate of global illumination for the scene, using 64 random occlusion samples per pixel. Right: Composite image including reflection, transparency, detailed shadows, ambient occlusion, and 4x4 jittered multi-sampling, totaling up to 288 rays per pixel. The car model is comprised of 1.6 million polygons and the image resolution is 1080p hi-def.

Abstract

Recent advances in software techniques have renewed interest in ray tracing images in interactive time [3]. These techniques have shown a significant performance improvement for primary and shadow rays, particularly when mapped to the CELL Broadband Engine [1, 2]. Much of this work has focused specifically on ray casting and simple shading, without fully addressing global effects such as reflection or ambient occlusion [5].

We present an interactive ray tracer for CELL which builds on previous work but additionally computes accurate reflections, transparency, detailed shadows, BRDF lighting, and cubic environment mapped textures. The system uses a combination of optimized SIMD ray kernels and a hierarchical scheduler which distributes work across a cluster of CELL-based systems. The optimized ray kernels explicitly cache BVH scene data [1, 2], and achieve 93-97% efficiency rates for the node and vertex caches. We further apply ray-packet techniques to accelerate traversal for ambient occlusion rays, which can be used as an approximation of global illumination [4, 5]. To this we add the novel twist of reversing direction of the ambient occlusion rays to point inward to the scene, which has the benefit of providing an early-exit condition for their packet traversal. The hierarchical scheduler, meanwhile, distributes work dynamically with a high degree of spatial affinity at both the per-CELL and per-node levels. By combining these techniques a CELL-based system can produce 720p ray traced images at interactive frame rates, even for moderately complex scenes containing more than one million polygons.

These results demonstrate that ray tracing and real time ambient occlusion are attractive for implementations on CELL-based systems.

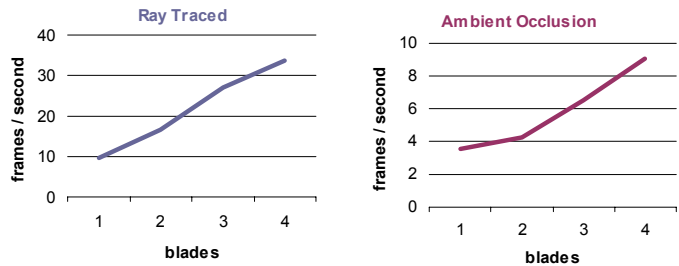


Figure 2: Scalable performance for animated sequence as it is dynamically rebalanced across a cluster of IBM BladeCenter® QS20 servers. Left: Frame rates for ray traced images without multi-sampling. Right: Frame rates for ambient occlusion, without multi-sampling. The image resolution is 720p hi-def.

References

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