**Master’s Thesis Proposal**

**Real-time Global Illumination using Voxel-based Ray-bundles**

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**Abstract**

Real-time global illumination has gained more and more interests in recent years due to the rapid evolvement of GPU computing power. Some approaches have been developed to try to simulate global illumination as accurate as possible by implementing robust ray-tracing algorithms using Shader Model 5 features of current GPUs. For example, bidirectional path tracing is employed to resolve the classic singularity issue of instant radiosity. While the rendering speed is acceptable for a certain level of scene complexity, maintaining high frame rates for arbitrary scenes is still a challenging work. In this thesis, we propose a novel hybrid rendering system that combines bidirectional path tracing and scene voxelization to accelerate VPL visibility tests and global ray-bundles generation. Meanwhile, we show that caustics maps can be integrated into the system as well.

Keywords: real-time global illumination, instant radiosity, global ray-bundles, scene voxelization

**1. Introduction**

Global illumination is an important lighting effect that simulates light propagation behavior in 3D space. It increases fidelity of computer generated images dramatically and thus has been an active research area in the field of image synthesis. Since the formal introduction of light transport equation [Kajiya 1986], many CPU-based off-line algorithms have been invented to solve it. While these techniques generate physically correct images, the speed of creating them are usually slow. Figure 1 shows images generated by PBRT, which is a CPU-based global illumination rendering system.

 

Figure 1. Image courtesy of PBRT. Left: Modern villa scene by Florent Boyer. Right: Jade Dragon by Rui Wang.

In order to implement global illumination for real-time applications such as video games, several approaches have been introduced. One family of these approaches is called many-light based methods, derived from [Keller 1997]. It provides a simple and elegant lighting computation framework that transforms the problem of solving lighting transport equation to the calculation of the direct illumination from many virtual light sources. The key observation is that general light transport problem can be approximated by generating a set of virtual light sources and doing direct illumination from them. This makes it a hardware-friendly algorithm which could be implemented on modern GPUs easily.