Master's Thesis Proposal

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Real-time transparency with Vulkan

Introduction

The problem with real-time transparency is that existing real-time engines cannot render physically accurate images for a group of phenomena, including subsurface scattering, volumetric lighting, refraction, and diffusion [McGuire 2016]. It is desirable to come up with a solution to bring real-time transparency rendering to the level that stable offline renderers have done for animations and films. There are existing algorithms that can improve real-time transparency rendering, such as NVIDIA's polygonal volumetric lighting [Hoobler 2016], phenomenological transparency [McGuire and Mara 2016], stochastic transparency [Enderton et al. 2011], and k-buffer [Callahan et al. 2005].

Real-time transparency effects can be broken down into two phenomena: transmission and partial coverage [McGuire 2016]. Transmission is the phenomenon that describes light passing through a medium; it encompasses effects such as refraction, diffusion, caustic, aberration, and colored shadows. Partial coverage, on the other hand, describes binary coverage within a pixel, including effects such as depth of field, motion blur, thin surfaces, and notably, aliasing. Partial coverage is an artificial problem that comes from sampling, and often can be traded for different anti-aliasing processing.

Background

Many modern game engines implement deferred shading. This technique reduces the overhead of dynamic lighting, but makes forward passes for transparent objects. Since transparent objects are not present in the g-buffer, some effects, such as ambient occlusion or transparent shadows, are not physically accurate. The ideal solution for real-time transparency rendering needs to be general-purpose, robust, and real-time.

Goals

In this thesis, I would like to improve current methods for rendering transparent objects in a modern game engine by taking advantage of the new Vulkan graphics API [Khronos Group 2016]. Vulkan targets high-performance real-time cross-platform 3D graphics and is specifically designed for multithreading. The API is relatively new and its potential is unexplored in many real-time applications.

I will begin with understanding what benefits Vulkan can bring, followed by researching the video game industry's approach to rendering transparent objects, and then proposing a possible Vulkan implementation in a game engine. For understanding Vulkan, I am perusing several materials on the subject (http://tinyurl.com/vulkan-resources), and experimenting with the API at my own pace. For researching real-time transparency rendering, I plan on starting with a literary survey to gain an intuition for the algorithms currently used in the industry. This will allow me to have a better understanding of how to improve the existing algorithm by taking advantage of Vulkan. Finally, I plan to use the Unreal Engine as the candidate game engine because it is an open source project, a popular choice among developers, and it has a rendering hardware interface for Vulkan.

Significance of thesis

The outcome of this thesis will introduce an alternative Vulkan implementation for transparency rendering in game engines. This could be used as a benchmark for comparing with the existing implementation in other APIs (OpenGL, DirectX, Metal). This in turn can help give developers an informed opinion in choosing which rendering path to use (forward or deferred) that is most optimal for the targeted platforms or applications.

References (or Works cited)

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