Asynchronous Rendering

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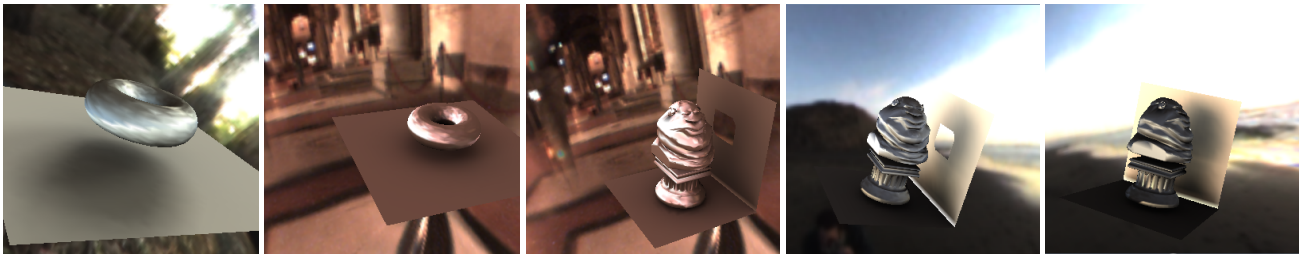

Figure 1: *These images are rendered on an iPhone 3GS which allows the environment lighting to be adjusted locally on the mobile phone. From left to right: a torus illuminated by the "rnl" and "stpeters" scene, a statue model illuminated by the "stpeters" scene, by the "beach" scene, and with different BRDF.)*

1 Introduction

We propose Asynchronous Rendering, a concept that is a generalization of previous work in rendering on mobile devices (or less-powerful thin-client like devices) in a networked environment. It is inspired by the post-rendering 3D warping [Mark et al. 1997] which allows the client side to render the 3D scenes at a frame rate that is *asynchronous* from the host side. We extend this concept further to allow various other aspects (such as lighting, materials, and even predictable motion) of the rendering to be asynchronous. It also differs from a streaming-based framework that is popularized by OnLive [OnLive 2008], AMD Fusion Render Cloud and NVIDIA RealityServer [NVIDIA 2009] where the synchronization between the client and the host is preferred.

Asynchronous Rendering is in particular suitable for the cloud computing environment. For example, the users can have local lighting control and freedom in view change while the precomputation is handled by the cloud servers.

2 What is Asynchronous Rendering?

Real-time 3D graphics on mobile device are usually limited by computing resource and power consumption. Therefore, the idea of offloading the heavy computation of 3D graphics to a more powerful desktop PC or server in a networked environment has appeared in many previous works. We observe that most of the previous work may be considered *synchronous rendering*, which means the rendering on the mobile devices attempts to catch up with the actual rendering on the server or host PC. An exception is the post-rendering 3D warping [Mark et al. 1997] which allows the client to render the 3D scenes at a frame rate that is asynchronous from the host side.

Here we propose the concept of Asynchronous Rendering where various aspects of the rendering become asynchronous between the client side and the server side. Those aspects include:

- Viewpoint: This is partially achieved in post-rendering 3D warping when the disocclusion artifact is not severe.
- Lighting: This could be achieved if deferred shading with a deep frame buffer is performed on the client side.
- Environment light: This could be achieved with precomputed light transport methods.
- Material: It may be desirable to change the surface BRDF or texture of some objects.
- Motion: For dynamic objects, the motion could be interpolated or extrapolated on the client side if the motion trajectory can be modeled or approximated by a function.

Asynchronous Rendering also enables an interesting type of application that we call Asynchronous Playback. When a rendering sequence on the server is recorded and stored as a file (in a fashion similar to a video recording), the rendering sequence can then be played back on the client but under a different setting such as a different lighting environment.

In this work we demonstrate a Spherical Harmonics (SH) renderer on a mobile device as a proof-of-concept prototype.

3 Implementation

In our implementation, a server calculates the spherical wavelet coefficients of the materials, visibility and environment lighting when receiving the requests. On the other hand, the client composes the viewing and lighting settings and converts the coefficients into global illumination colors. Thus, the client can change the view point or rotate the environment light independently of the server.

We implement the client program on an iPhone 3GS and achieve the performance of about 5 frames per second for a model with 3000 triangles and 80 coefficients per vertex. The computation of all coefficients on a 2.0GHz Core 2 Quad PC takes about 1.5 minutes. Figure 1 shows the rendering on an iPhone 3GS which demonstrates the effects of soft shadow and environment lighting.

In the future we plan to explore the other aspects of Asynchronous Rendering such as client-side surface material change on the client and the inclusion of dynamic objects.

References

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I3D 2010, Washington, DC, February 19 – 21, 2010.
ISBN 978-1-60558-938-1/10/0002