Interactive Global Illumination – Modeling, Quantifying and Exploiting Temporal Coherence

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Introduction

The goal of physically based global illumination is to render a realistic and physically accurate (up to a given error bound) image of a virtual world. The most relevant light paths from the light sources to the viewer's position have to be traced, simulating light interactions with the transmitting medium, e.g. air or water, and with objects in the scene. Since these interactions are simulated using physically based illumination models, the resulting image is a correct depiction of what would be seen in a real situation. The main drawback of physically based models is that rendering is a time consuming process, thus preventing their utilization in interactive settings.

In an animation many frames have to be rendered. From frame to frame some properties of the virtual scene change, such as the viewer's position, the model geometry, the objects materials' properties or the lighting conditions. Current approaches to render animations within these dynamic scenes consist on restarting the whole rendering process for each frame, thus being referred to as *brute force* approaches. However, changes in the scene are often incremental, suggesting that many results from previous frames can be reused, thus reducing the rendering workload. This property is known as **temporal coherence**. Temporal coherence is not well understood yet and it is seldom exploited in current rendering systems.

"Interactive Global Illumination within Dynamic Environments" is a research project headed by CCTC and funded by FCT, whose goal is to achieve global illumination rendering at interactive within these all-dynamic virtual worlds. To achieve this goal several different research axes will be pursued, including parallel processing, utilization of multiple high performance Graphics Processing Units (GPU) and the exploitation of temporal coherence. This thesis fits within this project scope and should run in the same period.

Goals

- Contribute to a better understanding and propose a clearer definition of coherence; this definition should allow quantification of coherence along a given domain, thus guiding coherence exploitation methods;
- Identify opportunities, benefits and costs for the exploitation of temporal coherence given the different dimensions of changes within the virtual world, including viewer's position, geometry, materials' properties and lighting conditions;
- Propose and evaluate techniques for exploiting temporal coherence using the interactive renderer developed within the above cited research project context;
- Model and quantify the previously identified benefits and costs.

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