Perceptually-driven Interactive Global Illumination

Master's Internship:
at REVES/INRIA Sophia-Antipolis
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1 Introduction

Indirect illumination is known to be smooth and to vary slowly. In this Master's thesis, we hypothesize that in many cases, global illumination can be rendered with a simple approximation, without the difference being perceivable to a human observer. We will categorize these cases, in terms of indirect lighting and (indirect) shadow frequencies, and we will design and run user experiments to verify these hypotheses. The results of the experiments will allow us to define a predictor which we integrate into a variant of the Instant Radiosity (IR) global illumination algorithm. A final user study will determine how well our predictor actually works, hopefully allowing us to achieve significant acceleration of global illumination without perceivable difference to a reference solution.

2 Previous work

There has been much work on global illumination, and there is quite a bit on perceptual techniques, e.g., [GH, DDP99, MTAS01]. The most closely related publication is [SFWG04]; it works with reflectance properties, and could be a source of potential ideas for this project.

Since we will be working with instant radiosity and it's GPU instanciations, the internship will begin with a survey of the work on this topic, especially the recent papers [SIP06, SIP07, LSK+07]. While the goal is *not* to compare directly to these methods, it is important to distinguish the new technique and to determine whether the new approach could be adapted to these methods.

3 Context and Motivation

It is a well known fact that far too much effort is spent in computing indirect lighting for global illumination (GI), given how little we can perceive these effects. The big problem has always been, how to identify the parts of the scene where GI *does* make a difference, as opposed to those where it *doesnt*. Our basic hypothesis is that the latter are far more frequent than the former.

An interesting recent solution is that of Arikan et al. [AFO05], who avoid visibility computation altogether for indirect light in some cases. The issue of separating local from distant lighting, mentioned in this work, is also something we will investigate in more detail in this internship.

4 Methodology

Initially we will base our work on instant radiosity (IR) [Kel97] and replace the expensive part by Dachsbacher and Stamminger [DS06] approximation where necessary. In essence, what we are doing is completely avoiding the visibility computation for indirect lighting. Our guess is that this is often a very legitimate choice. The goal is to determine an automatic methodology to determine when this is possible.

The intern will first implement this hybrid approach, and try and experiment with situations to see when the substitution is acceptable. Then we will try and determine criteria which create the categories where this is valid. A useful tool will (hopefully) be the kind of analysis developed by Durand et al. [DHS$^+$05]. There is existing code base at REVES which will simplify the implementation of IR and the Dachsbacher/Stamminger approximation.

We hope is that we will be able to characterize light paths in which the frequencies related to shadows such that we can just use the simplified version with an appropriate metric.

Once we have this characterisation, we will define our parameter space and design a set of perceptual experiments that will allow us to actually determine conditions for which the approximation is valid. These will necessarily be restricted and simplified conditions (in the spirit of the “gloss space” of Pelaccini et al. [PFG00]).

When we have defined space, we will be able to define a computational model which will guide our modified IR algorithm, allowing some of the virtual point lights of IR to be approximated with the method of [DS06].

A final user experiment will have to be run to confirm that the results are accurate in more realistic settings. We will prerecord a reference solution and our approximation and determine whether users can see the difference.

References

[AFO05] Okan Arikan, David A. Forsyth, and James F. O'Brien. Fast and detailed approximate global illumination by irradiance decomposition. In *SIGGRAPH '05: ACM SIGGRAPH 2005 Papers*, pages 1108–1114, New York, NY, USA, 2005. ACM Press.

[DDP99] Frédo Durand, George Drettakis, and Claude Puech. Fast and accurate hierarchical radiosity using global visibility. *ACM Transactions on Graphics*, Apr 1999.

[DHS+05] Frédo Durand, Nicolas Holzschuch, Cyril Soler, Eric Chan, and François X. Sillion. A frequency analysis of light transport. In *SIGGRAPH '05: ACM SIGGRAPH 2005 Papers*, pages 1115–1126, New York, NY, USA, 2005. ACM Press.

[DS06] Carsten Dachsbacher and Marc Stamminger. Splatting indirect illumination. In *I3D '06: Proceedings of the 2006 symposium on Interactive 3D graphics and games*, pages 93–100, New York, NY, USA, 2006. ACM Press.

[GH] S. Gibson and R. J. Hubbold.

[Kel97] Alexander Keller. Instant radiosity. In *SIGGRAPH '97: Proceedings of the 24th annual conference on Computer graphics and interactive techniques*, pages 49–56, New York, NY, USA, 1997. ACM Press/Addison-Wesley Publishing Co.

[LSK+07] Samuli Laine, Hannu Saransaari, Janne Kontkanen, Jaakko Lehtinen, and Timo Aila. Incremental instant radiosity for real-time indirect illumination. In *Proceedings of Eurographics Symposium on Rendering 2007*, pages xx–yy. Eurographics Association, 2007.

[MTAS01] Karol Myszkowski, Takehiro Tawara, Hiroyuki Akamine, and Hans-Peter Seidel. Perception-guided global illumination solution for animation rendering. In *SIGGRAPH '01: Proceedings of the 28th annual conference on Computer graphics and interactive techniques*, pages 221–230, New York, NY, USA, 2001. ACM Press.

[PFG00] Fabio Pellacini, James A. Ferwerda, and Donald P. Greenberg. Toward a psychophysically-based light reflection model for image synthesis. In *SIGGRAPH '00: Proceedings of the 27th annual conference on Computer graphics and interactive techniques*, pages 55–64, New York, NY, USA, 2000. ACM Press/Addison-Wesley Publishing Co.

[SFWG04] William A. Stokes, James A. Ferwerda, Bruce Walter, and Donald P. Greenberg. Perceptual illumination components: a new approach to efficient, high quality global illumination rendering. In *SIGGRAPH '04: ACM SIGGRAPH 2004 Papers*, pages 742–749, New York, NY, USA, 2004. ACM Press.

[SIP06] Benjamin Segovia, Jean-Claude Iehl, and Bernard Proche. Bidirectional Instant Radiosity. In *Proceedings of the 17th Eurographics Workshop on Rendering*, June 2006.

[SIP07] Benjamin Segovia, Jean-Claude Iehl, and Bernard Proche. Metropolis Instant Radiosity. *Computer Graphics Forum*, September 2007.