Real-time Global Illumination of Static Scenes with Dynamic Lights (Work in Progress)

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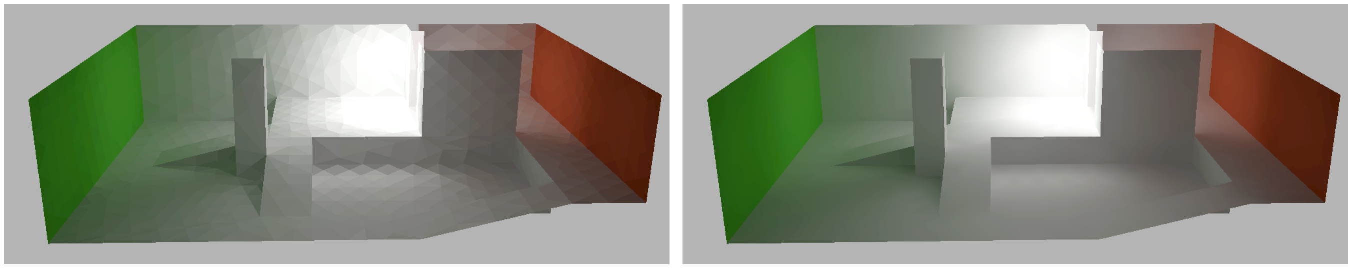

Figure 1: *Indirect illumination of a simple scene. Left: patches for which the light is calculated. Right: linear interpolation between patches.*

Abstract

We describe how the radiosity method can be used to compute the global illumination of a static scene with dynamic lights. A transfer function that maps the direct illumination to the global illumination is precalculated. Real-time performance is reached for simple scenes.

Keywords: global illumination, radiosity, real-time, precomputed radiance transfer

1 Introduction

The radiosity method can be used to compute the global illumination, direct and indirect lighting, of a scene that consists of ideal diffuse surfaces. The surfaces are first divided into patches. The radiosity equation system describes the relation between the global illumination of all patches $B = (B_1, \cdots, B_n)^\mathsf{T}$ and the emission of all patches $E = (E_1, \cdots, E_n)^\mathsf{T}$ [Hanrahan et al. 1991]:

$$MB = E$$

The matrix M depends on the geometric relation between the patches (form factors) and the patches' colors (diffuse reflectance). For our purposes we may consider E to be the direct illumination of the patches. The direct illumination of each patch can be computed in real-time using standard methods like shadow mapping [Akenine-Moller and Haines 2002]. The inverse of M describes the linear mapping from direct illumination to global illumination:

$$B = M^{-1}E$$

It holds coefficients that tell how much light that travels from one patch to another after an infinite number of bounces in the scene. The matrix M is very expensive to compute but if the geometry and textures of the scene are static, M remains static as well. M^{-1} may thus be precomputed and used as a transfer function that maps arbitrary direct illumination to global illumination. The process of computing the global illumination can thus be performed with a large matrix-vector multiplication. That is, for each patch that we want to illuminate globally, we sum over all other patches and accumulate their contribution. Illuminating all patches thus results in a time complexity of $O(n^2)$, where n is the number of patches.

2 Compressing the Matrix

For larger scenes a time complexity of $O(n^2)$ is not manageable. [Hanrahan et al. 1991] reduces the number of interactions, described by M, by clustering of small interactions. This method can be modified and used for M^{-1} as well. It however only clusters neighbouring patches lying in the same plane. For scenes consisting of large planar surfaces the time complexity is reduced to $O(n)$.

[Willmott et al. 1999] describe a method that extends clustering to patches that are just approximately planar. They use it for the radiosity equation system described by M. Extending it to M^{-1} is not as straight forward as the planar clusters first mentioned. This and other techniques are discussed by [Lehtinen et al. 2008]. It should also be noted that it is just necessary to update the interactions between patches visible on screen and those illuminated directly.

3 Conclusion

It is today possible to do real-time global illumination of simple static scenes with dynamic lights. There exist promising ideas and if they are all incorporated in an implementation, preferably accelerated by graphics hardware, real-time performance will probably also be possible for more complex scenes.

References

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