Spatial Image Based Lighting

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Motivation

The aim of this research is to investigate a spatial extension to the common image based lighting (IBL) process [1] suitable for practical use in areas such as visual effects, animation and gaming.

Background

Previous work by Unger et al. [2] concentrated on capturing and rendering with high frequency incident light fields. Their work involved complex capture apparatuses and rendering of single frames with global illumination. I extend their work to include unconstrained light field acquisition, an importance sampled direct lighting model and include render time analysis and example animations.

Acquisition

I capture the light field with an unconstrained camera with fisheye lens and high dynamic range imaging. Individual light field samples are calibrated with straightforward camera calibration techniques. The sparse set of light field samples are reconstructed with inverse distance weighted interpolation, depth correction [2] and occlusion correction [3].

Scene with spatial lighting

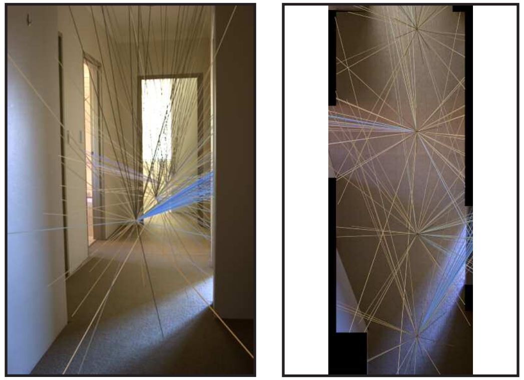
Capture setup (reverse)

Global Illumination

Global illumination rendering for primary lighting is implemented as in [2] but is only practical for highly specular surfaces. For surfaces with diffuse or less specular attributes a more appropriate solution is direct lighting.

Direct Lighting

For direct lighting the reconstructed light field is processed to build a three dimensional grid structure with importance sampled direct lighting [4] at each cell vertex.



Visualisation of four direct light grid vertices viewed from camera and above. Each line represents an importance sample.

Direct Light Interpolation

For smooth transition between cells I calculate the influence after shading from the eight surrounding vertices and combine with tri-linear interpolation. This process is robust and works well for diffuse and specular surfaces.

Light Vector Interpolation

Further performance improvements can be realised by interpolating importance sampled light vectors before shading.

While this technique is fast it is not as robust as shaded sampling interpolation as high frequency discontinuities in the light field can cause visually disturbing fault lines in the resulting render.

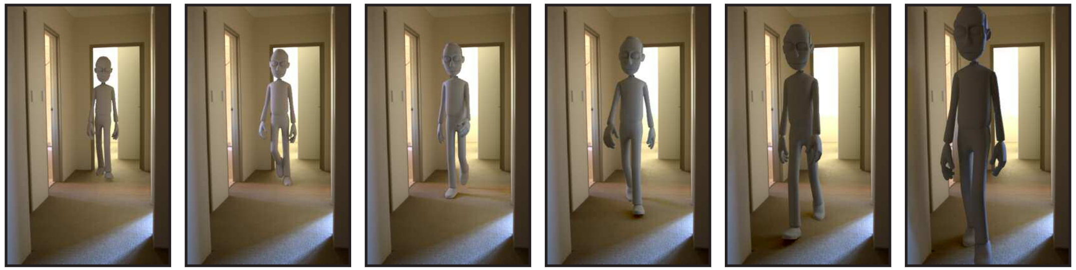
To overcome this problem I identify problem cells, those that exhibit a large average light vector error, and employ an alternative procedure such as:

- increase sampling rate
- improve matching of light vectors via a stochastic reevaluation procedure (see Figure right)
- switch to shaded sample interpolation

Global illumination for primary lighting, 2241 seconds

Direct light shaded sample interpolation, 284 seconds

Direct light vector interpolation, 83 seconds



Spatial image based lighting result, frames from an animation.
Note accurate scene shadows generated with differential rendering [1].

Shaded sample interpolation (65 sec.)

Light vector interpolation with fault line causing incorrect shading (14 sec.)

Error image (difference)

Light vector interpolation with optimised light sample matching (299 sec. one off preprocessing, 14 sec. render)

Further Work

Future work will focus on improvements to light sample interpolation, adaptive importance sampled light field creation, acquiring the light field with a video camera and real-time rendering.

Acknowledgements

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All images and animations rendered with V-Ray.

References

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[3] PRONK, J. 2006. Spatially Variant Real World Light for Computer Graphics. *Honours thesis, University of New South Wales.*

[4] DEBEVEC, P. 2005. A median cut algorithm for light probe sampling. In *ACM Siggraph 2005 Posters.*

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