GAZE DIRECTED HYBRID RENDERING USING PHOTON MAPPING

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INTRODUCTION

The ability of the human vision to see details is less at the peripheral of the vision than close to the gaze point. [2]

The hypothesis investigated in this project is that the preceding statement can be used in computer graphics to improve the perceived visual quality without sacrificing speed. The approach investigated is to render global illumination in an area around the gaze point, and use local illumination elsewhere. This approach is denoted gaze directed hybrid rendering, **Fig. 1**.

METHODS & MATERIALS

The gaze area and the outer area are rendered respectively with global illumination using photon mapping[1] and local illumination using OpenGL, **Fig. 3**.

These two separate renderings are merged into one texture with a smooth transition between the two renderings. The gaze area rendered with global illumination is positioned at the gaze point which is found with a Tobii X120 eye tracker.

To take maximum advantage of gaze directed hybrid rendering, a gaze directed photon mapping algorithm has been developed. This algorithm guides photons toward the gaze region to achieve a higher density of photons in this region. During the ray-tracing stage the photons that contribute to the shading are marked. The marked photons are reused in the next frame to guide a majority of the new photons in direction of the previous gaze region, **Fig. 2**.

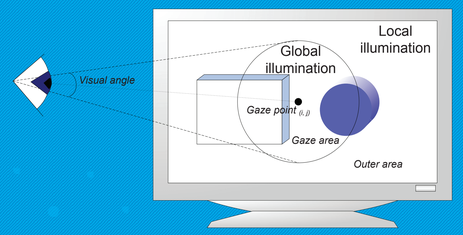


Fig. 1 The screen is divided into two areas, a gaze area encircling the gaze point and the outer area. The gaze area spans 20° visual angle.

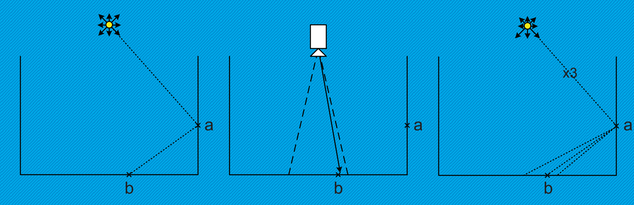


Fig. 2 The principle behind gaze directed photon mapping. In the very first frame photons are emitted traditionally. The photons used in the gaze area, found by ray-tracing, are reused to guide more photons to the gaze area.

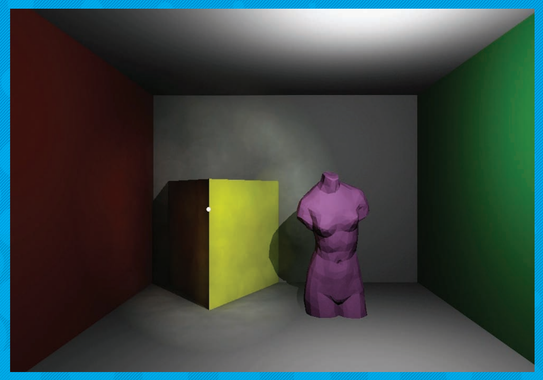


Fig. 3 The hybrid rendering - the gaze area is rendered with global illumination using photon mapping. The white dot is the gaze point. The outer area is rendered with local illumination.

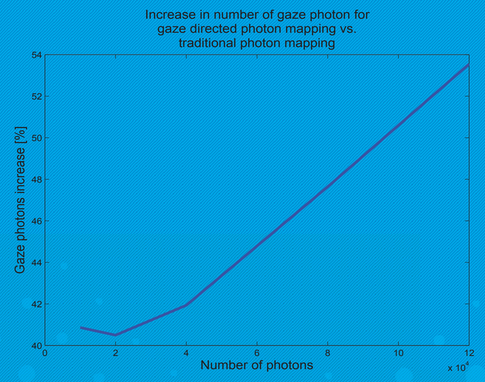
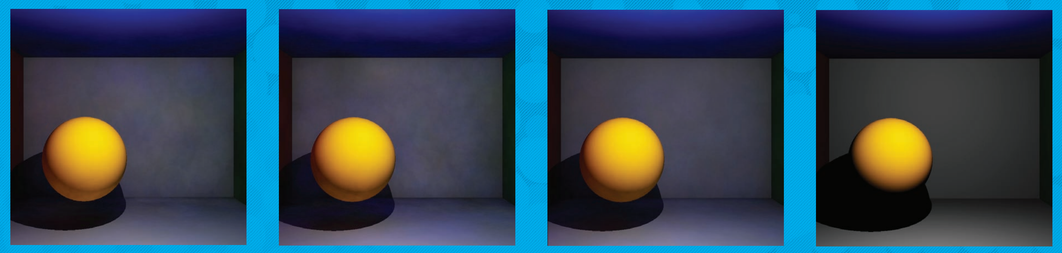


Fig. 4 The graph shows the increase in number of photons located in the gaze area by using gaze directed photon mapping instead of traditional photon mapping.



(a) **(b)** **(c)** **(d)**

Fig. 5 a) Gaze directed photon mapping with 40,000 photons. **b)** Traditional photon mapping with 60,000 photons. **c)** Gaze directed photon mapping with 60,000 photons. **d)** Ray-tracing without photon mapping.

RESULTS

Preliminary tests stated that the users were able to see the difference of the global and local illumination within a visual angle of 20°, which constitute to approximately 30 % of the screen area of a 22” monitor.
A test of the real time visual quality revealed that 77 % of the test subjects preferred gaze directed photon mapping instead of traditional photon mapping.

A quantitative analysis of the number of photons in the gaze region proved that up to 85 % more photons were located in the gaze region when using gaze directed photon mapping, **Fig. 4**.

Tests of the frame rate performance showed that hybrid rendering with gaze directed photon mapping is up to five times faster than rendering the entire screen with global illumination using photon mapping.

DISCUSSION

The idea of gaze directed hybrid rendering outlined here, can be used to achieve real time computer graphics of better quality at lower computation costs.

The results of the developed system showed that a performance improvement of up to 400 % is possible by using gaze directed hybrid rendering with gaze directed photon mapping, compared to rendering the scene with full screen photon mapping, with an identical number of photons in the gaze area.

REFERENCES
- [1] Jensen, H. W. (2001), Realistic Image Synthesis using Photon Mapping , A K Peters Natick, Massachusetts. - [2] Duchowski, A. T. (2007), Eye Tracking Methodology, Springer. - Dutre, P., Bala, K., and Bekaert, P. (2002), Advanced Global Illumination, A. K. Peters, Ltd.