Computational Holography:
The real 3-D by fast wave-field rendering in ultra high resolution

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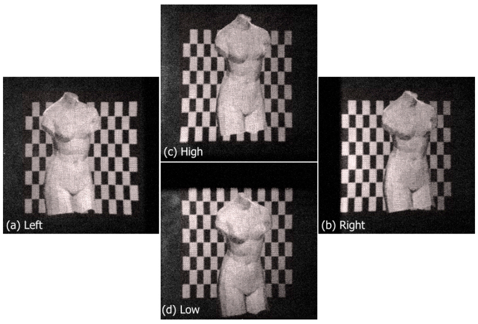

Fig. 1: Venus by Computational Holography

1. Introduction

James Cameron's *Avatar* pioneered 3-D films in practical meaning. All audiences of the movie were happy even though their eye points were fixed when they were watching the movie. However, there are certain area that fixed eye points are not acceptable. This is why the authors focus on *Computational Holography* (see Fig. 1).

Holography is a technique that allows the light scattered from an object to be recorded and later reconstructed so that it appears as if the object is in the same position relative to the recording medium as it was when recorded [Wikipedia]. One of advantages of holography is that it provides *full 3-D view*, meaning that viewers can see different views of the object from the corresponding view angles.

The computational holography (computer-generated holography) has long history and is often called an *ultimate 3-D rendering technology* since it produces not only sensation of depth but also lightwave from the rendered objects themselves. However, we must face difficulty of the computational holography. Synthesizing holography has been quite difficult due to its heavy load of computation. To illustrate, a stamp-sized synthesized holography requires 4 billion pixels (2^{16} x 2^{16} pixels). There have not been any practical technique in computing such ultra high resolution light field so far.

The authors propose a polygon/silhouette-based computational holography that overcomes a wall of that computational complexity [1]. This method numerically generates a lightwave of surfaces of arbitrary objects, whose shape is given in a set of vertex data of polygonal facets. Occluded areas of the scene are correctly removed by computing silhouette of the objects. The authors also propose a segmented frame buffer that can handle very large wave-field that cannot fit in a computer's memory of today.

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2. Fast Wave-field Rendering

The authors propose *polygon/silhouette-based wave-field rendering technique* for accurate and fast rendering of lightwave. This technique computes wave-field propagation from small facets and then integrates the all contribution from the facets.

The wave-field doesn't obey Kajiya's rendering equation. Instead of conventional ray-tracing, complex amplitude is computed. For reducing complexity of the integral and hiding back-faced/occluded areas, the silhouette of the object is firstly computed and used for culling unnecessary fields.

To save working memory of the integral, frame buffer is segmented in reasonable size. At this stage contributions of each facets to the selected segment is estimated and non-contributing facets are marked as ignorable (see Fig. 2). The computing of lightwave propagation is then done so that final wave field is drawn on the frame buffers. Those stages can run simultaneously on multi processors with a shared memory.

The authors demonstrate implementation of a large-scale computational holography, *venus*, produced by a laser lithography shown in Fig. 1.

4. Conclusion

The authors proposed large-scale full-parallax computacional holography and demonstrated *venus* for its feasibility. The future works include importing rendering technique in CGs.

Acknowledgement

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References

[1] K. Matsushima, S. Nakahara: *Extremely high-definition full-parallax computer-generated hologram created by the polygon-based method;* Applied Optics, Vol. 48, No. 34, pp. 54-63, 2009.

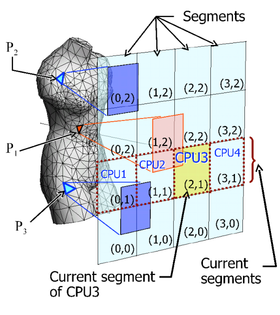

Fig. 2: Subdivision of Wave-field Computation