A Holographic Animation System Based on Holoprojection

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Abstract

We report the implementation of a system for displaying three-dimensional animations based on holoprojection. It is based in the holoprojection of two-dimensional slices (produced by a modified ray tracing program) of three-dimensional scenes. The final display is a truly spatial three-dimensional image with continuos horizontal parallax. It makes use of the holographic screen, a special diffractive lens, freeing the viewer from visual accessories.

1 Introduction

The three-dimensional exhibition is the technique that better represents the information. It's possible to represent a 3-D object in a 2-D surface, but it lacks truly depth cues. The depth cues that may be represented in a 2-D surface are: linear perspective, shadows, aerial perspective, oclusion, texture gradient, size of image in the retina and temporal parallax [7]. Those depth cues make possible a 2.5-D representation and are extensively used in Computer Graphics. However, for a spatial 3-D representation of a scene we need to provide other deph cues, such as binocular disparity and movement parallax. Those depth cues are important in scenes which present complex 3-D data or having unfamiliar objects. This includes scientific visualization, CAD, simulation and telepresence.

There are several techniques for displaying 3-D scenes, but none of the techniques have as many depth cues as holography, which has most (if not all) depth cues. However a hologram is a hard copy of the scene. Several techniques are proposted to accomplish the virtual holography in a search for holographic animation. The main techniques of virtual holography are electronical holography, scanning volumetric holography and holoprojection, which are described in section 2.

In this work we present a system for displaying three-dimensional animations based on holoprojection. It consists in the holoprojection of 2-D slices of a 3-D scenes.

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2 Virtual Holography

Virtual holography is used for exhibition of holographic animations. The main techniques are electronical holography, scanning volumetric holography and holoprojection.

The *electronical holography* [4, 5, 6] consists in the use of computer to generate the fringe pattern, simulating the interation of two lasers representing the object and reference beams. The fringe pattern are used for a holographic display to produce the 3-D image, like the reconstruction step in optical holography. This technique is slow due to computacional complexity of the physical simulation of light propagation and interference.

The *scanning volumetric holography* [7] uses a laser to project the points of the object over a rotating screen. The problem with this technique is the mechanical limitation, because the element of projection must be moved in all exhibition volume.

The *holoprojection* [1, 2] consists in a system for holographic visualization compounded for white-light source, diffraction grating, holographic screen and a computer that controls the process and generates the images displayed in three dimensions. The *holographic screen* is a special diffractive lens which receives a white beam of light from a projective lens diffracting it in different wavelenghts in different directions, generating several views, which consists in the decoding depth. The Figure 1 ilustres this. For simplicity, only three wavelengths were drawn.

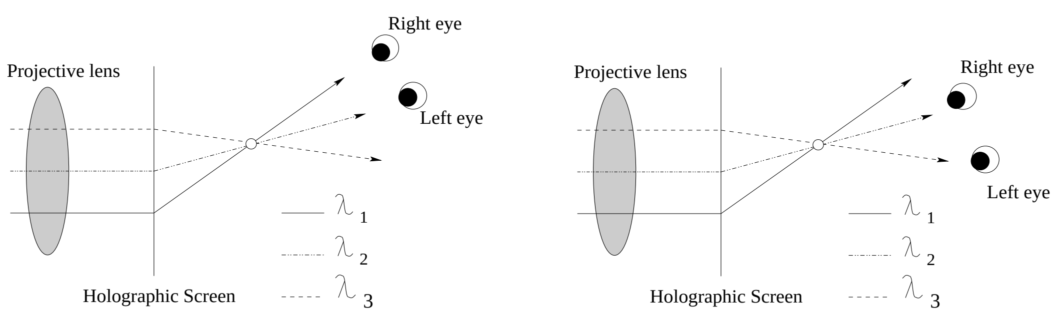

Figure 1: Example of paralaxe of the holographic screen.

3 The System

The system projects two-dimensional slices, which are created for a modified version of a ray tracing program from a three-dimensional scene description. Each slice projected passes for a diffraction grating for deph encoding, for a set of lens and is projected over a mirror in movement, which is controled for the computer in a sincronized way. This mirror put each projected slice in a transversal position in relation to the holographic screen, forming a exhibition volume. It is illustrated in the Figure 2. The projector is a Sharp XG-400U, wich is connected to a PC-AT 486 DX-2 66 MHz.

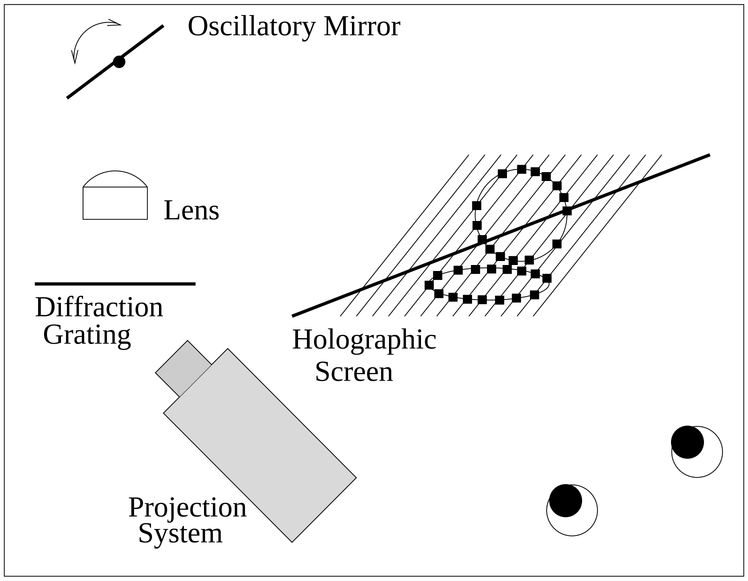

Figure 2: The holographic animation system.

4 Main Results

The generated images have continuous horizontal parallax, and may be exhibited as follows: 3 slices at a rate of 20 Hz, 4 slices at a rate of 15 Hz and 5 slices at a rate of 12 Hz. This limitation is due to the exhibition rate of the projector which is 60 Hz. The Figure 3 shows a stereopair of an achieved result. The image was projected in $63cm \times 35cm$ holographic screen with 4 slices. This stereopair was registered at a distance of $1m$, presenting a $21cm$ of visual field.

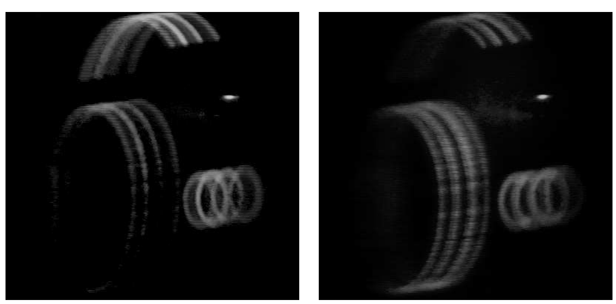

Figure 3: Stereopair of an achieved result.

5 Conclusion

The system generates animations of an exhibition volume formatted in 2-D slices of a 3-D scene with continuous horizontal parallax which can be observed without any visual accessory.

The limitation on the number of slices may be improved by the inclusion of a new projection system. There exists a LCD screen with exhibition rates of 1 KHz and 2 KHz [3]. Therefore, the limitation would reside on the data transfer rate. At a rate of 2 KHz our system may draw 3-D scenes with 64 slices at a rate of 30 Hz, or 100 slices at a rate of 20 Hz.

Therefore, the holographic animation system based on holoprojection of 2-D slices of a 3-D scene is an effective system whose improvement depends only on a substituting emergent display technology to the parts described here.

References

[1] E. Bertini, C. F. X. de Mendonça N., J. J. Lunazzi, and P. L. de Geus. Um sistema para visualização holográfica. *Anais do IX SIBGRAPI'96*, pages 23–29, 1996.

[2] M. Diamand. Sistema para visualização holográfica de figuras geradas por computador. Master's thesis, Faculdade de Engenharia Elétrica, UNICAMP, Dezembro 1994.

[3] N. A. Dodgson. Analysis of the viewing zone of the cambridge autostereoscopic display. *Applied Optics*, 35(10):1705–1710, April 1996.

[4] P. St. Hilaire, S. A. Benton, M. Lucente, M. L. Jepsen, J. Kollin, H. Yoshikawa, and J. Underkoffler. Electronic display system for computational holography. *Pratical Holography IV, Proccedings of the SPIE*, Volume 1212-20:174–182, 1990.

[5] M. Lucente and T. A. Galyean. Rendering interactive holografic images. *Proc. of SIGGRAPH 95 (LA, CA, Aug. 6-11, 1995). In Computer Graphics Proceedings*, pages 387–394, August 1995.

[6] M. Lucente, P. St. Hilaire, S. A. Benton, D. L. Arias, and J. A. Watlington. New approaches to holografic video. *SPIE Proceeding, Holographics Internacional '92*, paper 1732-48, July 1992.

[7] F. L. Wefer T. E. Clifton III. Direct volume display devices. *IEEE CGA*, pages 57–65, July 1993.