A HOLOGRAPHIC ANIMATION SYSTEM

E. G. da Fonseca, C. F. X. de Mendonça N. and P. L. de Geus
Institute of Computing - UNICAMP
emersong@cit.com.br, {xavier, paulo}@dcc.unicamp.br

J. J. Lunazzi, Institute of Physics - UNICAMP
lunazzi@ifi.unicamp.br

Abstract

To achieve full capability in holographic animation is the most common holographer's dream, and electronic means are the way for that. Following that intention, our work reports the implementation of a system for displaying textured images animation in three planes of depth such that all depth cues are present. The 3-D volume can be observed without either auxiliary devices such as stereo glasses, virtual reality helmet, etc., nor sensors for locating the observer.

Keywords: Holography, holoprojection, virtual holography, computer animation.

1 Introduction

Although it is possible to represent a 3-D object in a 2-D surface, the image thus formed does not have true depth cues. The depth cues that may be represented in a 2-D surface are: linear perspective, shadows, aerial perspective, occlusion, texture gradient, size of image in the retina and temporal parallax [1]. 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 depth cues, such as binocular disparity and movement parallax. Those depth cues are important in scenes which present complex 3-D data or have unfamiliar objects. This includes scientific visualization, CAD, simulation and telepresence. In a previous work we discussed some of the techniques for displaying volume images [2].

2 A System for Virtual Holography

We use a technique called *holoprojection* [3, 4, 5], in which a system for holographic visualization is made of a white-light source, a diffraction grating, a holographic screen and a computer that controls the mechanical apparatus and generates the images displayed in three dimensions. The *holographic screen* [6] is a special diffractive lens which receives a white beam of light from a projective lens and diffracts it in different wavelengths, to different directions. This can generate several views, which will encode depth.

The system projects two-dimensional slices which look like a sliced bread, however those slices are textured pictures shown in planes at different depths (see figure-1).

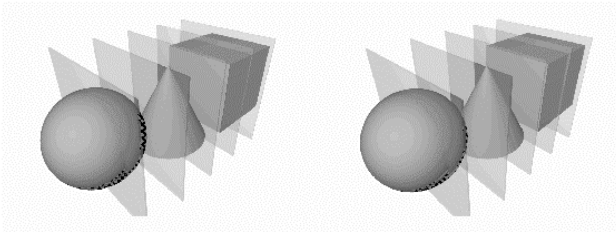

Figure-1: A stereo pair showing the slicing process.

Figure-2 displays the prototype of the Holoprojector. The slices created by a modified version of a ray tracing program from a three-dimensional scene description are shown one at a time. Each projected slice passes through a diffraction grating for depth encoding and then through a set of lens, so as to be projected over a mirror in movement, which is controlled by the computer in a synchronized way. This mirror puts each projected slice in a transversal position in relation to the holographic screen, thus forming an exhibition volume. The projector is a Sharp XG-400U, which is connected to a PC fitted with a suitable graphics card.

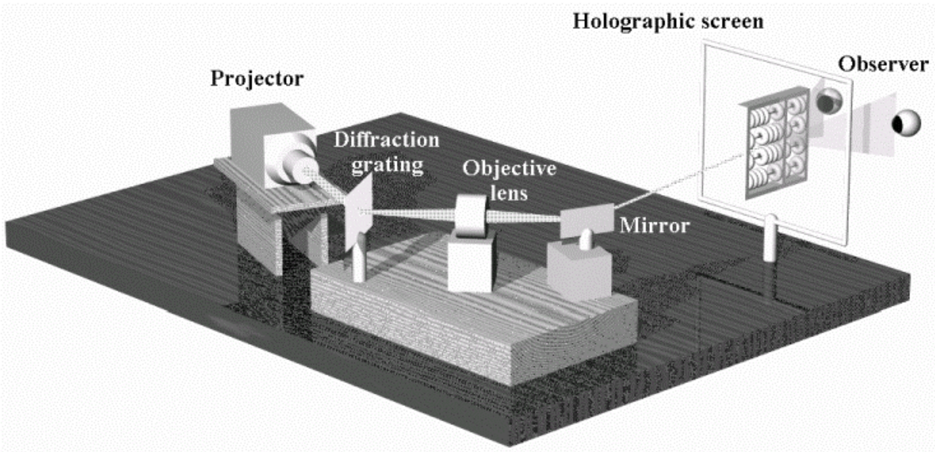

Figure-2: A view of the Holoprojector

3 Results

The prototype had proved effective and able to display a 12-frame animation, with 3 slices for each frame. The animation shown is a wooden ``*Walking Man*''. The generated images have continuous horizontal parallax, and can be exhibited at rate of 3 slices at 14 Hz. Currently, this limitation is due to the exhibition rate of the projector being used, which is 60 Hz. The figure-3 shows stereo pairs of three consecutive frames of the ``*Walking Man*'' animation. The original animation has 12 frames. The image was projected in *63 cm* $\times$ *35* cm holographic screen. The volume exhibited had *225 mm* $\times$ *138 mm* $\times$ *76 mm* of width, height and depth, respectively. The two stereo pairs were registered at a distance of *76 cm*, presenting a *13 cm* of visual field.

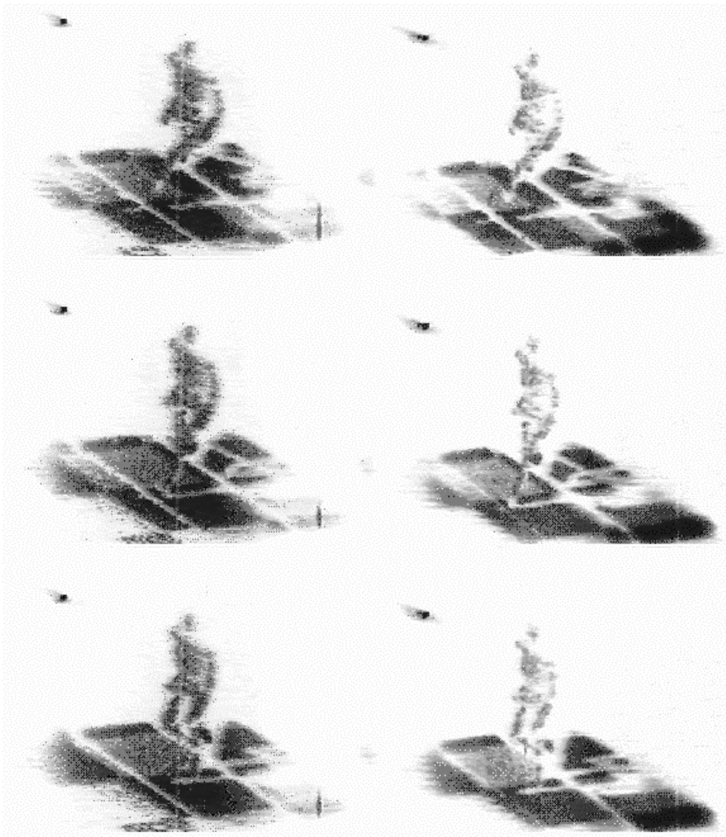

Figure-3: Stereo pairs of three consecutive frames of the ``*Walking Man*'' animation.

4 Conclusion

The system generates animations in 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 animation can be shown at a reasonable rate.

The limitation on the number of slices may be overcome by the inclusion of a new emergent display technology and of a new projection system. Already, there is in the market a LCD screen with exhibition rates of 1 to 2 kHz [7]. The limitation would then 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.

5 Acknowledgment

This research was supported in part by Brazil's National Research Council (CNPq), Foundation for Research Support of the State of São Paulo (FAPESP) and Foundation for Education and Research Support (FAEP) of the State University of Campinas (UNICAMP).

6 Bibliography

[1] T. E. Clifton III and F. L. Wefer. *Direct volume display devices.* **IEEE Computer Graphics & Applications**, pages 57—65, July, 1993.

[2] E. G. da Fonseca and C. F. X de Mendonça N. and J. J. Lunazzi. *A holographic animation system based on holoprojection*. **In the proceedings of the SLA'97**, pages 70–73. Also technical report IC-97-19, Institute of Computing, UNICAMP (http://www.dcc.unicamp.br/reltec-ftp-97-19.ps.gz), december, 1997.

[3] E. Bertini and C. F. X. de Mendonça N. and J. J. Lunazzi and P. L. de Geus. *Um sistema para visualização holográfica*. **Anais do IX SIBGRAPI'96**, pages 23–29, 1996. (http://www.visgraf.impa.br/sibgraphi96/trabs/pdf/a83.pdf).

[4] M. Diamand. *Sistema para Visualização Holográfica de Figuras Geradas por Computador*. Master thesis. Falculdade de Engenharia Elétrica, UNICAMP, 1994. (http://www.geocities.com/CapeCanaveral/Lab/6146/tese_md.html).

[5] J. J. Lunazzi and M. Diamand. *3D display system based on holographic screen and microcomputer-driven galvanometers*. **Applied Optics**, **34**(4697–4699), 1995.

[6] J. J. Lunazzi. Pseudoscopic *Imaging by Means of a Holographic Screen*. **Proc. of SPIE, 16th Congress of the International Commission for Optics – Optics as a Key to High Technology**, Volume 1983 in Part Two:583–584, August, 1993.

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