A Three-dimensional Animation System Based in the Holographic Stereogram Technique

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Relatório Técnico IC–97-20

Novembro de 1997

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November 4, 1997

Abstract

This work presents the implementation of a system for displaying three-dimensional animations based in the holographic stereogram technique. It uses chromatic codification for creation of the final image formed by diferent view points. The electronic animated images are pre-computed and stored in a movie file. They may be projected with white light to reache the size of the bigger holographic screens existing nowadays ($0.75m \times 1.14m$). The final animation is presented at video rates and observed without visual accessories.

1 Introduction

In the last decades the search for systems for displaying 3-D images has become an intense area of research interest. This fact is a natural follow up of the nature of the human visual system which is able to perceive the outside 3-D world. One can classify such display systems into two major classes as either stereoscopic or autostereoscopic display systems [6]. This classification is based respectively on either the 3-D cues depend on the combination of the display system and some kind of visual accessory or the 3-D cues are present on the display system and the observer may perceive the 3-D in a more natural way without the use of any visual accessory.

Some autostereoscopic display systems may sometimes offer some extra depth cues such as horizontal parallax. Intuitively the horizontal parallax may be defined as the change of the objects in a scene when the observer moves horizontally towards left or right seeing different views of the same scene.

All 3-D techniques today uses a set of different views to code the cues of depth. The techniques vary from the anaglyph to the hologram which has two and infinite views, respectively. The most common technique, the anaglyph has no horizontal parallax, and

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therefore, the scene will be at the same depth regardless the horizontal position of the observer. On the other hand, in the hologram technique the viewer may have continuous horizontal parallax. Although, holograms are a state of the art in displaying 3-D scenes, it still a freezing copy of the objects of a scene. It would be desireable to produce virtual display of scenes in the same quality as holograms. However, such high resolution in which one can code thousands of views are not possible for virtual display of scenes. Therefore, we must compromise and reduce the resolution of the scene and further reduce the horizontal parallax to a discrete number of views. There are several display systems which use this technique including the following. The Cambridge autoestereoscopic display described by Dodgson and Travis in [1, 7]. In this system a beam of light sources array is projected over a single set of lens and fast LCD screen. The position of chosen light source combined with the scene shown in LCD screen determines the view perceived by the observer. The system is strongly dependent on the speed of the LCD screen and the light sources switching. Our system differs from theirs in several ways including the following. It does not depend on the speed of screen and the view is coded in spectral color ranges. Nordin et al. in [5] reports an interesting system developed at the University of Alabama, Huntsville which is based on the partial pixel architecture. This system is very similar to the previous one, however instead of switching the position of the light beam source, it switches the position of single pixel over a diffraction grating. Our system differs from theirs, because our views are coded in spectral color ranges instead of being coded as the position of subset pixels. There is another system relevant to mention, the holovideo system of Lucente et al. in MIT reported in [2]. This system uses lasers to modulate light in the same way of reconstruction step in holography. It is intensively dependant on computational simulation and on the speed of the mirrors controlling the lasers. An important characteristic of this system is that it has the best final display resolution, even over our system. However, we show in section 4 that our system can be improved by a display system with wider number of spectral colors (other than only RGB) having a narrower intersection to each other.

In this work we describe an animation system based on a autostereoscopic display system with a discrete number of chromatic coded views. The autostereoscopic property is due to the use of a holographic screen.

2 Color Encoding of Depth

Color encoding of depth is shown to occur naturally in holograms that are reconstructed under white illumination. It can be registered in a common color photograph, allowing a simple method of visual decoding by means of ordinary colored 3-D spectacles [4]. In the same way, the color encoding of depth is shown to occurs naturally in images of objects observed through diffraction gratings under common white light illumination [3]. Both techniques may produce perfect anaglyphic images that may be seen as 3-D with color glasses or under the projection over a holographic screen.

Our motivation was to develop a system that generates different views of the same scene coded by spectral colors. The produced picture should display the same effect of the snapshot taken through a diffraction grating. We used a freeware ray-tracing program

(Pov-Ray V3.02) to do that. It is convenient to set the virtual camera far from the objects and set narrow view angles. The final drawing is combined by a program that code different views by spectral colors in a single picture. The shadows, the smooth and textures of the surfaces were left to the power of the ray-tracing program. The final drawing looks like a picture produced by a snapshot taken through a diffraction grating. The Figure 1 shows the process of the virtual cameras to collect the views and the final display may be seen in Figure 2.

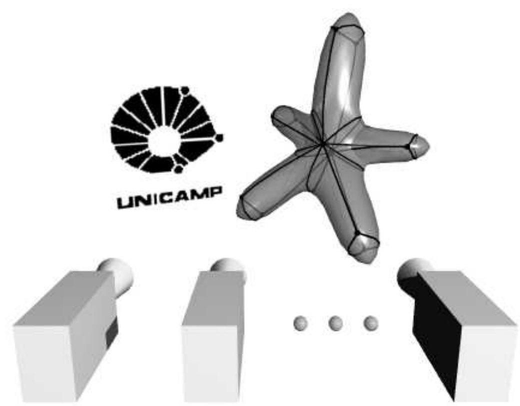

Figure 1: Registering different views of a scene.

3 Main Results

The system projects images formed by white light that can be diplayed in a size limited by the size of the holographic screen ($0.75m \times 1.14m$). The parallax is discrete and is shown in three colors only. Some intermediate parallax was obtained including intermediate views coded in non spectral colors (consisting of a mix of the intensity of the RGB colors, instead of a narrow range of spectral colors with little intersection with each other). The intermediate views loose intensity as the observer changes his horizontal position. This effect sometimes gives the impression that we do have horizontal parallax. However, the views coded with non spectral colors causes either a misleading weak blur which may confuses the observer or it gives the impression of improved parallax. The final display has excellent brightness and sharpness. The Figure 2 shows three views of an achieved result. This scene was projected in a $15cm \times 16cm$ holographic screen. The projector was $65cm$ far from holographic screen and the visual field was $11cm$ for a camera positioned at a distance of $85cm$. The exhibition volume is located ahead and behind the holographic screen. A X-shaped mark was fixed onto the screen to be used as reference for parallel-eye viewing.

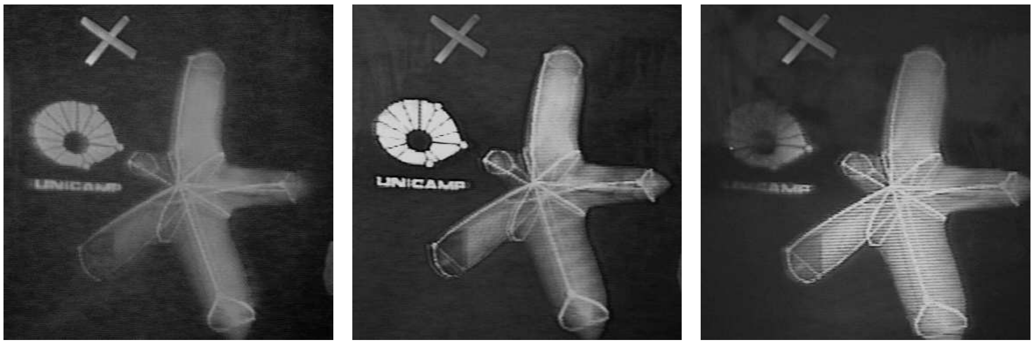

Figure 2: Three views of a frame.

4 Conclusion

We presented a 3-D autostereoscopic animation system based in the holographic stereogram technique with a discrete horizontal parallax. The number of views depend on the displaying system and can be improved by the appearing of a new display system that may exhibits more distinct color spectral ranges. There is also possible to display and capture 3-D images in real time by taking the scenes through a diffraction grating.

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