A PRACTICAL AND EFFICIENT APPROACH TO THE STEREOSCOPIC DISPLAY AND MANIPULATION OF CARTOGRAPHIC OBJECTS

by

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ABSTRACT

Until now the direct stereoscopic display of computer generated cartographic objects produced in real time has been either very expensive or very difficult. This paper presents an approach that is both more efficient than earlier methods and more practical. Several examples of cartographic surfaces will be shown where the stereoscopic vision aspect of the display can be used to more efficiently show the true character of the surfaces involved.

INTRODUCTION

For many decades cartographers have been faced with the challenge of showing a three dimensional cartographic surface on a two dimensional medium. This includes both terrain and thematic cartographic data. In the early decades the medium was the paper map whereas in more recent years graphic CRT displays showing virtual maps have largely taken over this task. Common approaches to this problem are to use isarithmic representations, profiles, meshes, or choroplethic representations for such data. Approaches known as analytical hill shading are also used. Horn (1982) provides a review of these methods used in cartography as well as some of the shading approaches used in computer graphics. However, the challenge of rendering a cartographic surface as a true three dimensional surface still remains. This paper describes an approach to directly creating true three dimensional color cartographic displays through the use of stereoscopic CRT displays.

EARLY APPROACHES TO STEREOSCOPIC DISPLAYS

One of the earliest approaches to the direct stereoscopic display of cartographic surfaces was developed with anaglyphs. Here two images of the same surface, usually of single or double profiles, were printed in red and blue ink on paper and slightly offset from each other. This twin image was then viewed through glasses that had a red lens for one eye and a blue lens for the other. This produced a true three dimensional effect, but correct colors could not be shown. A more mechanical traditional approach has been taken by photogrammetry where two air photos which overlap each other have been taken from slightly different angles, called parallax. These two photos can then be viewed with a device called a stereoscope to use the parallax to achieve a true three dimensional display of the terrain surface. Over the last several decades such mechanical photogrammetric devices have greatly increased in sophistication to increase the fidelity of the image. However, such devices still are limited to visible terrain and are not useful for viewing thematic surfaces such as population or temperature. A more recent innovation is the development of dual vision goggles which contain two separate television displays, one for each eye. Such devices are being used experimentally in a number of areas, but so far are limited to such experimental applications. Many of these dual vision devices significantly strain the eyes and hence are not practical for regular scientific work.

A MORE PRACTICAL AND EFFICIENT APPROACH

An approach that is far more practical and efficient for the average scientific user is a solution that has been made available by the Tektronix company recently in its 4200 series terminals and 4300 series workstations. This kind of stereoscopic display is generated from a single CRT screen workstation that creates the left and right images essentially simultaneously by alternating the images at the very fast rate of 120 Hertz noninterlaced. Therefore each image, left and right, is refreshed individually at a 60 Hertz rate. To the viewer this rate is perceived as continuous. These images are displayed through a liquid crystal polarizer that can be rapidly changed at the same 120 Hertz rate as the refresh cycle in the color CRT. The output from the polarizer is colored light that has been clockwise polarized for one image and counterclockwise polarized for the other. Radial polarization has been used here because it provides a much wider field of view than would more conventional linear polarization that is found in more conventional applications. The viewer then uses special radially polarized glasses to view the image stereoscopically. Since each lens of the glasses is radially polarized in opposite directions, the viewer sees a different image with each eye. Hence true 3-D stereoscopic display is achieved in a simple and efficient manner.

This approach can be explained in a more technical fashion as shown in Figure 1. The U,V coordinate display windows contains the point in their center called VRP, the View Reference Point. This VRP is then defined as the center of the viewing space. Usually there is only one Viewing Plane Normal, VPN, but since this is a stereoscopic display, two viewing plane normals are used, VPN-R and VPN-L, one for the left and one for the right portion of the stereoscopic image. Associated with each of the viewing plane normals is a viewing window, UV Window-R and

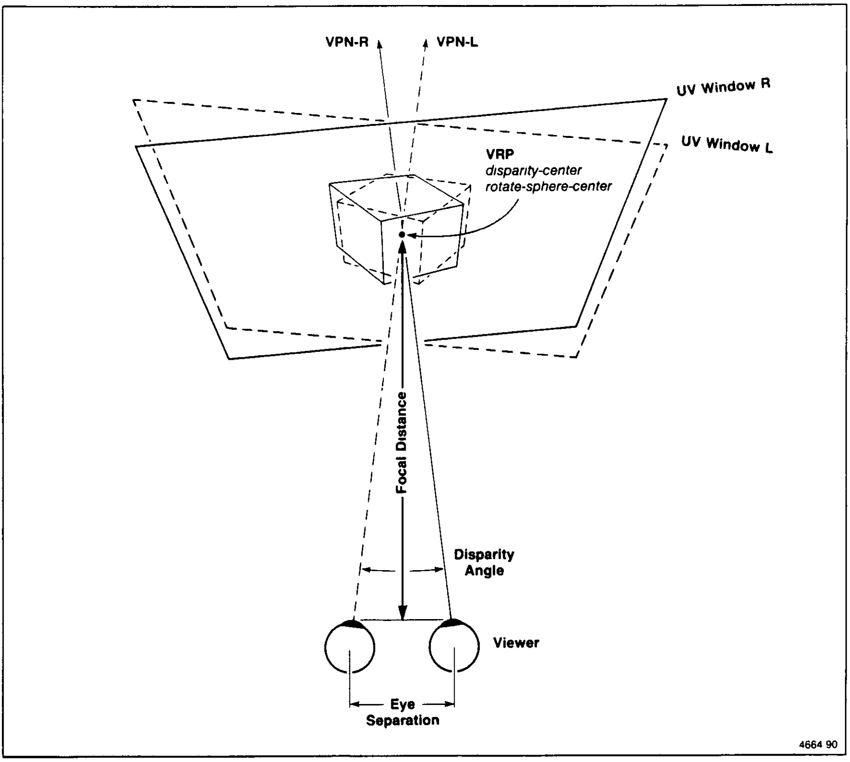

Figure 1. Stereoscopic Viewing Using Left and Right Images (Figure © Copyright Tektronix Inc. 1988)

UV Window-L. Each of these displays one component of the Left/Right stereo image. The angle between VPN-R and VPN-L is referred to by Tektronix as the Disparity Angle which is the angle of parallax between the Left and Right portions of the stereo display. The size of this angle is influenced by the size and color of the object(s) being displayed, as well as the stereoscopic perception characteristics of the individual viewer. The default is four degrees. With this kind of display and subsequent polarization, the right eye receives only the Right image while the left eye only receives the Left image. Therefore efficient stereoscopic vision is achieved.

Using such an approach to stereoscopic viewing produces a display that is both practical and efficient, and adds another dimension to the manipulation and display of virtual maps in interactive real time. It is practical because the stereoscopic image looks very real. The CRT display preserves the proper colors numerically assigned in the computer program driving the display. Use of the stereoscopic display is very effective because the radial polarization provides a wide angle of view such that several people can view the image at the same time. The practicality of the display is further appreciated because all of the stereoscopic image generation is done internally in the electronics of the CRT hardware and does not require any special software development by the user, although the disparity angle may have to be adjusted for individual viewers. Therefore, any computer display program that runs properly on the lower level Tektronix equipment will probably run on the stereoscopic display equipment with no modification. This stereoscopic display is also more efficient because it can be used in interactive real time. Therefore all of the interactive design manipulation strategies that one would usually associate with 3-D virtual maps (Moellering, 1977) can be enhanced with this kind of true three dimensional stereoscopic display.

CONCLUSION

As is clear from the discussion above, this new approach to the digital stereoscopic display of cartographic data using the Tektronix radial polarization technique is very effective for cartographic applications. It is convenient to use and easy for the programmer in that no new special software is necessary to implement this approach. At the same time this approach does not suffer the disadvantages of earlier attempts.

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