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A GeoWall with Physics and Astronomy Applications

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A GeoWall with Physics and Astronomy Applications

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A GeoWall is a passive stereoscopic projection system that can be used by students, teachers, and researchers for visualization of the structure and dynamics of three-dimensional systems and data. The type of system described here adequately provides 3-D visualization in natural color for large or small groups of viewers. The name "GeoWall" derives from its initial development to visualize data in the geosciences.[1] An early GeoWall system was developed by Paul Morin at the electronic visualization laboratory at the University of Minnesota and was applied in an introductory geology course in spring of 2001. Since that time, several stereoscopic media, which are applicable to introductory-level physics and astronomy classes, have been developed and released into the public domain. In addition to the GeoWall's application in the classroom, there is considerable value in its use as part of a general science outreach program. In this paper we briefly describe the theory of operation of stereoscopic projection and the basic necessary components of a GeoWall system. Then we briefly describe how we are using a GeoWall as an instructional tool for the classroom and informal astronomy education and in research. Finally, we list sources for several of the free software media in physics and astronomy available for use with a GeoWall system.

Theory of Operation and Components

To see a stereoscopic image, distinct images for the left and right eyes must be presented in such a manner that they are separately seen by the corresponding eye.[2] An *anaglyph* accomplishes this using coloration. The anaglyph movie or still picture has right-eye and left-eye images shaded in contrasting colors, usually red and cyan, and superimposed onto a single image. When viewed through correspondingly colored filters over the left and right eye, a 3-D image can result. When most people think of 3-D glasses, they usually think of the red/cyan glasses that have been used for viewing 3-D movies, television, or still images. One of the problems with using this technique is that the perceived colors in the 3-D images are distorted, resulting in an image that may not be as pleasing as the original image.

The passive stereoscopic projection technique of a GeoWall system accomplishes the same thing but with perpendicularly aligned polarizing filters.* Special glasses with Polaroid lenses aligned at 45° on the left and -45° on the right are available for this purpose. Projectors for the left-eye and right-eye images are placed behind polarizing filters in alignment with the corresponding eye lenses (see Fig. 1). Most companies that supply the required polarizing glasses also sell polarizing filters for the two projectors.[3]

It is important to note that for a GeoWall system, only particular types of projectors and screens will work to provide a stereoscopic effect. The projectors must not themselves emit polarized light (as common LCD projectors do), and the reflecting screen must preserve the polarization of the incident light (as common white screens do not). Most GeoWall systems incorporate Digital Light Processing (DLP) projectors and polarization preserving "silver" screens. Similar configurations using circularly polarized light and/or rear projection screens are possible as well. Recommendations for suitable projectors, screens, and sources for the Polaroid glasses are available on-

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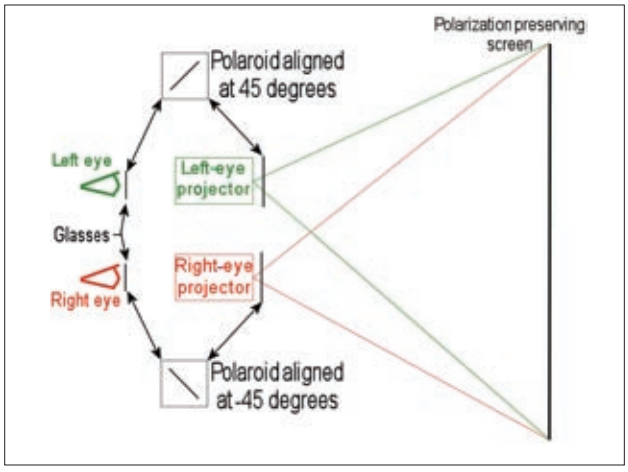

Fig. 1. Basic configuration for a passive stereoscopic projection system. Left-eye and right-eye images are projected through orthogonal Polaroid filters. The superimposed images are again separated into left-eye and right-eye images by special Polaroid glasses.

Fig. 2. The basic setup for a stereoscopic projection system includes a CPU with dual video output feeding two DLP projectors that project through orthogonally aligned Polaroid filters and are aligned onto a polarization preserving screen.

Fig. 3. An enthralled audience during a "Mars Night" astronomy outreach activity.

line from the GeoWall Consortium.[4]

The remaining hardware components of a basic GeoWall system include a stacking projector stand with adjustable mounts to align the projected images onto the screen. Both portable table-standing and permanent ceiling-mounted stacking projector stands are available.[4] Finally, a computer with a dual-monitor video output card is required to feed video to the projectors. Of course, the system with the faster CPU and video processor will perform the better. Recommended minimums are a 1-GHz CPU with 512MB RAM and an AGP dual video graphics card. Two flat panel video monitors or a dual flat panel video monitor is recommended for operator setup and control but are not essential. Any of the three most common computer operating systems, Windows 2000/XP, Linux, and Mac OS X, can be used in a GeoWall system. Because a higher percentage of the stereoscopic software and media is written for the Windows and Linux operating systems, most users choose one or the other, or a dual boot configuration with both. The total cost for a basic GeoWall system can be as low as $8000, of which the cost of two DLP projectors is the largest share. A portable GeoWall system being used at the University of Texas at Brownsville is pictured in Figs. 2 and 3, as it was set up for a "Mars Night" astronomy outreach activity on the UTB campus in early November 2005.

The perception of depth is

possible by visual parallax in the superimposed images. Corresponding points in the two images may "appear" either behind or in front of the screen due to positive or negative parallax as the observer's eyes adjust to view the image. The 3-D images produced with a stereoscopic projection system can appear so realistic that if the observer sways side-to-side or moves around, the image also appears to move.

Classroom, Outreach, and Research Applications for a GeoWall System

We both use a GeoWall system in our introductory astronomy courses to view and discuss stereoscopic images of the Martian terrain from the Mars Pathfinder and the ongoing Opportunity and Spirit rover missions. High-resolution stereo images of the crusts of the Earth and Mars, which can be zoomed in on and magnified, are used while studying comparative planetology. The actual 3-D placements of stars in the constellations are vividly revealed for study. Data from the Sloan Digital Sky Survey are examined to illustrate the distribution of galaxies in the local group and throughout the observed universe.

At Stephen F. Austin State University, stereoscopic photography is being used by students in the search for asteroids and minor planets. In a variation on detecting moving objects against the background of stars, called "blinking," stereo images are created showing an asteroid in the foreground to the stars.

At the University of Texas at Brownsville, a portable GeoWall system is being deployed for science and astronomy outreach to the surrounding community. This outreach program includes special public presentations on current topics in astronomy and school presentations for grades K-12.[5] Stereoscopic movies representing the data from numerical simulations of binary black hole mergers have been created. We also have developed VRML representations of the geometric appearance of relativistically moving objects that can be observed in 3-D.

Software and Media for a GeoWall System

Below is a description of some of the stereoscopic software packages and resources that are freely available for GeoWall systems and are applicable to physics, astronomy, and physical science courses.

Viewer software for projection of stereoscopic photographs:

Viewer

Platform: Linux

Author: Russ Burdick

http://www-users.cs.umn.edu/~wburdick/geowall/viewer.html

View

Platform: Linux, Windows 2000/XP

Author: Terry Jay Jones, part of AstroWall zip package.

http://webusers.astro.umn.edu/~tjj/

Wallview

Platform: Windows 2000/XP

Author: Ken Chin-Purcell

http://geowall.geo.lsa.umich.edu/wallview.html

StereoViewer

Platform: Java VM

Author: Phillip Dukes

http://pdukes.phys.utb.edu/StereoViewer

Graphics 3D

Platform: Windows 2000/XP

Author: Dan Bruton

http://www.physics.sfasu.edu/astro/Graphics3d/

Stereoscopic photographs of Mars from ongoing Opportunity and Spirit missions:

—A selection of excellent Mars stereoscopic photographs in color and black-and-white has been compiled and made available for download by Marvin Simkin at Arizona State University.

- http://simkin.asu.edu/geowall/mars/

—All the photographs transmitted from Opportunity and Spirit are available for download. Most are available as left-right stereo image pairs.

- http://marsrovers.jpl.nasa.gov/gallery/all/opportunity.html
- http://marsrovers.jpl.nasa.gov/gallery/all/spirit.html

—Cylindrical projection images of the surfaces of the Earth and Mars are available in stereoscopic pairs.

- http://geowall.geo.lsa.umich.edu/edc/StereoPairs/etopo2/
- http://geowall.geo.lsa.umich.edu/edc/StereoPairs/Mars/

Three-dimensional data set and animation viewers:

Immersaview

Description: An interactive VRML and Open Inventor model stereoscopic viewer.

Platform: Windows 2000/XP, Linux, Mac OS X
Author: Electronic Visualization Lab of the University of Illinois at Chicago.
- http://www.evl.uic.edu/cavern/agave/immersaview/

—VRML representations of the geometric appearance of relativistically moving objects illustrating visual shearing effects and Terrell rotation can be viewed stereoscopically using Immersaview.
- http://pdukes.phys.utb.edu/RelVisual/

Partiview

Description: Program to visualize and animate particle data in three dimensions.
Platform: Windows 2000/XP, Linux, Mac OS X
Author: Stuart Levy
- http://haydenplanetarium.org/universe/partiview

—A collection of very impressive astronomy and astrophysical media for Partiview is available from the National Center for Supercomputing Applications (NCSA) at http://virdir.ncsa.uiuc.edu/partiview.
A collection of Partiview resources for introductory astronomy is also available at http://pdukes.phys.utb.edu/partiview.

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*Column Editor's Note:

Older readers might remember that this method was used during the 3-D movie craze of the early to mid-'50s. "The House of Wax," "Fort Ti," and "The Creature from the Black Lagoon" come to mind.

References

1. The GeoWall Consortium at http://GeoWall.geo.lsa.umich.edu.
2. Curt Gabrielson, "One brain, two eyes, three-D," *Phys. Teach.* **34**, 10 (Jan. 1996); H. Richard Crane, "Uncommon uses of the stereoscope," *Phys. Teach.* **25**, 588 (Dec.1987).
3. See, for example, http://www.studio3d.com.
4. Sources for GeoWall components can be found at http://GeoWall.geo.lsa.umich.edu/hardware.html.
5. For a list of past activities, see http://outreach.phys.utb.edu/sciencewall.

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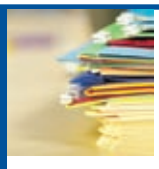

Papers worth rereading

Visual Puns Involving Ω

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Robert P. Lanni, "The Omega Competition," *Phys. Teach.* **16**, 483 (Oct. 1978). Here are 10 examples of terrible visual puns involving an Ω; can you think of any more?