

Affordable System for Viewing Spatial Data in Stereo

By Brian Davis, SAIC, Contractor to the USGS Earth Resources Observation Systems Data Center

If “two heads are better than one,” when are three dimensions better than two? The practical answer is probably “when it is cost effective.” Recent advancements in the necessary hardware components have made such systems possible, and more recent advancements in software systems from ESRI and other companies have made such systems more usable.

The goal of the GeoWall Consortium (GeoWall.org) is to make three-dimensional display systems from low-cost commodity components. This unofficial group of academic and federal agency researchers is not funded as a consortium but is a consortium in the spirit of promoting open source software and sharing data and information.

One drawback of stereo display is that not everyone can perceive depth through stereopsis. Approximately 10 percent of the population is at least partially “stereo blind.” Up to 1 percent of the population is fully stereo blind. However, users with normal vision who are not experts in GIS data or applications can benefit greatly from three-dimensional visual representations of landscapes and other GIS data. Land managers, first responders, emergency personnel, and disaster response officials can now benefit from more accurate, realistic, and interactive digital representations as more robust hardware and software systems become more pervasive.

Three Dimensions: Active Versus Passive

Historically, virtual reality and other stereo display systems have required high-end components with hefty price tags. Systems such as CAVE require multiple Silicon Graphics supercomputers and expensive shutter glasses synchronized to the double-refresh rate of the projector. [CAVE is a room-sized, high-resolution three-dimensional video and audio environment useful for communicating scientific visualizations to multiple persons at the same time.] Combined with active stereo goggles, these systems produce dramatic effects but are out of reach of most visualization researchers’ budgets.

On the low end of the three-dimensional display spectrum, printed anaglyph depictions have been employed for many years. In addition to the obvious limitation of noninteractive printed graphics, these red/blue representations restrict the colors that can be used. Limiting the use of two of the three primary colors essentially reduces the color choices to green, black, and white.

Although the passive linear polarization employed by the GeoWall system cuts down the

total light output, restricted color use is eliminated. Reduced light output is becoming less of a concern because projectors are rapidly becoming brighter and cheaper. These Digital Light Projection (DLP) technology projectors, in combination with affordable PC graphics cards, are making full-color, interactive, digital three-dimensional data representation practical and affordable for the first time.

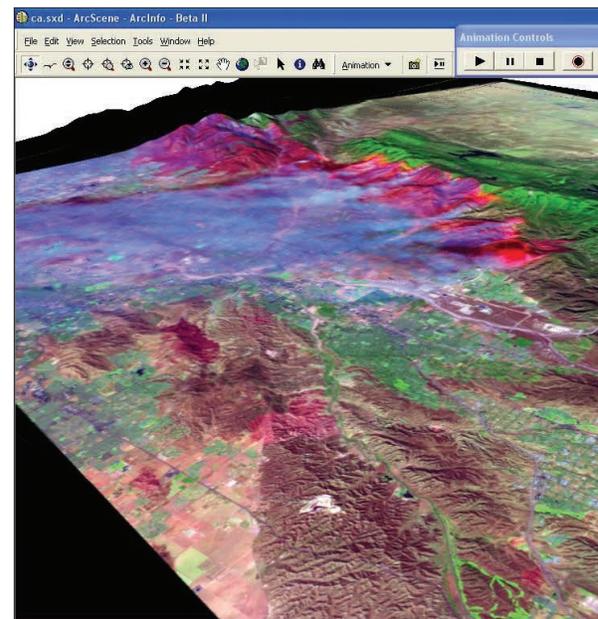
How GeoWall Works

A GeoWall system takes the output from a dual video graphics card and routes it to a pair of projectors. The light from the projectors is polarized separately to produce two separate views. Special projection screen material is required to retain the polarization of these light waves. Readily available polarized glasses, such as those used at theme parks, are used to filter the light again. The glasses allow each eye to see one—and only one—of the two outputs.

With this passive stereo system, if a user’s software can send two separate views to each of the two ports of a graphics card, the viewer’s brain can be fooled into believing it is seeing two separate views (from two distinct angles) and three-dimensional depth is perceived. In animations, some GeoWall applications can add the fourth dimension—time.

The first GeoWall system, dubbed AGAVE, was prototyped in February of 2001 in the Electronic Visualization Laboratory (EVL) at University of Illinois at Chicago. EVL staff members installed the Linux operating system on a commodity PC and a newly available dual-output graphics card and ported their CAVE library of software to this platform. The total cost of the components was inexpensive—less than \$10,000. This system was aligned using LEGO blocks and Super Glue, but it displayed the data impressively in stereo. It convincingly demonstrated the potential for an affordable three-dimensional display system. Since that time, GeoWall applications have been ported to Windows and Macintosh platforms, which has eliminated any architecture restrictions.

The application’s name, GeoWall, was derived from a combination of geology, because the initial collaborators were working on geology visualizations, and wall (as in one wall of a CAVE). Subsequently, some consortium members have made the case for *Geo* representing geography. As a result, many members are referring to these systems simply as “Walls.” When used with ArcScene, these systems could reasonably be called GISWalls.



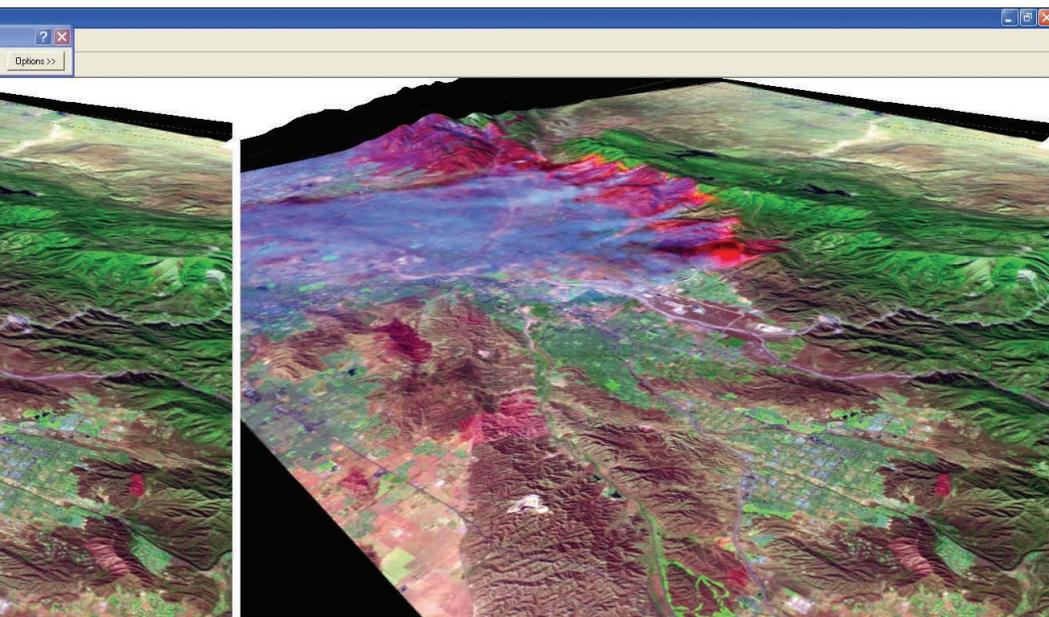
Leading Edge Hardware, Bleeding Edge Software

However, sometimes the free or open-source software that accompanies leading edge hardware implies bleeding edge (graduate student) software. After the initial excitement of seeing data in three dimensions using freely available viewing applications, users invariably begin to ask questions such as, “Can you overlay data?” “Can you tell me where I am?” “Can you add data?” “Can you select/deselect points?” and “Can you interact with the data?” Until recently, the answer was no.

Commercial GIS Three-Dimensional Display

With the release of the ArcGIS 9 3D Analyst extension, the answer to the above questions is now yes. The ArcScene application in this extension gives the user perspective views. ArcScene users know the advantage of perspective views. ArcScene can generate two separate stereo perspective views that simulate a three-dimensional virtual world. GIS users can combine topographic data with imagery layers and even create fly-through animations and enjoy interactive GIS functionality. The benefits that accompany a hardened, deployed, and supported commercial software product are not lost on the academic research community.

On November 19–20, 2003, a Beta II release of ArcGIS 9 3D Analyst extension was successfully demonstrated as part of a GIS Day event held at the Washington, D.C., headquarters of the United States Environmental Protection Agency. Agency staff from the Earth Resources Observation Systems (EROS) Data Center used ArcScene to display Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) satellite imagery of the 2003 Southern California wildfires in three dimensions to high-level officials from federal agencies as well as congressional staffers and elementary school children. ESRI staff from the Vienna, Virginia, office who attended the event expressed interest in setting up their own



ArcScene can be used with the GeoWall system to produce high-quality stereo presentations at a reasonable cost.

GeoWall. After an informal discussion at GIS Day and a couple of e-mails, they had a GeoWall up and running.

The GeoWall Consortium has been successful in expanding the use of three-dimensional display technology. In less than three years, the number of known systems has grown to more than 250 and members can no longer keep track of locations or numbers. At the GeoWall Web site, several viewing applications and numerous datasets are available for download in addition to information about setting up GeoWall for use with ArcScene. See the accompanying article "Setting Up Your Own GeoWall" for an overview of the process. For more information on GeoWall, contact

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ization Laboratory there. He has published research in earth science data visualization, parallel supercomputing, high-speed networking, and surface hydrology modeling. He received a computer science degree from Augustana College in Sioux Falls, South Dakota.

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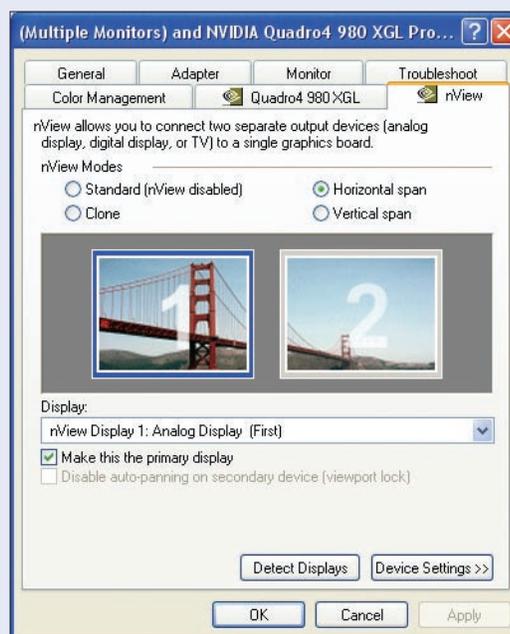
Setting Up Your Own GeoWall

GeoWall provides an affordable tool for researchers and educators. The GeoWall Web site contains complete instructions for creating a GeoWall system through either identifying appropriate components already on hand or procuring any necessary components. The site includes a list of vendors familiar with GeoWall requirements and supplies contact information for them. The site includes several viewing applications that can be downloaded as well as numerous sample datasets.

The steps to setting up a GeoWall system running ArcScene are simple, especially if ArcGIS 9 is already loaded. The following steps provide an overview of the process for setting up GeoWall for ArcScene. These instructions assume a working knowledge of this extension. For specific instructions on setting up and configuring ArcScene on a GeoWall system, visit geowall.geo.lsa.umich.edu/edc/src/Arc/ArcSceneOnTheWall.doc.

1. Set up the necessary display properties for the graphics card used (i.e., nVidia Quadro4 980 XGL, Select Horizontal Span) in the nView tab of the system's Windows display properties popup menu.
2. Start ArcGIS 9, the ArcGIS 9 3D Analyst extension, and ArcScene. Add data layers.
3. Open the Layer Properties dialog box. Under the Display tab, set the resampling method to bilinear. Under the Symbology tab, set Stretch to None. Under the Base Heights tab, set the source of the base height data. Close the Layer Properties dialog box.
4. Choose View > View Setting. In the View Settings dialog box, set the Project to Stereo View and the Stereo View Preferences to Free. Close the View Settings dialog box. Hide the Table of Contents.

Visit geowall.org for additional information on this project.



Detailed instructions for setting up a GeoWall system using ArcScene can be found at geowall.org.