

GEOWALL AS AN EFFECTIVE AID FOR TEACHING PHOTO INTERPRETATION TO GIS USERS

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ABSTRACT

Photo-interpretation is traditionally taught by practice with actual photographs and, occasionally, field work to evaluate the accuracy of possible interpretations. These methods are effective with familiar terrain and cultural features but are of limited value for distant or unfamiliar features. We consider the usefulness of three-dimensional display technology such as GeoWall, a family of applications for using a pair of projectors to produce a stereoscopic image on a screen, as an alternative teaching tool. This technology has shown considerable promise for teaching in geology, physical geography, and related fields; here we extend that experience specifically to photo interpretation. As new sources of 3D data, including web services such as Google Earth™ have become available, visualization tools have become more useful for studying cultural, as well as physical, features. Drawing on our teaching experience in both business and university settings, we suggest that 3D display tools are an effective alternative to traditional tools in that they provide students the opportunity to evaluate their initial interpretations by considering features from different perspectives and at different scales, yet at a small fraction of the cost of field work.

Keywords: GeoWall, photo interpretation

INTRODUCTION

The rapid spread of Geographic Information Systems classes into the undergraduate curriculum has been a boon to the business of geospatial services. Private firms, government agencies, tribal governments, and others find a steady flow of new geography graduates whose academic work has included exposure to GIS. At the same time, however, the attention to GIS in the undergraduate curriculum may be occurring at the cost of reduced emphasis on traditional skills of cartography and of photo interpretation as a step in the cartographic process. Our experience in teaching and in the practice of map-making indicates a need for increased attention to photo interpretation. We have found three-dimensional display technology, including GeoWall, to be a tool with potential to improve instruction in photo interpretation and, by extension, in GIS.

A well-rounded education in GIS demands that students be exposed to photo interpretation. While many GIS practitioners will never do photo interpretation as part of their careers, we argue that photo interpretation is still an important background skill. It is painfully easy for a GIS student who is challenged to master a body of theory and a set of analytical techniques to forget that the data on which those techniques are practiced have to come from somewhere. A survey of introductory and intermediate GIS syllabi suggest that much of the lab experience students have is based on data provided by the instructor. Actual data collection exercises in these classes are typically limited to assignments using global navigation satellite system (GNSS) receivers or digitizing data from an existing map. This is perfectly reasonable, and makes the best use of scarce time in the instructional lab, but leaves the student with no understanding of how those GIS data were developed and what errors or limitations they may contain.

Some GIS students, of course, will be called upon to do photo interpretation professionally, or will work in occupations in which part of their duties involve contracting for imagery and interpretation services. These students, in particular, are poorly served by a curriculum that glosses over photo interpretation.

At the same time, industry demands a cadre of potential employees who arrive with photo interpretation skills or can be taught adequate skills quickly. Wilson and Company, for example, has hired approximately 20 staff each year over recent years, specifically to work on photo interpretation for a variety of clients in private industry, civil government, and the DOD community.

Photo interpretation is hard work. The discipline of looking at an image analytically, rather than aesthetically, is new to many students and new employees. Then, the specific analytical techniques of measuring and classifying the content of an image need to be mastered. Finally, analysts need to learn the subtle skills of combining an understanding of the cultural geography of the place with the information in an image to yield an interpretation that is informed by both culture and terrain. We have been challenged, in our roles as an educator and a practitioner, to develop better and faster ways to teach photo interpretation. One of the most promising is the family of three-dimensional viewing technologies popularly known as GeoWall.

GEOWALL

GeoWall is an assembly of hardware and software that project an image on a screen that, when viewed with polarized glasses, simulates a real-world three-dimensional view. (Steinwand, et al., 2002) The technology is supported by a consortium of vendors and users (Geowall Consortium, 2009). GeoWall is not the brand name of a specific product but rather a combination of products that a user or vendor can use to assemble the 3D viewing environment. An installation generally consists of a microcomputer with a video card providing two output ports, a pair of projectors ganged together, a specialized screen, and 3D display software. The system operates by splitting the video output into two separate polarized streams which, when viewed through polarized glasses, create the impression of a 3D image.

The installation we have used incorporates a 'shuttle PC workstation with a 2.5 GHz processor running Windows XP Professional, two Panasonic D3500 projectors, circular polarized filters, and a 6' by 8' Da-Lite 3D screen. It is almost portable; the entire system, when packed in sturdy shipping cases, fills a small station wagon, leaving room only for the driver. In 2008 a series of public relations/outreach events were held for groups of 50-75 people viewing in 3-D simultaneously. The system can be effectively packed in rugged Pelican cases for shipping via ground carrier or air freight. In 2008 the system was shipped to Wilson's corporate headquarters in Albuquerque, and in 2009 shipped to the US Army Corps of Engineers District office in Albuquerque.

GeoWall technology has been used as a teaching tool in other settings. Physical geographers and geologists have used it as an alternative to field trips (Kelly and Riggs, 2006). Our experience also suggests it has great gee-whiz value, particularly when used with a gaming controller instead of a conventional mouse: students and potential students simply enjoy flying through 3D terrain. Whether this enthusiasm translates to enrollment in geography and geology classes, we cannot judge. A similar level of enthusiasm was found among museum visitors experiencing 3D visualizations, though, again, we must remain aware that enthusiasm does not always translate into increased understanding. (Mir 2002) Terry Slocum and his colleagues (2007) found potential for the GeoWall in geography instruction and considerable enthusiasm among cultural as well as physical geographers. Their study is noteworthy both for its scrupulous application of focus-group methodology and for applying 3D technology to viewing demographic data as well as physical features. They highlighted a noteworthy peril as well: the temptation to use exaggerated elevation displays for visual appeal can lead to misunderstanding of the true nature of landforms.

USING GEOWALL TO INCORPORATE PHOTO INTERPRETATION INTO THE GIS CURRICULUM

Our efforts to incorporate GeoWall into the GIS curriculum have been built on a two-step instructional process. First, we teach principles of photo interpretation. This module exposes the student to basic techniques for analyzing an aerial photograph based on the familiar criteria of shape, size, shadows, color, texture, pattern, and association. The class is then given a series of images and asked to interpret the scene. The exercises call for application of measurement skills, interpretation of landcover, drawing inferences about land use, recent events, and cultures of the

inhabitants. Students then complete an independent lab assignment in which they georeference an air photo, classify features of the natural and built environments, and, using vector tools, map the area.

This teaching model has been reasonably successful, though it has shown several limitations. Students are generally successful at identifying, classifying, and digitizing common environmental features such as industrial facilities, transportation corridors, farms, and residential areas. They struggle when confronted by places that are culturally foreign. The odd arrangement of roads and buildings on military bases, for example, often stump the students. Similarly, they struggle with topography and land cover that are remote from their experience. A student who can effortlessly tell the difference between a corn and a soybean field, for example, may not recognize a blueberry field as an agricultural site at all, much less identify the crop. Students who can successfully interpret the shapes and landcover adjoining braided streams of the West or Midwest will often fail to recognize an agricultural canal or correctly identify the direction of flow.

At Wilson and Company, The GeoWall is used extensively as a teaching and training tool for new and existing employees. Small groups of new employees are taught the geospatial extraction basics to efficiently deliver a consistent message for a variety of land cover, terrain types, and collection specifications and attributions. Current employees utilize the GeoWall for pre-project planning and reconnaissance, as well as group quality control reviews of compiled datasets to maintain standards and uniformity throughout the project area. Using the GeoWall in this manner allows an instructor to bypass the traditional and inefficient one-to-one basic instruction at a single workstation, and eliminates the all-too-familiar scene of a large group of people huddled uncomfortably around one stereo monitor for long periods of time. The time saved can then be applied to useful one-on-one advanced technical training or review at the individual employee's learning style and level.

The majority of Wilson & Company's photo interpretation workforce is from the Midwestern United States. The majority of the company's photo interpretation projects are located in coastal areas (NOAA's shoreline mapping program) or outside the US (non CONUS work for our DOD customers). The workforce from the Midwest is challenged with correctly identifying manmade features in the ocean and coastal zones and indentifying land use, land cover and cultural details in imagery from other continents and regions of the world.

To attempt to improve our educational outcomes, in both our university our private industry work, we have recently incorporated GeoWall 3D viewing into our teaching tools. Our initial impression is that 3D technology may help trainee analysts recognize and interpret culturally foreign landscapes. While the number of students and trainees with whom we have worked is too small to support statistical testing, initial work suggests that the 3D environment helps students learn what to look for in a landscape, and that the 3D experience may improve their analytical skills even when they are using conventional 2D images.

Tall objects are, of course, particularly troubling to an analyst using 2D images. Novice analysts can fail to recognize that objects such as chimneys, cooling towers, or storage tanks have any vertical dimension at all, perhaps leading to a misunderstanding of an entire industrial site. This kind of classification challenge is easily overcome by some exposure to 3D images. A student who has seen that same storage tank in 3D is more likely to recognize its distinctive shape, shadows, or context when they encounter it, or something similar in 2D.

GeoWall and other 3D viewing technology seem to have potential for interpretation of shoreline images as well. Coastlines can be particularly vexing in 2D imagery. Visual cues concerning the coastal topography, such as shoreline cliffs or vertically-cut sand features, are generally lost in planimetric views. Digital elevation model data, including LiDAR if it is available, can supplement 2D imagery and help an analyst make sense of coastal conditions. But 3D imagery, combining the digital elevation model data into the image, is considerably more intuitive and leads to quicker understanding of coastal landforms and of areas of important interaction between humans and their environment, including identifying those parts of the overall coastal landscape that are at greatest risk of flooding from storm surges or sea level rise (McDermott and Kostelnick, 2007).

INSTRUCTIONAL OUTCOMES

Although our sample sizes are too small to support quantifiable conclusions, initial evaluations and comments from students suggest that 3D visualization improves performance on photo interpretation tasks. In one exercise, a small group of students was asked to identify the direction of flow of river with very low gradient. Some students were provided with a 1 meter NAIP image and a hypsometric tint of LiDAR elevation data for the study area; a second group was given the same image and a 3D representation of the same hypsometrically tinted LiDAR data. Students with access to the 3D image were marginally more successful at correctly identifying the direction of flow. Other students were given a mapping assignment in which they were asked to digitize and classify features from a 1 meter color orthophoto of an unfamiliar landscape in coastal Maine. They were asked to use view 3D view of the

image draped over a 10 meter DEM before completing the mapping assignment. Their comments on the 3D experience were generally favorable, and suggested that the 3D viewing environment helped them make sense of both landscape and cultural features that were foreign to their experience.

GEOWALL AS AN OUTREACH TOOL

In 2008 and again in 2009 NGA (National Geospatial Intelligence Agency, formerly NIMA & DMA) conducted photo interpretation test in their trade show booth at major Remote Sensing and GIS conferences as part of their employment recruiting campaigns.

Wilson & Company has also utilized the GeoWall at career fairs for both attracting interest and for baseline assessment of interested participants 3-D visualization strength.

FUTURE

Our experience indicates that GeoWall technology has potential to improve photo interpretation instruction in both academic and industry settings. At present, application of the technology is still constrained by cost and, more severely, by the size and cumbersome nature of the equipment. As paired projectors become more compact or are replaced by other viewing media, and as the combination of hardware and software becomes more routinely available, we expect to see increased opportunity to apply 3D technology in teaching situations.

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