VISUALIZATION OF PLANETARY DATA WITH ADVISER: APPLICATIONS TO THE MOON AND BEYOND.

A. C. Loomis[1], J. N. Huffman[1], J. W. Head[2], C. I. Fassett[2], J. L. Dickson[2], A. S. Forsberg[3], [1]Center for Computation and Visualization, Brown University, Providence, RI 02912 (Andrew_Loomis@brown.edu), [2]Department of Geological Sciences, Brown University, Providence, RI 02912, [3]Department of Computer Science, Brown University, Providence, RI 02912.

Introduction: Recent missions to the Moon, Mars, and Mercury have made apparent the necessity of using digital platforms for the analysis of the large and diverse geographical datasets that are being produced. Geographic Information System(GIS) software has already proven to be useful in this area. The convenient features that it provides such as data co-registration, on-the-fly reprojection, and rapid viewing have made this software a principal tool when working with geographic data. But both the ever increasing size and sampling rate of images and image catalogs as well as the increase in elevation and stereo-pair data complementing camera and multi-spectral data challenges even the most recent software, and it leads us to explore new techniques for real time visualization and the geological analysis and mapping of these datasets.

The ADVISER (Advanced Visualization in Solar System Exploration and Research) project is focused on investigating new advances in the areas of computer visualization, hardware, and software to determine how they contribute to the scientific analysis and geological mapping of planetary data [1,2,3]. In doing so, we are exploring the differences between levels of immersion, stereoscopic vs. monoscopic viewing, field of view size, physical display size, and their effects on the visualization experience as measured by real-world geoscience tasks. This investigation is of particular interest to us as we seek to incorporate and visualize the wealth and diversity of incoming Moon data into our system.

The ADVISER System: Our previous work with Mars data visualization led us to develop a set of tools that allow us to leverage the experience of geoscientists with field training and not restrict them to top down analysis for remote locations [2]. We are simultaneously developing these tools for use in four different environments. First, a “Cave” environment for the immersive exploration of 3D elevation and image data. Second, a high resolution tiled-wall wall display for the viewing of stereo imagery and planetary-scale mosaics. Third, a commercially available rear projection television, which we call a Practical Powerwall, for “in lab” stereo visualization. And fourth, the desktop environment, which allows researchers access to a similar toolset to those available in our other systems without dedicated display hardware.

The Cave. Our 3D exploration tool runs in a “Cave” [4], a fully immersive virtual reality environment consisting of four projection surfaces (three walls and the floor) in a 2.5m x 2.5m x 2.5m cube (Figure 1.). Users interact with the visualizations through easy to use handheld tracked input devices. Our ADVISER Cave implementation gives us ability to display large global datasets without downsampling and lets geoscientists interactively explore this data on a multitude of scales. We aim to replicate the experience of geologists in the field by giving them the ability to complete scientific and mapping tasks by means of a virtual field kit [2]. The ability to change the vertical exaggeration, lighting, image contrast, and add elevation contours further our ability for in depth exploration of the geographic data. More detailed and in depth looks at the ADVISER Cave environment are available [1,2].

Figure 1. Students using the Cave to explore the Martian surface.

High-Resolution Tiled Wall Display. In conjunction with our fully immersive Cave environment, we also have a high resolution tiled wall display equipped with active stereo. Using 9 projectors arranged in a 3 x 3 grid we are able to achieve an effective resolution of 2400 x 1800 pixels on a wall measuring 1.8m x 1.8m (Figure 2.). We have developed a complementary set of ADVISER tools to those that we have in the Cave for work in this environment [3]. Researches can explore full resolution HiRISE and CTX stereo image pairs at an interactive speeds. We provide tools to stretch, brighten, darken, and composite different image layers together in real time. While using the Tiled Wall does not provide the a fully immersive feel, the high resolution and brightness make it an invaluable tool and bridge the gap between our desktop systems and the Cave [3].

Figure 2. Geoscientists using the Tiled Wall to analyze full resolution HiRISE imagery.

Practical Powerwall. Both the Cave and Tiled wall are not well suited for "in lab" research because they are University resources that exist in their own separate building [3]. To give researches the ability to access and work with our tools from their own labs, we have put together a separate system that uses a 61" (~1.5m) rear projection television (Figure 3.). This system has HD resolution and stereo capabilities. We have adapted a similar ADVISER toolset to the one on the Tiled Wall for use with the Practical Powerwall [3]. This allows us to explore and display high resolution stereo image pairs in real time from the lab.

Desktop Environment. We also provide a version of our tools for use on the desktop. Although the core ADVISER toolset was initially developed to work in the Cave environment, our goal is to provide a consistent user experience and familiar tools for every level of data visualization that we provide.

Application to the Moon: In recent years, the amount of available data on the Moon has significantly increased. Kaguya, Chandrayaan-1, and the Lunar Reconnaissance Orbiter (LRO) have all obtained important new data. As part of the ADVISER project we are very interested using our existing toolset to analyze and explore all of this new data.

For our purposes, the Lunar Orbiter Laser Altimeter (LOLA) is particularly important. LOLA will provide high-precision elevation data by measuring five simultaneous LIDAR tracks across the lunar surface [5]. Spatial resolution at up to ~30 m/px are anticipated [5]. Using this topographic model, we can overlay images, such as the the 50-cm/px data provided by the Lunar Reconnaissance Orbiter Camera (LROC)[6] onto terrain. These high resolution images will be used in the selection of future landing sites for spacecraft on the Moon[6]. In addition, we will use the NASA Ames Stereo Pipeline[7] to generate very high resolution Digital Elevation Models (DEMs) from the stereo images taken by LROC. Our tools will then allow us composite these higher resolution DEMs with the planetary DEM provided by LOLA.

Integrating all this new data into the ADVISER framework is a sizable challenge. We have begun to look at different ways to standardize how we use and store data. We've added a tiling system similar to that seen in NASA World Wind to allow for the efficient display and interaction of high resolution global datasets [8]. We seek to avoid the distortions created at certain key locations by such tiling systems by storing data in multiple map projections as opposed to a single one. We've combined this system with a modified version of the ROAM [9] terrain rendering algorithm. This will provide us with a means to handle the dense LOLA elevation dataset in conjunction with the LROC image overlays at the high framerates needed in the Cave system.

Summary: We continue to make progress towards our goal of developing immersive visualization and analysis tools that increase science return from planetary science data. We will also continue to improve the ADVISER toolset guided by the needs of real-world geoscience research questions—especially those made possible by recently acquired Moon data.

References: [1] Head, J.W. et al. (2005) *Photogramm. Eng. Rem. Sens*., 71, 10. [2] Forsberg, A. et al. (2006) *IEEE Comp. Graphics & App.*, 26, 46-54. [3] Huffman, J. et al. (2009) LPSC, 40, 2086. [4] Cruz-Neira, C. et al. (1993) Proceedings of IEEE 1993 Symposium on Research Frontiers in Virtual Reality, 59-66. [5] Smith, D.E. et al., (2009), Space Sci. Rev., in press, doi: 10.1007/s11214-009-9512-y [6] Tschimmel, M. et al (2009), LPSC 40, 2475. [7] Broxton, M.J., and Edwards, L.J. (2008), LPSC 39, 2419. [8] World Wind Map Tile System (n.d.) Retrieved Dec. 9, 2009 from http://worldwindcentral.com/wiki/Tiling_System. [9] Duchaineau, M. et al. (1997), IEEE Proc. Vis., 81-88.

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Figure 3. Researchers using the Practical Powerwall to explore MOLA data in stereo.