THE STEREO VIEW OF THE SOLAR SYSTEM; Paul Schenk, Daniel Wilson, and Robert Morris, Lunar &Planetary Institute, Houston, TX 77062; Timothy J. Parker, Jet Univ. of Southern California, Los Angeles, CA 90089.

Stereo imaging can literally transform our perception of planetary bodies. It is of primary importance in distinguishing topography from albedo, namely in areas where high sun angle or complex albedo variations make topography ambiguous. This is especially true for Io, Triton, and Mars where volcanic and aeolian deposits have complex color and albedo patterns. Polar regions, where nonuniform frosts can confuse topographic information, are also good stereo candidates, as are fresh crater deposits. Determination of relief is also important in specific investigations. For example, in physical volcanology where regional slopes can control flow morphology, or thermal studies where topography across craters is a measure of lithospheric viscosity and heat flow.

Stereo can be used as an interpretive tool when viewing images taken under different illumination or filters. Our brain works best stereoscopically and by merging two images optically feature recognition and 'effective' resolution is improved. In areas with variable albedo photoclinometry (PC) will not work in monoscopic images. PC will not produce reliable topography over broad areas due to accumulated errors and unaccounted for albedo variations. As with Magellan, the only way to obtain reliable pixel-scale topography (digital elevation models) over large areas in the outer solar system for future planned missions will be by stereo. It should also be possible to map the global geoid figure using a properly acquired data set, as has been attempted for Io. To this end, we are in process of generating a stereo image catalog of the solar system, with particular emphasis on the outer solar system. Work has also begun in earnest on Viking stereo imagery of Mars, and Mariner 10 stereo of Mercury.

STEREO: Processing & Problems

The Voyager image library contains numerous untapped stereo targets on the icy satellites. However, because of planetary curvature, changes in viewing geometry and target-spacecraft distances it is not possible to optically fuse most Voyager stereo pairs in their original format. The production of useful stereo pairs requires a complex set of procedures. Once a set of images with suitable stereo parameters is selected, the images are calibrated for vidicon effects and spatially filtered to enhance detail. The images are then co-registered and projected to a common orthographic map format centered on the feature(s) of interest. To mosaic multiple frames without forming distracting image boundary 'scarps' it was necessary to update the camera pointing vectors for all the images with subpixel accuracy, which has proved time consuming. The images are assembled into left and right mosaics that are high-pass filtered to remove the global brightness variation and contrast stretched for optimal retention of dynamic range and viewing pleasure.

Voyager images were not targeted for stereo, however. To achieve suitable stereo separation it was sometimes necessary to use images with significantly differing spatial resolution, or filters, depending on image sequencing. Solar illumination angles changed during some imaging sequences, although this was mostly a problem for the small inner satellites of Saturn. The positions of some vidicon reseaus are not accurate or remappable with extreme precision, resulting in some ambiguity regarding very-long-wavelength topography. Image smear during the Voyager 1 Jupiter flyby reduced the potential stereo targets for Io, Ganymede, and Callisto. Finally, relief on the icy Galilean satellites rarely exceeds 2 km, and image resolution is relatively low, requiring greater angular separation between images to produce stereo.

STEREO COVERAGE AND RESULTS

In the outer solar system, the best stereo occurs on Miranda, Rhea, and Io. The best Io stereo pairs often required use of green filter wide-angle images. Differences in photometric properties and colors of geologic units should be remembered when interpreting these stereo pairs. Up to 20% of Io can be mapped with stereo at resolutions ranging from 500 m to 2 km. Additional coverage at lower resolution exists, and a search for undiscovered plumes will be possible. Several previously unknown prominent mountain structures have been identified. Relief on large volcanic constructs is variable. At Ra Patera, relief is unexpectedly low, implying very shallow slopes or late-stage topographic subsidence. On Rhea, most of the lit northern hemisphere is visible in stereo. The surface is extremely rough: no smooth terrains of any kind are apparent. Evidence for large ringed structures is ambiguous, but global scale linear structures are apparent. Particularly impressive are craters, which have steep rimwalls and prominent central peaks, consistent with earlier results based on photoclinometry. Image targeting permitted stereo coverage of ~8% of Ganymede's surface, with vertical exaggeration factors ranging from ~2 to 6. Examples of major features on Ganymede seen in stereo include craters, grooves, smooth terrain, palimpsests, and the large basin Gilgamesh. Despite low resolution and low relief, portions of the Valhalla ring structure on Callisto can be seen stereoscopically. 'Flows' emanating from ring scarps appear to be thicker than anticipated.

Geologic mapping based on these and other stereo products is in progress. Stereo results for Mars have a high scientific potential, if pointing problems can be overcome. Preliminary products will be presented.

STEREO ON FUTURE MISSIONS

Operational and planned missions offer many excellent stereo opportunities in the coming decades. In many cases, proper planning can produce selected stereo with a minimum number of additional images. In some cases, combination of new mission images with Voyager or other older data sets can produce 'cheap' but high quality stereo results. Here, image resolution appropriate viewing angle separation and particularly solar illumination must be considered so that scientifically useful stereo can result. Combination of stereo with color data can be of special importance, as shown by our Io results.