MAGELLAN RADAR DATA FOR VENUS TOPOGRAPHIC MAPPING; Sherman S.C. Wu and Elpis A. Howington-Kraus, U.S. Geological Survey, Flagstaff, AZ 86001

In order to make topographic maps of Venus from Magellan synthetic aperture radar (SAR) stereoimage pairs, we have created a digital radargrammetry workstation and software package called DSWV (Digital SAR Workstation-Venus). DSWV performs the functions of triangulation, digital elevation measurement using automatic correlation techniques, contour mapping, orthophoto rectification, and image mosaicking. Standard image-processing and enhancement techniques can also be applied to the data. We will demonstrate the capabilities of the DSWV package and show results both from our initial test of the software and from more extensive applications now in progress. The hardware used for the demonstration will consist of a SUN SPARCserver 670MP with a Vitec 50B video processor, a Tektronix stereo display, and a three-dimensional trackball used as a measuring device.

During its first three cycles of operation, the Magellan spacecraft obtained radar images of 98% of the surface of Venus. In cycles 1 and 3, about 25% of the surface was covered by usable stereopairs with both views illuminated from the same side. In cycles 1 and 2, about 45% of the surface was imaged in stereo but with opposite-side illumination (Ford et al., 1993). The basic image datasets (one from each orbit of Magellan) are highly elongated, roughly north-south strips called F-BIDRs. The DSWV uses these image strips, rather than the non-orthorectified mosaics that have been produced from them, to maximize stereoradargrammetric accuracy. Enabling the software to read the Magellan F-BIDR data was one of the main steps by which the DSWV was developed from the earlier DSW2 package that had been developed for the analysis of airborne SAR data such as that obtained by the STAR-1 system (Poehler et al., 1993). The other important step in the development of the DSWV was the creation of a mathematical model of the geometric properties of the Magellan observations of Venus, which differ from the properties of airborne SAR. This model allows the DSWV to determine the pixel coordinates (C1, C2) in sinusoidal projection of any point on Venus for which the body-fixed (X,Y,Z) coordinates in the VBF85 system are known; the model can be inverted to determine body-fixed coordinates of a feature from its pixel coordinates in a pair of images. The transformation from body-fixed to pixel coordinates occurs in three steps: (a) an approximate transformation (neglecting the nonzero elevation of the point) is used to locate the feature in the image accurately enough to determine in which burst of Magellan's pulsed operation the feature was imaged most strongly; (b) the position and velocity of the spacecraft at the time of that burst are used to compute the range and Doppler coordinates of the feature; and (c) the range-Doppler coordinates are converted to pixel coordinates by the same transformation that was used in the processing of the Magellan

images. A correction for refraction of the radar beam by the Venusian atmosphere is included in the calculation. The mathematical model also allows for errors in the spacecraft ephemeris for each orbit. The knowledge of spacecraft position (along-track, cross-track, and radial) for each orbit can therefore be improved as part of the triangulation process.

We initially tested the DSWV package with a set of four Magellan F-BIDRs: those from orbits 877 and 878 of cycle 1 and those from orbits 2674 and 2675 of cycle 3. A test area was selected where these images overlap (long 72° 56′ 20" to 73° 30′ 20", and lat -0° 5′ 0" to -2° 58′ 20"). We measured 39 triangulation points with an average residual in the C1 and C2 coordinates of 0.5 pixel and a maximum residual of 1 pixel after the triangulation adjustment. A total of 131 topographic profiles were measured by using both manual and automatic image correlation, and they were used to construct a digital elevation model (DTM). The DTM was then used to produce a topographic contour map of the test area and an orthorectified image mosaic.

We are currently using the DSWV to produce a DTM and derived products for a larger region located on the west flank of Maxwell Montes. The dataset for this application consists of images from orbits 512-536 of cycle 1 and orbits 4075-4106 of cycle 3. The cycle 3 images are special products (FS-BIDRs) with a viewing geometry optimized for stereo viewing of Maxwell. At the 25th LPSC, we will present the results of this analysis along with those of the initial test area, and we will demonstrate the DSWV package.

[1] Ford J.P. et al. (1993) Guide to Magellan image interpretation, JPL Publ. 93-14, 148 p.

[2] Poehler P. et al. (1993) Digital workstation for Venus topographic mapping, Proceedings of SPIE, State-of-the-Art Mapping, v. 1943, 45-56.