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Correction of Shading Effects of HRSC Images using Photometric Models on Pixel-scale Surface Orientation

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Since 2004 the *High Resolution Stereo Camera (HRSC)* is orbiting Mars on board the spacecraft *Mars Express* and delivers image and height data important for – amongst others – geomorphological interpretations of the fluvial, glacial and volcanic history of Mars. Because of the highly elliptical, non-sun-synchronous orbit of Mars Express (due to other instrument's observation requirements), single HRSC images often have different illumination conditions leading to non-coherent shading effects which prevent a seamless mosaicking of adjacent HRSC image strips. We want to present our approach for the systematic correction of these shading effects using simple and approved photometric models applied on the real surface orientaion derived by the associated HRSC-DTM.

The most important step towards an image correction for shading effects by use of photometric models is the derivation of the illumination conditions relating to the single pixel's surface orientation. We are developing software for the calculation of these angles by combining several existing data sources using the SPICE [1] library and the VICAR Run-Time Library [2]. These data sources consist of the HRSC level 2 image, its associated DTM derived by DLR's matching algorithms, the geometric camera calibration for HRSC (GEOCAL), the external orientation of the camera (EXTORI) and the NAIF SPICE kernel information. The data sources are combined to calculate exact incidence and emission angle values for every pixel in the image. These illumination angles are used as parameters for approved photometric functions for the calculation of photometrically corrected gray values, which are transformed to an orthogonal image (level 4) by use of the DTM and the geometric calibration files.

In our pragmatic approach we restrict the use of photometric models to simple functions with a reduced set of parameters either deduced from the images or estimated on a global basis. In a previous work [3], a GIS-based testing environment using Lambert, Lommel-Seeliger and Minnaert functions showed promising results. For the systematic correction, the illumination angles rotated by surface orientations are re-transformed to the level 2 image geometry and then applied to every gray value of the image by use of the photometric function. Selectively the shading-corrected intensities for every pixel as well as the reflectance or radiance values can be calculated. The result of this step is a level 2 HRSC image without influences of the relief. In a last step, the software transforms the level 2 image to a level 4 ortho-image by additional use of the associated DTM and the GEOCAL files. The photometrically and geometrically corrected HRSC ortho-image significantly advances the use of HRSC imagery for geomorphological interpretation.

References

[1] The NASA Planetary Science Division's Ancillary Information System: http://naif.jpl.nasa.gov/naif/

[2] Multimission Image Processing Laboratory's VICAR Run-Time Library: http://www-mipl.jpl.nasa.gov/RTL/

[3] Wulf, G. et al. (2009): Photometric Corrections of Planetary Color-Image Data using GIS tools, EPSC 2009, http://meetingorganizer.copernicus.org/EPSC2009/EPSC2009-765.pdf

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