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Photometric Lambert Correction for Global Mosaicking of HRSC Data

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The High Resolution Stereo Camera (HRSC) is a push-broom image sensor onboard Mars Express recording the Martian surface in 3D and color. Being in orbit since 2004, the camera has obtained over 3,600 panchromatic image sequences covering about 70% of the planet's surface at 10-20 m/pixel. The composition of an homogenous global mosaic is a major challenge due to the strong elliptical and highly irregular orbit of the spacecraft, which often results in large variations of illumination and atmospheric conditions between individual images. For the purpose of a global mosaic in the full Nadir resolution of 12.5 m per pixel we present a first-order systematic photometric correction for the individual image sequences based on a Lambertian reflection model.

During the radiometric calibration of the HRSC data, values for the reflectance scaling factor and the reflectance offset are added to the individual image labels. These parameters can be used for a linear transformation from the original DN values into spectral reflectance values. The spectral reflectance varies with the solar incidence angle, topography (changing the local incidence angle and therefore adding an exta geometry factor for each ground pixel), the bi-directional reflectance distribution function (BRDF) of the surface, and atmospheric effects. Mosaicking the spectral values together as images sometimes shows large brightness differences. One major contributor to the brightness differences between two images is the differing solar geometry due to the varying time of day when the individual images were obtained. This variation causes two images of the same or adjacent areas to have different image brightnesses. As a first-order correction for the varying illumination conditions and resulting brightness variations, the images are corrected for the solar incidence angle by assuming an ideal diffusely reflecting behaviour of the surface. This correction requires the calculation of the solar geometry for each image pixel by an image-to-ground function. For the calculations we are using the VICAR framework and the SPICE library. Under the Lambertian assumption, the reflectance diminishment resulting from an inclined Sun angle can be corrected by dividing the measured reflectance by the cosine of the illumination angle. After rectification of the corrected images, the individual images are mosaicked together. The overall visual impression shows a much better integration of the individual image sequences. The correction resolves the direct correlation between the reflectance and the incidence angles from the data. It does not account for topographic, atmospheric or BRDF influences to the measurements. Since the main purpose of the global HRSC image mosaic is the application for geomorphologic studies with a good visual impression of the albedo variations and the topography, the remaining distortions at the image seams can be equalized by non-reversible image matching techniques.