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A Shape-from-Shading Refiner for Spatial Data derived from Mars Express HRSC Imagery

EGON DORRER[1], HELMUT MAYER[1], ALEXEY OSTROVSKIY[1], JÖRG RENTER[1], SERGIY REZNIK[1], GERHARD NEUKUM[2] and THE HRSC CO-INVESTIGATOR TEAM

[1]*Munich Bundeswehr University, D-85577 Neubiberg, Germany*
[2]*Freie Universität Berlin, D-12249 Berlin, Germany*

The paper is an account of investigations into the use of a shape-from-shading (SFS) method for the improvement of spatial data obtained from photogrammetric processing of HRSC high resolution stereo imagery on ESA's Mars Express Mission. This work is part of one of the five HRSC co-investigator science team's working groups dedicated solely to the derivation of spatial data and generation of digital image maps of the Martian surface. The paper describes the over-all process denoted De-Re-Shading (DRS) for the purpose of modifying illumination induced shades in the image scenes. Major objective is both optimization, i.e., avoidance of relief reversal, and homogenization, i.e., avoidance of discontinuities, of relief shading in the computed ortho-image maps. Prerequisite is an elevation model (DEM) with utmost correspondence to the original radiometric image information and attainable only by SFS. As kernel of DRS, SFS depends on several geometrical and physical factors,
e.g., surface reflection and material, shadows, light source distribution, image resolution, initial DEM accuracy, map projection, etc., and constitutes a non-trivial problem. After a brief description of SFS from the methodical viewpoint, to be characterized by variational calculus, conjugate gradient method, direct discretization of functional, Lambert reflection, constant albedo, etc., both the advantages and disadvantages of DRS are discussed with the help of several processed scenes. The results (Figs. 1 to 3) clearly indicate the method's refinement capability for spatial data.

Keywords: digital elevation model; ortho-image; multi-line pushbroom camera; conjugate gradient method; Lambert reflection

Figure 1: Original irradiance of orthoimage based on initial DEM.

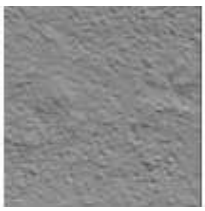

Figure 2: Reflected radiance of initial DEM

Figure 3: Reflected radiance of SFS-refined DEM