



Refined elevation models and reflectance for HRSC images

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Current elevation models produced using stereo processing of HRSC images have a much lower effective resolution than the nadir images. Refinement of these elevation models is possible by calculating reflectance properties across the surface and using the resulting reflectance model with a recently developed shape from shading algorithm. Multiple reflectance parameters are found at each point on the surface, allowing for the use of the Minnaert model, or Lambert model with a varying offset term to compensate for atmospheric effects. As this would make the reflectance configuration under-constrained for arbitrary reflectance variation, a requirement of neighbouring point consistency is used to provide sufficient constraint on the problem, while still allowing piecewise constant reflectance variation to be represented. The effectiveness of this approach has been quantitatively shown for synthetic surfaces. However, application to HRSC stereo elevation models is more difficult due to the surface orientations being very inaccurate at the full resolution. Accordingly, the elevation model is used at a greatly reduced resolution, and a filter is used to smooth erroneous points where the assumption of neighbouring point consistency cannot be satisfied. The calculated reflectance map is then used to refine the original elevation model using shape from shading (also known as photogrammetry) and the reflectance parameters are recalculated for the refined surface. The resulting high resolution elevation model appears to be significantly more detailed than the original, and does not exhibit obvious errors when viewed under differing illumination directions.