The HRSC DTM test

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Abstract

Photogrammetric data processing of HRSC (High Resolution Stereo Camera) images has reached a very high level over the last 2 years. The systematic processing chain at DLR runs well and stable. Several members of the HRSC CoI team are able to produce DTMs using different approaches, or handle alternative modules for parts of the DTM generation process. Partly, these approaches are currently limited to small areas
The performance of image matching algorithms is well researched and has been documented in the literature. In general, it is agreed that in “simple” terrain (enough grey value variation, not too rough terrain) and with adequate image acquisition geometry (similar flying height, similar direction of optical axes, known relative image rotation if any), very good results can be achieved by totally automatic approaches: the matching completeness in these areas reaches 100 %, at a density of various pixels per DTM grid mesh, and the geometric accuracy is well below one pixel. Things start to be much more complicated if more realistic situations are faced, such as steep terrain, height discontinuities, occlusions, poor texture, atmospheric haze, increased image noise, compression artefacts etc.

It is against this background that the desire was expressed within the CoI team to compare the individual approaches. The Photogrammetry and Cartography Working Group with the HRSC CoI team has taken up this challenge and is organising an HRSC DTM test under the auspices of ISPRS Working Group IV/7 *Extraterrestrial Mapping.* IPI, University of Hannover, and DLR Berlin-Adlershof act as pilot centres for the test, and will analyse the produced data in concert with the IPSRS WG IV/ 7 chair. Based on commonly agreed test data set incl. image orientations refined by bundle adjustment, every group will derive a DTM of this area. Some groups will further refine the DTM using blunder elimination techniques or shape-from-shading. The resulting DTMs are subsequently assessed quantitatively and qualitatively.

Key aspects of the analysis are the reconstruction of fine details, the obtained completeness and the geometric accuracy of the DTM. All quality parameters will be related to image resolution and image texture, and to the computing effort of the used method, and thus its

applicability of the evaluated processes to local sites, complete orbits, and global DTM compilations (the entire HRSC data set).

The evaluation will be three-fold. For deriving qualitative results about the preservation of fine details in the DTM and about possible noise and gross errors, shaded relief images with different illumination direction will be generated from the derived DTM. The shaded relief images will then be visually compared to the HRSC images of the nadir channel and may be overlaid with the matching density maps and derived height contour lines. In the second part, a quantitative analysis based on reference data will be carried out. As independent reference the MOLA DTM as the most consistent and complete Mars topography data available, and in particular MOLA tracks, will be used. Additional reference data may come from MOC NA stereo image processing.

Two datasets have been chosen as the highest priority for initial comparison. These are a single image from orbit 1235, and a block of three adjacent images from 0894, 0905, 0927. In addition to the aspired processing of complete orbit images, sub-sets have been defined for contributions of limited areas. The sub-set test area of interest in orbit 1235 covers western Candor Chasma at approximately -8° to -4°N and 282° to 284°E with a nadir resolution of 27 m/pixel, and includes the spectrally distinctive Ceti Mensa. The second sub-set test area covers Nanedi Vallis at approximately 2,5° to 7,5°N and 310° to 314°E with 12 to 15 m/pixel. In addition to being scientifically interesting this area provides a test of capabilities for producing seamless DTMs from blocks of images.

This paper will report about the HRSC DTM test, in particular about the used test images, the specifications for DTMs to be generated, the procedures for the evaluation of the derived DTMs, and about the obtained results.