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3D processing of HiRISE stereo pair using a non-rigorous sensor model and epi-polarity

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The accuracy and spatial resolutions of modern planetary mapping missions are being rapidly improved by more sophisticated sensors and tracking systems. Especially for Mars, orbital cameras such as MOC, THEMIS and HRSC are providing optical imagery up-to 10-20 metres or even a few metres' resolutions. Moreover the capability of stereo imaging of HRSC and MOC-NA make it feasible to extract a relatively high resolution DEM (Digital Elevation Model) for geological and geo-morphological research.

However, even with HRSC which has 12.5 m spatial resolution, the quality of reconstructed 3D Martian surfaces is still not suitable for several purposes such as landing site survey, local roughness extraction and small structure observations. The successful deployment of the NASA MRO with the 30cm HiRISE has dramatically upgraded the resolution limit of Martian surface observation for the targets, many of which have never been observed by other optical sensors before. The difficulty in fully exploiting the potential of HiRISE is that the tracking information which is indispensable for sensor modeling and stereo 3D data extraction, is not yet available at a sufficiently high accuracy. Therefore photogrammetrically well controlled stereo or monocular mapping by HiRISE has only been performed by a few teams who can fully access and update all sensor and navigation data [1,2] (Heyd et al., 2007 LPSC, Kirk et al., 2007 ISPRS WG IV/7 Workshop). We have developed a simple generic mapping method for HIRISE stereo imagery and applied this to a stereo pair in the Eberswalde Delta which is publicly available. Without any detailed tracking information and sensor specification, it produce what appears to be a very reasonable quality set of mapping products including a 2.5m resolution stereo DTM and a 30cm ortho-

image which is controlled up to 30-40m horizontal accuracy when compared with a bundle-adjusted HRSC image. The theory of this method is based on a non-rigorous sensor model employing HRSC intersection points as the control information [3] (Kim et al., 2007) which also exploits epi-polarity. For more reliable horizontal and vertical control, the quality of the HRSC intersection point was optimized by employing a sophisticated image matching and bundle adjusted orientation information for HRSC which was kindly provided by U of Hannover. By creating epi-polar rectified images of HiRISE and then applying a non-rigorous sensor model, the degrees of freedom of the geospatial coordinates were reduced and the relative coordinate was easily converted into a Mars mapping coordinate system. In addition, using image matching with epi-polar rectified image pair provided more reliable disparity values. The constructed DTM is well correlated with the geo-morphological features, which is observed in the optical image. However, a current unknown with this method is that it is still not clear whether stereo intersections of HRSC image can provided sufficient vertical accuracy to project relative disparity into ellipsoidal heights. We suggest that we could use this method as a temporary mapping aid to an eventual rigorous mapping of HiRISE. Over the areas which have been acquired using HiRISE stereo scenes, this method is being tested and evaluations perform to compare against HSRC products.

[1] Heyd E. M., et al.(2007) LPSC. [2] Kirk R.L., et al. (2007) ISPRS WG IV/7 Workshop. [3] Kim J-R., et al., (2007) LPSC.