AUTOMATED PLANET-WIDE DTM GENERATION FROM NASA MRO DATA – A STATUS REPORT.

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Introduction: Within the EU-FP7 iMars project (http://i-mars.eu), a fully automated multi-resolution DTM processing chain has been developed, called Co-registration ASP-Gotcha Optimised (CASP-GO), based on the open source NASA Ames Stereo Pipeline (ASP) [1], Mutual Shape Adapted Scale Invariant Feature Transform (MSA-SIFT) based multi-resolution image co-registration [2], and Gotcha [3] sub-pixel refinement method. The implemented system guarantees global geo-referencing compliance with respect to High Resolution Stereo Colour imaging (HRSC), and hence to the Mars Orbiter Laser Altimeter (MOLA), providing refined stereo matching completeness and accuracy based on the open source ASP platform.

Method: Apart from the ASP pre-processing, cross-correlation matching, triangulation, and DTM/ORI generation, five additional workflows are introduced to further improve the ASP results. These include (a) a fast Maximum likelihood sub-pixel refinement method to build a float initial disparity map; (b) an outlier rejection and erosion scheme to define and eliminate mis-matches; (c) an ALSC and region growing (Gotcha) based refinement and densification method to refine the disparity value and match unmatched and mis-matched area; (d) co-kriging grid-point interpolation to generate DTM as well as height uncertainties for each DTM point; (e) ORI co-registration w.r.t. HRSC.

Results: The CASP-GO processing chain has been tested/applied to stereo Mars Reconnaissance Orbiter (MRO) Context Camera (CTX) imagery (6m) of planet-wide DTMs (1540 stereo pairs) and is now being applied to MRO High Resolution Image Science Experiment (HiRISE) 25cm NASA images (~400 stereo pairs that have 5 or more repeat views) using a large Linux cluster at MSSL and cloud computing resources from the Microsoft® Azure® Cloud.

In this paper, we discuss issues discovered from experimenting with the use of the open-source ASP DTM processing chain and introduce our new working solutions. These issues include global co-registration accuracy, de-noising, dealing with failure in matching, matching confidence estimation, outlier definition and rejection scheme, various DTM artefacts, uncertainty estimation, and quality-efficiency trade-offs. Examples of DTM processing results from CTX over the MC-11E+W map quadrant area are shown in (Figure 1).

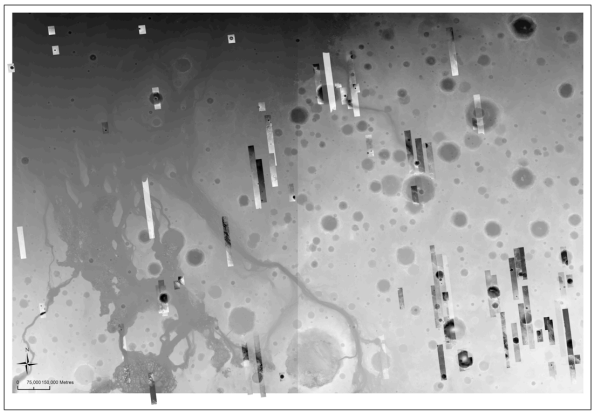

Figure 1 Example of processed DTM products from USGS MC11-E and MC11-W area overlaid on HRSC mosaic.

The CASP-GO output includes ORI, DTM, Gotcha mask, co-kriging mask, uncertainty map and hill-shaded colourised browser products, which can be directly ingested into the iMars web-GIS server.

All of the products will be made available through web-GIS, using PDS4 to the planetary science community by the end of the project (3/2017). Generation of Odered Point Cloud (OPC) for 3D real-time visualisation on GPU at MSSL using Pro3D®, specifically for HiRISE products, will be done in collaboration with Joanneum Research and VRVis, from previous work within the PRoViDE project. The CASP-GO software can also be applied in future to the ExoMars Trace Gas Orbiter 2016 CaSSiS instrument colour stereo views. We plan to further extend the capability and make the CASP-GO open source.

References: [1] Moratto, Z. M., M. J. Broxton, R. A. Beyer, M. Lundy, and K. Husmann, 2010. Ames Stereo Pipeline, NASA's Open Source Automated Stereogrammetry Software. Lunar and Planetary Science Conference 41, abstract #2364. [2] Y. Tao, J.-P. Muller, W. Poole (2016) Automated localisation of Mars rovers using co-registered HiRISE-CTX-HRSC orthorectified images and wide baseline Navcam orthorectified mosaics, ICARUS, Vol 280, p139-157, [3] Shin, D. and J.-P. Muller, Progressively weighted affine adaptive correlation matching for quasi-dense 3D reconstruction. Pattern Recognition, 2012. 45(10): p. 3795 -3809.

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