CASP-GO auto-DTM: A new paradigm for Martian 3D mapping

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Introduction: Understanding the role of different planetary surface formation processes within our Solar System is one of the fundamental goals of planetary science research. Critical to this is measuring the 3D surface shape. There has been a revolution in planetary surface observations from orbiting spacecraft over the last 13 years, especially for 3D imaging of surface shape. The goal of this work is to maximize the exploitation of stereo observations of the surface to generate high quality co-registered digital terrain models (DTMs) using data from different spacecraft instruments. These DTMs can then provide improved capability for geological and geomorphological studies of the Martian surface as well as being critical to selecting the best landing site areas for future robotic and human exploration.

CASP-GO: Within the EU-FP7 iMars project, a fully automated multi-resolution DTM processing chain has been developed, called the 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 (HRSC), images and DTMs and thence to the Mars Orbiter Laser Altimeter (MOLA [4].

The CASP-GO processing chain has been used to generate ~4,000 CTX stereo products covering ~20% of the Martian surface at 18m/pixel compared to the HRSC coverage of around 50% with grid-spacing from 50-150m [5]. Examples of different types of surface geology will be shown from these CTX DTMs and ORIs.

The quality assessed multi-resolution co-registered 3D models are available to the international community of planetary geo-scientists through an interactive webGIS system (http://imars.mssl.ucl.ac.uk) developed by S. Walter at the Free University Berlin, and now hosted at UCL-MSSL.

The CASP-GO pipeline is planned to be made available as open-source through the NASA Ames GitHub. The processed ORIs and DTMs will also eventually be publicly available through the JPL-PDS Imaging node via a MSSL-JPL APPS-PDS4 collaboration.

In the future, the processed multi-resolution co-registered DTM products can be employed to assist future ESA rover missions and the CASP-GO software is planned to be modified to operate with the ESA ExoMars Trace Gas Orbiter 2016 CaSSiS instrument to provide high-quality co-registered colour stereo. We are hoping to provide backline support on the CASP-GO pipeline in collaboration with NASA Ames and the ExoMars CaSSiS team. The ≈4,000 CTX DTMs contain a wealth of new scientific information which when coupled with the ≈50% coverage of HRSC DTM products opens up huge areas on Mars for detailed scientific exploitation.

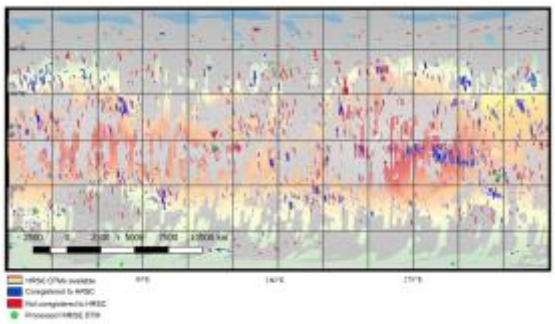

Figure 1: Location of the processed CASP-GO CTX and HiRISE DTMs within the iMars project showing on top of HRSC level 4 and MOLA DTM.

References:
[1] Shean, D. E. and et al., **ISPRS** 116, 2016. [2] Tao, Y. and Muller, J.-P., **Icarus**, 280, 139-157, 2016. [3] Shin, D., and Muller, J.-P., **PR**, 45, 3795-3809, 2012. [4] Tao, Y. and Muller, J.-P., **ISPRS**, 3, 115-121, 2016. [5] Gwinner, K. and et al., **PSS** 126, 93-138, 2016.

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