EPSC Abstracts
Vol. 10, EPSC2015-673, 2015
European Planetary Science Congress 2015

EU-FP7-iMARS: analysis of Mars multi-resolution images using auto-coregistration, data mining and crowd source techniques: A Mid-term Report

Jan-Peter Muller [1], Vladimir Yershov[1], Panagiotis Sidiripoulos[1], Klaus Gwinner[2], Konrad Willner[2], Lida Fanara[2], Marita Waelisch[2], Stephan van Gasselt[3], Sebastian Walter[3], Anton Ivanov[4], Federico Cantini[4], Jeremy Morley[5], James Sprinks[5], Michele Giordano[5], J. Wardlaw[5], Jungrack Kim[6], W-T Chen[6], Robert Houghton[7], Steven Bamford[8]

[1]Imaging Group, Mullard Space Science Laboratory, University College London, Holmbury St Mary, Surrey, RH56NT, UK
[2]DLR, Deutsches Zentrum für Luft - und Raumfahrt EV, Rutherfordstrasse, 2 Berlin - 12489 Germany
[3]Freie Universität Berlin, Malteserstrasse, 74-100 Berlin – 12249, Germany
[4]École Polytechnique Federale de Lausanne, ELD 014, Station 11 Lausanne – 1015, Switzerland
[5]The University of Nottingham, The Nottingham Geospatial Building, Triumph Road Nottingham, NG7 2TU UK
[6]University of Seoul, Jeonnong Dong 90 Dongdaemun Gu Seoul - 130 743, Republic of Korea
[7]Human Factors Research Group, Faculty of Engineering, University of Nottingham, Nottingham NG7 2RD UK
[8]School of Physics and Astronomy University of Nottingham, University Park Nottingham, NG7 2RD UK

[1] Corresponding Author j.muller@ucl.ac.uk

Abstract

Understanding the role of different solid surface formation processes within our Solar System is one of the fundamental goals of planetary science research. There has been a revolution in planetary surface observations over the last 8 years, especially in 3D imaging of surface shape (down to resolutions of 10s of cms) and subsequent terrain correction of imagery from orbiting spacecraft. This has led to the potential to be able to overlay different epochs back to the mid-1970s. Within iMars, a processing system has been developed to generate 3D Digital Terrain Models (DTMs) and corresponding OrthoRectified Images (ORIs) fully automatically from NASA MRO HiRISE and CTX stereo-pairs which are co-registered to corresponding HRSC ORI/DTMs. In parallel, iMars has developed a fully automated processing chain for co-registering level-1 (EDR) images from all previous NASA orbital missions to these HRSC ORIs and in the case of HiRISE these are further co-registered to previously co-registered CTX-to-HRSC ORIs. Examples will be shown of these multi-resolution ORIs and the application of different data mining algorithms to change detection using these co-registered images. iMars has recently launched a citizen science experiment to evaluate best practices for future citizen scientist validation of such data mining processed results. An example of the iMars website will be shown along with an embedded Version 0 prototype of a webGIS based on OGC standards.

1. Introduction

Since January 2004, the ESA Mars Express has been acquiring global data, especially HRSC stereo (12.5-25m nadir images) with 87% coverage with images ≤25m and more than 65% useful for stereo mapping (e.g. atmosphere sufficiently clear). The derived HRSC orthorectified images (ORIs) and corresponding Digital Terrain Models (DTMs) are co-registered to the global MOLA heights and have planimetric accuracy at the subgrid point level (≈9-25m RMS). This means that non-HRSC can be co-registered to HRSC ORIs to create a time layer stack of all available images of high resolution (≤100m and ≤20m). DTM/ORIs can also be retrieved for the ≈4,000 stereo-pairs from the NASA CTX and HiRISE instruments (≈1% of total). iMars has built a processing platform which can automatically co-register level-1 (EDR) data from non-HRSC images to the corresponding ORIs/DTMs and examples of this processing chain will be demonstrated in the meeting. In the second half of the iMars project these processing systems will be exercised "in anger" on all available images above a certain quality threshold to generate a time layer stack for every available image. These co-registered and orthorectified images are being used together with several different data mining approaches to try to locate and identify changes due to previously observed surface change features such as dark streaks, gullies, new impact craters, dune movement, polar pits, RSLs (Recurring Slope Linae) and avalanches. A quantitative assessment through a workshop at EGU 2014 and a corresponding online questionnaire was made of the scientific interests of European planetary scientists. This survey determined that change detection research was under-developed in Europe. In 2016, it is planned to involve geoscientists in further quantitative studies of automatically determined change features. In parallel to expert user assessments of the automatically determined change detection features, a series of citizen science assessments will be made of these auto-changed features.

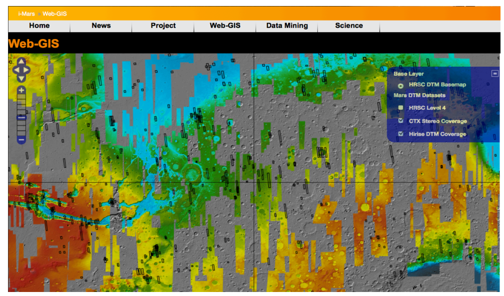

Figure 1. Example of iMars webGIS displaying all HRSC processed DTMs.

The results of the project, including DTMs (see Figure 1) will be disseminated through an OGC-compliant webGIS system based on the PRoGIS described in Giordano et al. (2015). This interface will also be employed within the citizen science assessment.

2. Methods

A number of automated stereo processing chains were assessed in a round-robin exercise within iMars. The two best, NASA Ames stereo pipeline and the

University of Seoul (UoS) were employed in a comparative quantitative assessment. The UoS system was ported by UCL staff [Yershov et al., this conference] onto a linux cluster and in parallel, UoS staff prepared the software for implementing on a parallel system in Korea.

A fully automated co-registration system described elsewhere in this conference (Sidiropoulos & Muller) has been developed to generate level-1b CTX-to-HRSC-ORI, HiRISE-to-CTX and HiRISE-to-HRSC_ORI pairs. The same system can also be applied to older (and future) image pairs form older NASA missions (e.g. MOC-to-HRSC, etc..). An example of the feature selection and auto-coregistration is shown in Figure 3 below.

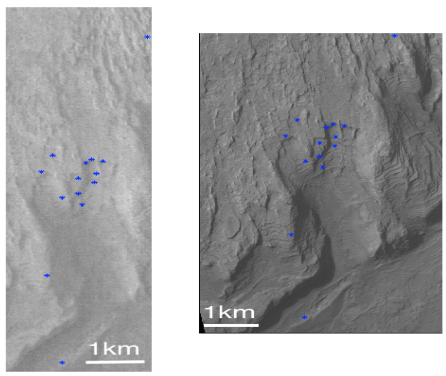

Figure 2. Automated feature points detected from HRSC ORI (left) and CTX level-1.

3. Results

An example of a multi-resolution DTM is shown in Figure 2 from UoS.

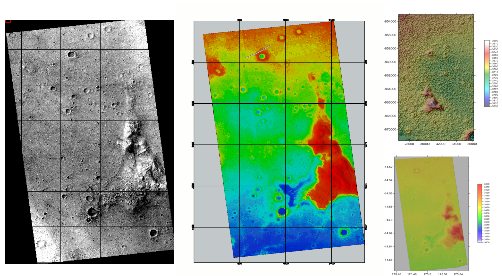

Figure 3. HiRISE ORI and DTM (leftmost panels), CTX-DTM (upper right) and HRSC-DTM of the MER-A Spirit rover site generated using the UoS processing chain.

In the next phase of the project, the DTM and auto-coregistration system will be deployed to process the ≈750k images that have been acquired to date form orbit of Mars. In addition, the automated data mining will be applied to co-registered sets of ORIs and DTMs and all of the results into the database of the webGIS. These data mining results will be assessed within a citizen science project under the aegis of the Zooniverse project. A sample screen for an initial experiment conducted by the University of Nottingham is shown in Figure 4.

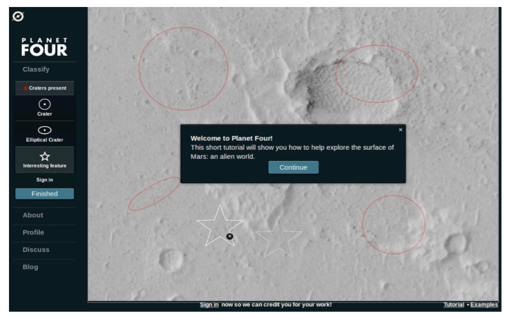

Figure 4. Example screen of a Zooniverse experiment for citizen science for Mars crater detection.

6. Summary and Conclusions

The iMars project is well into the development of the basic processing chains, which will be used in production in the next half of the project to generate a time series of almost 40 years of Mars' observations from orbit. A report will be given on how expert users are being consulted on its evaluation.

Acknowledgements

The research leading to these results has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) under iMars grant agreement n° 607379. Partial support is also provided from the STFC "MSSL Consolidated Grant" ST/K000977/1.