EU-FP7-IMARS: ANALYSIS OF MARS MULTI-RESOLUTION IMAGES USING AUTO-COREGISTRATION, DATA MINING AND CROWD SOURCE TECHNIQUES: AN OVERVIEW OF RECENT PROGRESS

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ABSTRACT:

Understanding the role of different planetary 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 7 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 ability to be able to overlay different epochs back to the mid-1970s, examine time-varying changes, such as the recent discovery of boulder movement [Orloff et al., 2011] or the sublimation of sub-surface ice revealed by meteoritic impact [Byrne et al., 2009] and the motion of dust mixed with permafrost as observed by McEwen et al. [2011] as well as examine geophysical phenomena, such as surface roughness on different length scales. Consequently we are seeing a dramatic improvement in our understanding of surface formation processes which is changing our perception of Mars as no longer a "dead planet".

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). It has been demonstrated [Gwinner et al., 2010; Heipke et al.,2007] that HRSC has the highest possible planimetric accuracy of ≤25m and is well co-registered with MOLA, which represents the global 3D reference frame. HRSC 3D and terrain-corrected image products therefore represent the best available 3D reference data for Mars.

NASA began imaging the surface of Mars, initially from flybys in the 1960s with the first orbiter with images ≤100m in the late 1970s from Viking Orbiter. The most recent orbiter to begin imaging in November 2006 is the NASA Mars Reconnaissance orbiter (MRO) which has acquired surface imagery of around 1% of the Martian surface from HiRISE (at ≈20cm) and ≈5% from CTX (≈6m) in stereo. Unfortunately, for most of these NASA images, especially VO, MGS, MO and HiRISE their accuracy of georeferencing is often worse than the quality of Mars reference data from HRSC. This reduces their value for analysing changes in time series. Kim & Muller (2009) and Lin et al. (2010) showed how HRSC 3D products could be employed to automatically co-register HiRISE and CTX.

Within the iMars project (http://i-Mars.eu), a fully automated large-scale processing ("Big Data") solution is being developed to generate the best possible multi-resolution DTM of Mars co-registered to HRSC (50-100m grid) products generated at DLR and at UCL from CTX (6-20m grid, loc.cit.) and HiRISE (1-3m grids) on a GPU farm at UCL and a large-scale linux cluster based at UCL-MSSL with 224 cores and 0.25 Pb of storage. The HRSC products provided by DLR are employed to provide a geographic reference for all current, future and historical NASA products using automated co-registration based on feature points. The results of this automated co-registration will here be shown including their assessment with time series of HiRISE images over the same site. The metadata already available for all orbital imagery acquired to date, with poor georeferencing information, has been employed to determine the "sweet spots" which have long time series of measurements with different spatial resolution ranges over the last ≈50 years of observations and these are shown in a companion paper [Sidiripoulos & Muller, this conference].

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Two of the constituent consortium partners have developed their own HiRISE and CTX DTM processing systems and the results are being compared against third party products from the NASA Ames pipeline [Shean et al., 2001] and the USGS SOCET® + ISIS processing systems [Kirk et al., 2008]. In 2015, as much as possible of the CTX and HiRISE stereo coverage will be processed into DTMs and subsequently the entire NASA and ESA record of orbital images at resolutions ≤100m will be co-registered. The updated georeferencing information employed to generate a time series of terrain relief corrected orthorectified images (ORIs) back to 1977. Web-GIS using OGC protocols will be employed to allow visual exploration of changes of the surface. Data mining processing chains are being developed to search for changes in the Martian surface from 1971-2015 and the output of this data mining will be compared against the results from citizen scientists' measurements in a specialised Zooniverse implementation. Finally, co-registered data sets will be distributed through both European and US channels in a manner to be decided towards the end of the project. The resultant co-registered image datasets will represent the best possible capture of changes and evolutions in the Martian surface.

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