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Investigation of small scale roughness properties of Martian terrains using Mars Reconnaissance Orbiter data.

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Studies of layered terrains in polar regions as well as inside craters and other areas on Mars often require knowledge of local topography at much finer resolution than global MOLA topography allows. For example, in the polar layered deposits spatial relationships are important to understand unconformities that are observed on the edges of the layered terrains [15,3]. Their formation process is not understood at this point, yet fine scale topography, joint with ground penetrating radar like SHARAD and MARSIS may shed light on their 3D structure. Landing site analysis also requires knowledge of local slopes and roughness at scales from 1 to 10 m [1,2]. Mars Orbiter Camera [13] has taken stereo images at these scales, however interpretation was difficult due to unstable behavior of the Mars Global Surveyor spacecraft during image take (wobbling effect). Mars Reconnaissance Orbiter (MRO) is much better stabilized, since it is required for optimal operation of its high resolution camera.

In this work we have utilized data from MRO sensors (CTX camera [11] and HIRISE camera [12] in order to derive digital elevation models (DEM) from images targeted as stereo pairs. We employed methods and approaches utilized for the Mars Orbiter Camera (MOC) stereo data [4,5]. CTX data varies in resolution and stereo pairs analyzed in this work can be derived at approximately 10m scale. HIRISE images allow DEM post spacing at around 1 meter. The latter are very big images and our computer infrastructure was only able to process either reduced resolution images, covering larger surface or working with smaller patches at the original resolution.

We employed stereo matching technique described in [5,9], in conjunction with radiometric and geometric image processing in ISIS3 [16]. This technique is capable of deriving tiepoint co-registration at subpixel precision and has proven itself when used for Pathfinder and MER operations [8]. Considerable part of this work was to accommodate CTX and HIRISE image processing in the existing data processing pipeline and improve it at the same time. Currently the workflow is not finished: DEM units are relative and are not in elevation.
We have been able to derive successful DEMs from CTX data Becquerel [14] and Crommelin craters as well as for some areas in the North Polar Layered Terrain. Due to its tremendous resolution HIRISE data showing great surface detail, hence allowing better correlation than other sensors considered in this work. In all cases DEM were showing considerable potential for exploration of terrain characteristics. Next steps include cross validation results with DEM produced by other teams and sensors (HRSC [6], HIRISE [7]) and providing elevation in terms of absolute height over a MOLA areoid.

MRO imaging data allows us an unprecedented look at Martian terrain. This work provides a step forward derivation of DEM from HIRISE and CTX datasets and currently undergoing validation vs. other existing datasets. We will present our latest results for layering structures in both North and South Polar Layered deposits as well as layered structures inside Becquerel and Crommelin craters. Digital Elevation models derived from the CTX sensor can also be utilized effectively as a input for clutter reduction models, which are in turn used for the ground penetrating SHARAD instrument [13].

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