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Reconstruction of Titan topography using generic stereo processor and its potential application for the investigation of surface process

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altimetry and stereo analyses have been widely used for this purpose and achieved high quality 3D topographic data over various planetary surfaces such as Venus, Mercury, Moon and Mars. However, in contrast with inner plane and satellite, the base data sets to compose digital topography over outer planets and satellites are very limited. Titan, the largest satellite of Saturn has also too limited data inventory to achieve sufficient spatial resolution in topographic data, in spite of increasing interests about the detailed topography owing to the recent interesting discoveries on methane fluvial system, aeolian geomorphologies and possible tectonic activity. Therefore the endeavours to increase the coverage of digital topography employing radargrammetry (Kirk et al. 2009), radar altimetry (Elachi, et al. 2005) and SARtopo (Stiles et al. 2009) have been actively conducted. Although these efforts result in the construction of a global topographic map, the consequent spatial resolutions of global topography is still poor and cover the resolution ranges from 520m to 1700m (Lorentz et al. 2013).
In this study, we tried to improve the coverage and the quality of Titan digital terrain model employing approaches as follows; 1) A semi-automated stereo matching scheme manipulating low signal-to-noise SAR image pair incorporating adaptive filtering and base topography, 2) the geodetic control improvement of stereo SAR pair based on generic sensor model and tie points, 3) the introduction of radarclinometry to refine the topography from stereo analyses. The developed scheme was applied for a few testing areas especially over the fluvial channels and the lakes which are only the acting hydrological system in solar system except terrestrial one and well covered by SAR images. Considering geodetic controllability over the SAR images is better than 3-4 pixel when the images were projected onto zero height plane, it was evaluated that the stereo processed using the generic sensor model produced stable DTM and ortho image. The estimated max resolution of radargrammetric DTM by the proposed system is 0.7 km. The constructed topography revealed many interesting geomorphic features such as drainage networks, rugged terrains and impact craters in detail. Since geodetic accuracies of DTMs are consequently guaranteed compared with the known height ranges, it will be possible to apply the constructed DTMs for the interpretation and modelling of Titan surface processes. Therefore, we tried the hydrodynamic simulation over the channels around Ligeia Mare using DTM constructed by radargrammetry and radarclinometry and observed the accordance between the simulation output and the real world topography.
To fully demonstrate the potential of these approaches, technical details will be continuously improved and applied over more test areas. The introduction of advanced radarclinometric techniques considering radar illumination conditions together with the improved image matcher incorporating contouring matching will be next tasks.