Automated Surface Change Detection on Mars Using HiRISE: Preliminary Tests

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ABSTRACT: We evaluated the possibility to co-register accurately HiRISE images (~30 cm resolution) for change detection applications or surface displacements measurements. Our preliminary tests show an excellent coregability of HiRISE images using COSI-Corr. In principle it should be possible to co-register images with accuracy ranging from 3 to 10 centimeters, such that changes at this scale and coarser can be measured. Two major sources of artifacts currently limit the technique application. A first source is due to uncertainties on the acquisition geometry: unmodeled attitudes of the spacecraft during the images acquisitions introduce distortions in the offset maps with amplitude of up to a few pixels; the staggered arrangement of the CCD detectors in the focal plane, combined with the unmodeled attitude variations, introduce along-track stripes in the offset maps; static misalignments of the CCD detectors around their nominal location are also suspected. The second source is due to topographic error, which leaves parallax effect in the orthorectified images, and is ultimately retrieved in the offset maps. The correction of the geometric artifacts and a high quality DEM extraction are currently the most limiting factors. Their correction is therefore the next necessary step to take.

QUESTION: Can surface dynamics being monitored with HiRISE imagery using COSI-Corr?

Successful results on Earth:

The 1999, Mw 7.1 Hector Mine earthquake, California from correlation between a 1998 SPOT1 10m and a 2000 SPOT2 10m

Disparity maps obtained from correlation of 2 HiRISE images with identical viewing angles over the Victoria crater area
Images kept in the camera geometry, no topographic artifacts — Jitter and CCDs artifacts of few pixels

Promising results on Mars:

HRISE DEM, and disparity maps obtained from correlation of the orthorectified images
Correlation standard deviation: 1/5 - 1/3 pixel — May monitor surface displacement of ~ 5 to 10 cm
BUT geometric artifacts must be corrected first (DEM and disparity maps artifacts)

CONCLUSION: HiRISE images co-registration and correlation is achieved with an accuracy of few tenths of a pixel. Precise surface dynamics monitoring is possible, but geometric uncertainties (i.e. acquisition, topography) must be corrected first.

References:
