GEOMETRIC GROUND CONTROL OF VERY HIGH RESOLUTION IMAGERY USING HRSC INTERSECTION POINTS AND A NON-RIGOROUS CAMERA MODEL

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ABSTRACT:

Geometric Ground control information for extra-terrestrial imagery is usually very difficult to achieve with acceptable accuracy. It has therefore been of long-standing interest in the extra-terrestrial mapping community to create accurately adjusted imagery without using "real ground control points". MOLA footprint tracks, which are crossover corrected, are now widely used for this purpose including applications such as HRSC image block adjustment which has proved very effective as control information. However, it is very difficult to apply these methods to very high resolution images such as MOC-NA and HiRiSE using only MOLA considering the large footprint size (~150m) of MOLA compared with the corresponding resolution of MOC-NA (1-6m) and HiRiSE (<1m). Moreover, it has also well-known that the height value of MOLA is not necessarily the central altitude of the illuminated area.

A method is here proposed to establish a ground control network for very high resolution imagery (MOC-NA) using image matched points to orthorectified HRSC image map products employing the intersection geometry information. An image matching scheme has been developed for HRSC stereo to produce high resolution DTMs with grid-spacing up to ≥30m. These DTMS have then be applied to orthorectify the HRSC images. Then matched point pairs are selected automatically from both MOC-NA and HRSC images using image "chips" in low sloped terrain. Considering the resolution difference between MOC-NA (4-6m mostly) and HRSC (15m), it is then possible to produce a minimum horizontal accuracy of 40-60m if HRSC stereo is already bundle block adjusted using MOLA. The horizontal and vertical coordinates are produced using the 3D coordinates from the HRSC stereo routine's intersection values with these matched points. As an initial test, we have applied an affine transformation and it's variants as it has been successfully applied to solving high resolution terrestrial EO image's camera modelling by Fraser and Yamakawa (2002).

The ortho-rectified test MOC-NA images show a maximum error of 10 pixels when MOC-NA check points are introduced and a maximum of 3 pixels' difference compared with a HRSC nadir image. A DTM was constructed in some well controlled images. In these test images, MOC-NA pairs over the rugged terrain of Bahram valley and Ceraunius Tholus, showed DTMs much finer detail than the corresponding HRSC stereo image derived DTM.

Currently this method has the following limitations : 1) the affine transformation only works over a sub-image of the whole MOC-NA strip because the method does not appear to be suitable for wide FoVs. Currently, the maximum size of such a sub-image is restricted to 600 by 1500 pixels; 2) 3D intersection with affine transformation can only be calculated with well distributed control points.

More sophisticated non-rigorous models are currently under investigation including Rational Polynomial Coefficients (RPC) which have been successfully applied to a large variety of different types of EO imagery. We have experimented with a terrain independent RPC interpolated using SPICE information and bias correction proposed by Hanley et al. (2002) which is known as an effective way to attain reasonable accuracy even with poorly determined and just a few control points. A comparative analysis will be presented using these different methods and recommendations made as to which method appears to work best with Mars' imagery. This method offers the possibility of being able to create stereo intersection geometry as well as planimetrically co-registered datasets over the full range of resolutions from HiRise to Viking Orbiter using the unique properties of the HRSC, suitably bundle-block adjusted and the MOLA tracks.

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