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Automated navigation of Mars rovers using HiRISE-CTX-HRSC co-registered orthorectified images and DTMs

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Fusion of orbital and rover imagery is critical to a better understanding of the geological and geomorphological context of current and future rovers on Mars. A critical component of this is to ensure that the most accurate possible co-registration can be achieved between orbital images (co-registered to MOLA tracks) and rover imagery. Currently this is either performed by hand or uses Incremental Bundle Adjustment that does not guarantee compliance of rover and global aerographic co-ordinates. The objective of this work is to produce the most accurate possible Mars rover locations in global aerographic coordinates. The first stage of the work involves automated tie-point/feature based co-registration of high-quality image maps from coarse to fine spatial resolutions, i.e. HRSC ORI (∼12.5metre/pixel) and DTM (∼75mpp), CTX ORI (∼6mpp) and DTM (∼6mpp), HiRISE ORI (∼0.25mpp) and DTM (∼1mpp). The second stage of the work involves stereo reconstruction using ground data captured by Navigation cameras onboard MER-A/-B/MSL rover, bundle adjustment of the NavCam ORI/DTM for wide baseline mosaic, and co-registration of NavCam ORI (0.01mpp) and HiRISE ORI based on combined mutual information and edge feature registration techniques. The registration accuracy achieved is up to the sub pixel level of the coarser layer, e.g. 1.25mpp for HRSC-to-CTX, and the final rover traverse has a resolution of 0.025mpp.

The development work is based on previous research/development work on HiRISE/HRSC ORI/DTM co-registration [1], stereo ground reconstruction [2], and multi-resolution data fusion [3] within the EU-FP7-PRoVisG project (http://provisg.eu). The co-registered rover locations and multi-layer map have been partly integrated into the interactive web-GIS system (http://progisweb.eu) developed for scientific data selection and visualisation within the PRoVisG and EU-FP7-PRoViDE project (http://provide-space.eu). Further assessment will be performed within PRoViDE. The final products are sets of co-registered multi-layer maps and updated SPICE kernel files in a common global coordinates.

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