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Shape and rotational elements of comet 67P/ Churyumov-Gerasimenko derived by stereo-photogrammetric analysis of OSIRIS NAC image data

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The European Space Agency's Rosetta spacecraft is equipped with the OSIRIS imaging system which consists of a wide-angle and a narrow-angle camera (WAC and NAC). After the approach phase, Rosetta was inserted into a descent trajectory of comet 67P/Churyumov-Gerasimenko (C-G) in early August 2014. Until early September, OSIRIS acquired several hundred NAC images of C-G's surface at different scales (from ~5 m/pixel during approach to ~0.9 m/pixel during descent). In that one month observation period, the surface was imaged several times within different mapping sequences. With the comet's rotation period of ~12.4 h and the low spacecraft velocity (< 1 m/s), the entire NAC dataset provides multiple NAC stereo coverage, adequate for stereo-photogrammetric (SPG) analysis towards the derivation of 3D surface models.
We constrained the OSIRIS NAC images with our stereo requirements (15° < stereo angles < 45°, incidence angles <85°, emission angles <45°, differences in illumination < 10°, scale better than 5 m/pixel) and extracted about 220 NAC images that provide at least triple stereo image coverage for the entire illuminated surface in about 250 independent multi-stereo image combinations. For each image combination we determined tie points by multi-image matching in order to set-up a 3D control network and a dense surface point cloud for the precise reconstruction of C-G's shape.
The control point network defines the input for a stereo-photogrammetric least squares adjustment. Based on the statistical analysis of adjustments we first refined C-G's rotational state (pole orientation and rotational period) and its behavior over time. Based upon this description of the orientation of C-G's body-fixed reference frame, we derived corrections for the nominal navigation data (pointing and position) within a final stereo-photogrammetric block adjustment where the mean 3D point accuracy of more than 100 million surface points has been improved from ~10 m to the sub-meter range. We finally applied point filtering and interpolation techniques to these surface 3D points and show the resulting SPG-based 3D surface model with a lateral sampling rate of about 2 m.