Topographic modeling of wide- and narrow-angle stereo images obtained by the LRO camera – and applications in lunar geodesy and geology

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We applied stereo-photogrammetric methods to image data obtained by the Wide- and Narrow Angle Cameras (WAC and NAC) of the Lunar Reconnaissance Orbiter Camera system (LROC). From polar orbit tracks, LROC WAC captures images with a mean ground resolution of 75 m/pxl and substantial cross-track stereo overlap. We have derived a near-global digital terrain model (DTM) at a 100 m raster, the “GLD100” (Scholten et al., 2011). In contrast, the spacecraft was tilted in consecutive orbits to produce stereo overlap for the NAC. Several hundreds of such stereo sequences in local areas have been obtained. The typical products that are derived from these datasets are DTMs at 1-2 m raster.
The topography and ortho-rectified imagery provide a rich source of data for studies of Lunar morphology and cartography. Using NAC and WAC DTMs, we have carried out a study of selected landings sites, including those of the Luna and Apollo spacecraft. Surface images obtained by the astronauts and orbit image data were precisely tied using landmarks (e. g. rocks, boulders, and Apollo station equipment). In particular, the positions from where the Apollo 17 astronauts recorded panoramic images, at the so-called “traverse stations”, were precisely determined using the ortho-images (0.5 m/pixel), DTMs and historic Apollo panoramas. The precise tie between imaged features and their determined ground coordinates allowed us also to reconstruct the panoramic image mosaics taken by the astronauts, some of which were found to suffer from geometric distortions. Also, the traverses of the Lunokhod roving vehicles were identified in the high-resolution images and mapped in 3D.
We used the GLD100 to study the inventory of lunar impact basins. Among more than 30 previously tentatively proposed basins, we have several confident identifications, including Coulomb-Sarton, Dirichlet-Jackson, Fecunditatis, Fitzgerald-Jackson, Freundlich-Sharonov, Nubium, Pingre-Hausen, Sikorsky-Rittenhouse, and Wegener-Winlock, for which we determined new center coordinates, basin diameters and depths.