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Apollo Metric Camera Terrain Model Generation and Densification Approaches

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Background and Approaches

The investigation of the Earth's moon has become a major scientific and technical goal as a variety of recent and future mission plans to the Moon show. The background for these attempts are – among others – the construction of permanent posts by 2020 as the exploration plans of ESA and NASA document.

In the context of the US Apollo 15–17 missions (July 1971 to December 1972) the Fairchild Metric Camera employed in the Command Module's SIM–Bay has taken high–resolution image data from the near–side of lunar equatorial latitudes with an overlap of 78% and with a spatial resolution of up to 20 m per pixel from an orbit altitude of ∼ 100 km. Orbit altitude (mid–frame range) was determined using the SIM–bay Laser Altimeter instrument. On the basis of this high–resolution stereo data a variety of terrain–model products have been generated thus far. Such data led to generation of very–high terrain models from confined areas, such as the Apollo 15 landing site at Hadley Rille as performed, e.g., by USGS Flagstaff.

In the course of past and especially ongoing and future missions to the Moon, we are currently working on implementing a semi–automatic data processing environment which allows us to merge multi–sensor terrain–model data in order to achieve highest–possible data resolution of selected areas. We aim at (a) photogrammetrically derived best–possible terrain model data set from Metric Camera frame images and merge this set with laser–altimetry data based on past and recent missions, such as the SELENE LALT instrument as soon as the data becomes available. This way, additional control points are incorporated into the processing workflow for the Metric Camera-derived terrain models.

The currently available terrain model mosaics of the Apollo traverses made by USGS are in the range of 64 px/degree. This, however, provides a much more detailed picture of the lunar topography than that provided by the Clementine LIDAR instrument for which a terrain model resolution of 0.25◦ has been acquired. With the available high–resolution Apollo image data it should theoretically be possible to achieve much higher spatial resolutions (below 100 m/px) of selected areas for in–depth geoscientific studies and for investigations focussed on possible future landing sites. Unfortunately, exterior and interior orientation data of the Apollo Metric Camera are poorly constrained and image scans of the Apollo Metric Camera data incorporate additional uncertainties and distortions.

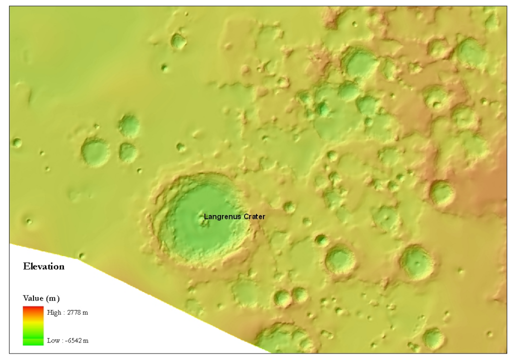

Figure 1: Color–coded shaded relief representation of the Langrenus imapct–crater site, terrain model data by USGS with 64 px/degree, 1998

During this project we focus on the Langrenus impact crater site (figure 1) located at 60.9°E/8.9°S which was covered by the Metric Camera during the Apollo 15 and 16 missions and for which 12+11 frame scans were made available through the Apollo Image Archive[1]. The workflow is based upon the commercial ERDAS Imagine OrthobasePro software package with which we are able to generate terrain model data and derive orthoimage mosaics and make use of recent topography constraints as provided by other missions to adjust and correct positional properties and orientation deficits by means of control points.

The motivation for this work is not only the availability and exploitation of new lunar mission data but also the fact that densification of terrain model data has become important also in the context of other planetary mission and instruments, such as Mars Express (MEx) and the MEx HRSC instrument for which ongoing work is focussed of the systematic combination of Mars Orbiter Laser Altimeter data and high–resolution photogrammetrically derived stereo–image data.

[1] http://apollo.sese.asu.edu/