Comparison Analysis of Lunar Topographic Models Derived from Chang'E-1 and SELENE Data

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Lunar topographic information is of paramount importance for lunar exploration missions and lunar scientific investigations. Previous and recent lunar missions (e.g., the Chinese Chang'E-1 mission, Japanese SELENE mission, and NASA's Clementine and Lunar Reconnaissance Orbiter missions) have collected vast amounts of lunar surface data for topographic modeling purposes, which include lunar imagery and laser altimeter data at different resolutions. In lunar topographic models derived from the imagery and laser altimeter data, it is not uncommon to see inconsistencies due to the unavoidable errors (e.g., errors from sensor positions and orientations). This paper presents the comparison analysis results of lunar topographic models derived from the imagery and laser altimeter data collected in the Chang'E-1 and SELENE missions.
Firstly, the DEMs (digital terrain models) derived from the Chang'E-1 and SELENE data are compared at two selected areas, the Apollo 15 and 16 landing site areas. A six-parameter transformation (three translation parameters and three rotation parameters) is performed to register the SELENE DEM to the Chang'E-1 DEM using a couple of conjugate points (mountain peaks or centers of small craters). These conjugate points are carefully selected manually. Results show that there are small shifts between these two data sets. For the Apollo 15 landing site area, there is about a 350 m offset between these two data sets in the horizontal direction, and the SELENE data is higher than the Chang'E-1 data by about 150 m. For the Apollo 16 landing site area, the horizontal shift between these two data sets is 1.5 km and the SELENE data is higher than the Chang'E-1 data by about 90 m.
Secondly, an Iterative Closest Point (ICP) algorithm is employed for the detailed comparison of the DEMs derived from the Chang'E-1 and SELENE data. An additional parameter, scale, is added in the matching of the two DEMs in addition to the previous six transformation parameters. This method is based on the search for pairs of nearest points in two data sets and estimates the rigid body transformation that aligns them. The optimized transformation parameters are obtained through a least squares process. The Chang'E-1 and SELENE data at the Apollo 15 and 16 landing site areas, and the data at the Sinus Iridum area (a potential landing site for future Chinese lunar landed missions) are used for comparison analysis. Detailed profiles derived from the DEMs are compared. Results indicate that the topography derived from Chang'E-1 data shows a relatively consistent trend with the topography determined by the SELENE laser altimeter data.