

Co-registration of ChangE-1 Stereo Images and Laser Altimeter Data for 3D Mapping of Lunar Surface

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This paper presents a method of co-registration of ChangE-1 (CE-1) lunar orbiter stereo images and laser altimeter (LAM) data for 3D mapping of lunar surface. First, a DEM is automatically generated from the three-line array CCD stereo images based on rigorous pushbroom sensor model and hierarchical image matching. The DEM is then registered to LAM data through surface matching with a 3D similarity transformation model. Consequently, the exterior orientation parameters (EOPs) of the images are adjusted using the similarity transformation model so that the images and LAM data are co-registered.

The developed method is tested using CE-1 stereo images of a 61 km by 120 km (image resolution 120 m) area and 620 LAM points of 11 orbits. The area has an elevation range of -2759.76 m to 719.23 m, referencing to the mean radius of 1737.4 km. We project the LAM points onto the forward-, nadir-, and backward-looking images using the original and adjusted EOPs respectively. Taking the projected points in the nadir-looking image as base points, their homologous points in forward- and backward-looking images are obtained by least squares matching. The position differences between these homologous points and the projected positions of the LAM points in the forward- and backward-looking images are calculated and used to depict the inconsistency between the imagery and LAM data. Before the co-registration, the average difference is $\pm 2\sim 3$ pixels, and the standard deviation of the differences is sub-pixel. The differences are generally in opposite directions in the forward- and backward-looking images. After the co-registration, the average difference is reduced to subpixel level, which demonstrates the effectiveness of the proposed co-registration method.