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HIGH PRECISION TOPOGRAPHIC MAPPING AT CHANG'E-3 LANDING SITE WITH MULTI-SOURCE DATA

Y. Liu, B. Liu, B. Xu, Z. Liu, K. Di *

State Key Laboratory of Remote Sensing Science, Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences, P.O.Box 9718, Datun Road, Chaoyang District, Beijing 100101, China - dikc@radi.ac.cn

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ABSTRACT:

Chang'e-3 (CE-3) is the first lander and rover of China following the success of Chang'e-1 (CE-1) and Chang'e-2 (CE-2) orbiters. CE-3 was launched on 2 December 2013 and landed on Mare Imbrium (44.12 °N, 19.51 °E) – east of Sinus Iridum on 14 December 2013, and the rover Yutu was released to lunar surface and began its exploration soon after landing. Undoubtedly, high precision topographic data can provide detailed terrain information to ensure the safety of the rover as well as to support scientific analysis. Before CE-3 landing, multi-source lunar data are available at the landing site, such as LOLA data and WAC/NAC images from LRO mission, multi-resolution CCD images from CE-1 and CE-2 mission; during landing, 4,672 multi-resolution images were sequentially acquired by the descent camera.

In this research, multi-source data are co-registered into a uniform geographic framework for high precision topographic mapping at CE-3 landing site. First, multiple tracks of CE-2 CCD images with 7 m and 1.5 m resolution are registered together using self-calibration bundle adjustment method and their internal consistencies can be improved to ~0.6 pixel level. Compared with LRO WAC mosaic, the DEM and orthoimage products generated from CE-2 CCD images have an offset of 500~800 m to the west and 500~1000 m to the north. In order to remove these inconsistencies, dozens of ground control points (GCPs) are selected from LOLA data and LRO WAC mosaic and incorporated into the adjustment of CE-2 images. LRO NAC images are also registered after orthorectification with the rigorous sensor model. A multi-resolution DEM and orthoimage at the CE-3 landing area is generated using the descent camera images. The resolution is higher than 1 m within an area of 1 km*1km and can reach as high as 0.1 m within a range of 50 m from the landing point. Absolute orientation of the descent image derived products is performed with several GCPs and the height accuracy reaches about 1m. Finally, orbiter images including LRO WAC/NAC images and CE-2 CCD images and the descent camera images are rectified into the same geographic framework for unified, multi-scale, high precision mapping of the CE-3 landing site. Key technologies and the mapping products of this research have been used to support surface operations of CE-3 mission.

* Corresponding author.