

Acquisition strategies for terrestrial photogrammetric surveys

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Close-range photogrammetry based on Structure from Motion (SfM) and dense image matching algorithms is being rapidly adopted in the fields of geosciences thanks to its characteristics of low costs, portability of the instrumentation, high level of automation, and high levels of detail. However, special care should be taken while planning photogrammetric surveys to optimize the 3D model quality and spatial coverage. This means that the geometric configurations of the multi-view camera network and the control data have to be designed in accordance with the required accuracy, resolution and completeness. From a practical application point of view, a proper planning (of both photos and control data) of the photogrammetric survey especially for ground-based acquisition, is not always ensured due to limited accessibility of the target object and the presence of occlusions.

In this work, we investigate how to solve these practical problems of a ground-based photogrammetric survey. We propose a different image acquisition strategy based on image sequences acquired in panorama mode. This means that at each established position a series of pictures with overlapping fields of view are taken on a conventional tripod, turning the camera about a common point of rotation, to cover the object of interest. While due to the offset of the pivot point from the projection center, these images cannot be stitched into a panorama, we demonstrate how to still take advantage of this capturing mode. Additionally, we test different geo-referencing procedures using i) different ground control points (GCP) configurations i.e. number and distribution of artificial targets measured with topographic instrumentation, ii) natural features employed as GCPs whose coordinates are extracted from a modern terrestrial laser scanner (TLS) point cloud, and iii) directly observed coordinates of the camera positions. Images of the test field in a low-slope artificial hill were acquired from the ground using an SLR camera.

To validate the photogrammetric results, we use a TLS survey as benchmark. For accuracy assessment of the photogrammetric results, we derive the main statistics from both the digital elevation model and the point cloud by comparing them to the reference TLS data.

Our results show a higher accuracy of the photogrammetric 3D model generated by the panorama imagery in comparison to the single views acquired from the same positions. The average 3D distance between the TLS and the photogrammetric point cloud is 0.016 m and 0.023 m for the panorama and the single images, respectively.

The experiments on the geo-referencing methods demonstrate the introduction of model distortions by inappropriate GCP distributions. The number of control points shows a lower influence on the resulting accuracy. The combined use of directly observed camera positions and natural features provides a practical solution to geo-reference the photogrammetric 3D model without the artificial target locations near the object of interest.