Documentation of Remote Archaeological Sites – a Comparison Between Long Range Laser Scanning and Uav–Based Photogrammetry

Ephraim Friedli and Pascal Theiler (Switzerland)

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SUMMARY

In this paper we focus on two geodetic methods for documenting remote archaeological sites. We evaluate and compare the two methods – terrestrial long-range laser scanning and aerial photogrammetry based on unmanned aerial vehicles (UAV) – with respect to the demands of archaeological surveys. The investigation is based on two archaeological sites in the Peruvian Andes. Santa Maria, the smaller site, spanning about 0.16 square kilometres, is located in a high mountain valley and is covered with vegetation, i.e. grass and bushes. The larger site, Cutamalla, spanning 0.35 square kilometres, is located at the crest of a mountain at an altitude of 3300 metre and thereby represents one of the highest areas in this region. The data sets were acquired during a field campaign in collaboration with the German Archaeological Institute (DAI) within the "Verbundprojekt Anden-Transekt" in 2011. The principal goal was to generate high resolution digital terrain models (DTM) as well as orthophotos. The resulting terrain models with resolutions of 10 centimetres prove that both methods can be used to derive DTM's that fulfil the archaeological requirements, i.e. objects of interest such as terrace structures or brick walls are clearly visible. A comparison of the models shows, that the planar congruency is within some centimetres, whereas the height differences are up to some decimetres. Reasons for the larger height discrepancies are the different effects of vegetation and man-made structures on the terrestrial and on the airborne measurements as well as inaccuracies arising during the post-processing (i.e. registration, filtering or matching). We also compared the methods regarding economic and practical aspects. UAV-based photogrammetry enables one to capture a complete scene with high and approximately constant resolution over the entire area. However, to keep the acquisition and processing time (i.e. ground control point distribution, amount of images) feasible, the observed area should not exceed a few hectares. Furthermore, the application of a UAV is limited by wind, precipitation and potentially legal restrictions. Terrestrial long-range laser scanning is more robust with respect to meteorological conditions, does not necessarily require ground control points in the observed site and can acquire data over large areas. The main drawbacks of laser scanning are the required line-of-sight between the instrument and the features to be scanned, and that the spatial resolution decreases linearly with distance and thus varies within a single scan, which influences the effective resolution of the final DTM. Consequently, the acquisition from multiple stations becomes necessary which increases the effort for fieldwork and post-processing. Finally, due to the different viewing angles and sensing principles, TLS is less accurate for horizontal structures whereas UAV-bases photogrammetry is less accurate

for vertical ones. Within the above project, long-range laser scanning proved to be more efficient for the Santa Maria site due to larger height differences and the visibility of the valley's counter slope. The rather flat area of Cutamalla was better suited for UAV-based photogrammetry than for TLS. Current investigations exploit the advantages of combining both methods.