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A low-cost approach for the documentation and monitoring of an archaeological excavation site

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The documentation of archaeological excavations and in particular a constant monitoring is often time-consuming and depending on human′s capabilities. Thus, remote sensing methods, which allow an objective reproduction of the current state of an excavation and additional information are of interest. Therefore, a low-cost approach was tested on an open-air excavation site for two days in September 2015. The Magdalenian excavation site of Bad Kösen-Lengefeld, Germany is one important site in a system of about 100 sites in the area of the small rivers Saale and Unstrut.
The whole site and the surrounding area (200 by 200 m) was first observed by a GoPro Hero 3+ mounted on a DJI-Phantom 2 UAV. Ground control points were set-up in a regular grid covering the whole area. The achieved accuracy is 20 mm with a ground resolution of 45 mm.
As a test, the GoPro Hero 3+ camera was additionally mounted on a small, extendable pole. With this second low-cost, easy to apply monitoring approach, pictures were automatically taken every second in a stop-and-go mode. In order to capture the excavation pit (7 by 4 m), two different angles were used for holding the pole, which focused on the middle and on the border of the pit. This procedure was repeated on the following day in order to document the excavation process. For the registration of the images, the already existing and measured excavation nails were used, which are equally distributed over the whole site in a 1 m grid. Thus, a high accurate registration of the images was possible (>10 mm). In order to approve the accuracy of the already derived data, the whole site was also observed by a Faro Focus 3D LS 120 laser scanner. The measurements of this device were registered by spherical targets, which were measured in the same reference system.
The accuracy of the registration and the ground resolution for the image based approach for both days was about 4 mm. From these two measurements the process of the excavation was easily derived by computing the differences between the point clouds. The mean difference between the laser scanner measurements and the corresponding image observations of about 5 mm proves the overall accuracy.
The results show, that the study site can fastly and easily be documented and monitored in a high-resolution by low-cost systems. The approach uses the surveying information of already existing measurements, as tachymetric measurements are usually conducted on nearly all excavation sites. Overall the presented approach worked successfully. The high-resolution dataset allows to easily document the ongoing excavation. A daily observation would lead to a complete documentation in 3D.