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The potential of low-cost RPAS for multi-view reconstruction of rock cliffs

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RPAS, also known as drones or UAVs, have been used in military applications for many years. Nevertheless, the technology has become accessible to everyone only in recent years (Westoby et al., 2012; Nex and Remondino, 2014). Electric multirotor helicopters or multicopters have become one of the most exciting developments and several off-the-shelf platforms (including camera) are now available. In particular, RPAS can provide 3D models of sub-vertical rock faces, which for instance are needed for rockfall hazard assessments along road cuts and very steep mountains. The current work investigates the potential of two low-cost off-the-shelf quadcopters equipped with digital cameras for multi-view reconstruction of sub-vertical rock cliffs. The two platforms used are a DJI Phantom 1 (P1) equipped with a Gopro Hero 3+ (12MP) and a DJI Phantom 3 Professional (P3). The latter comes with an integrated 12MP camera mounted on a 3-axis gimbal. Both platforms cost less than 1.500€ including camera.

The study area is a small rock cliff near the Callaghan Campus of the University of Newcastle (Thoeni et al., 2014). The wall is partly smooth with some evident geological features such as non-persistent joints and sharp edges. Several flights were performed with both cameras set in time-lapse mode. Hence, images were taken automatically but the flights were performed manually since the investigated rock face is very irregular which required adjusting the yaw and roll for optimal coverage since the flights were performed very close to the cliff face.

The digital images were processed with a commercial SfM software package. Thereby, several processing options and camera networks were investigated in order to define the most accurate configuration. Firstly, the difference between the use of coded ground control targets versus natural features was studied. Coded targets generally provide the best accuracy but they need to be placed on the surface which is not always possible as rock cliffs are not easily accessible. Nevertheless, work natural features can provide a good alternative if chosen wisely. Secondly, the influence of using fixed interior orientation parameters and self-calibration was investigated. The results show that in the case of the used sensors and camera networks self-calibration provides better results. This can mainly be attributed to the fact that the object distance is not constant and rather small (less than 10m) and that both cameras do not provide an option for fixing the interior orientation parameters. Finally, the results of both platforms are as well compared to a point cloud obtained with a terrestrial laser scanner where generally a very good agreement is observed.

References

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