Comparison of 3D point cloud quality based on image data acquired with various UAV- and camera systems from low cost to professional

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"Earth observation is diversifying […]" (Grainger 2017). This statement by Alan Grainger condenses recent and future developments incorporating *in situ*, unmanned aerial vehicle (UAV), airborne, spaceborne, and citizen observatory based measurements to monitor state and processes of the earth. In the past years citizen science for Earth Observation gained great recognition by policy. E.g., the Horizon 2020 Programme is funding several citizen science observatory projects. These developments are the consequence of the main bottle neck in Earth Observation: missing reference data. Foresightful, some scientists (e.g. Dell'Acqua and De Vecchi 2017; See et al. 2016) discuss opportunities to incorporate volunteered geographic information (VGI) in political frameworks such as the Copernicus program to complement the *in situ* component. Successful projects such as Geo-Wiki or Crowd4Sat demonstrate the vast potential of citizen science in Earth Observation. However, to date all projects and initiatives focus on 2D information such as single photographs or the manual classification of satellite imagery. What is entirely missing is the third dimension which is mandatory for several observation applications such as vegetation biomass estimation or the identification of damage in buildings for disaster management.

Currently, up-to-date 3D reference information is hardly available. The acquisition of such data causes high efforts either in terms of labour or in terms of equipment (laserscanners etc.) – or both. The advent of low cost (< 1000 €) and easy to fly light weight drones (< 5 kg) has the potential to supplement the need for 3D reference information. The heavily growing interest in UAVs can be illustrated by the following figures. For 2013 (MarketsandMarkets 2013) assessed that the global UAV market is worth 5,400 M€. The forecast for 2018 (made only 5 years ago) was a value of 6,350 M€. Now in 2018 the new assessment says that the global UAV market is worth 15,420 M€ and will grow up to 44,460 M€ in 2025 (MarketsandMarkets 2018).

Although the great potential of Structure-from-Motion (SfM) based methods for 3D reconstruction has been demonstrated for a wide range of applications, several issues need to be solved to foster trust and acceptance in this kind of data by the scientific community and administrative bodies, in particular if this data are acquired by citizens. The issue with the potentially highest priority is the quality of the generated 3D point clouds derived from multiple views.

To address this issue, on 1st November in 2018 a comprehensive UAV campaign was accomplished close to the city of Jena, Germany. During this campaign, eight drones equipped with dissimilar cameras operating in different modes acquired data over an area featuring different land cover types including forest, buildings, grassland, and water surfaces. This UAV campaign, which included among others/also citizen scientists as drone pilots flying their own UAVs, was accompanied by DLR's 3K sensor to gather a high grade reference dataset. Additionally, airborne LiDAR data with a nominal point density of 4 points per m² are available as well. The flight altitude of the drones was 100 m above the ground, the image overlap along and across track was 75%. The processing of the data was accomplished by applying Agisoft Photoscan 1.4.4. The quality assessment of the resulting point clouds comprised the vertical (height) and horizontal (2D location) accuracy for different objects and surfaces within the test site. Although the evaluation of the results is still ongoing, first results promise a wide usability of low cost drone data acquired by citizens.

References

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