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Towards specifying and optimizing 3D point cloud quality based on UAV-borne image data acquired by citizen scientists

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One of the workgroups of the DLR Institute for Data Science is dedicated to citizen science related questions such as i) psychologic aspects with regard to the engagement of people, ii) the processing of citizen science data, e.g. semantic attribution, data quality & reliability assessment, and iii) strategies to optimize the exploitation of the data, e.g. automation, visualization, or handling of heterogeneous data. The research has close links to crisis management using social media data and volunteered geographic information as well as to Earth Observation, e.g. local to global reference data generation for model training and validation. The work includes the exploration of 2D and 3D data acquired by unmanned aerial vehicles (UAVs) to address the main bottle neck in satellite based Earth Observation: missing reference data. Successful projects such as Geo-Wiki or Crowd4Sat demonstrate the vast potential of citizen science in this field. However, to date all initiatives focus on 2D information such as single photographs or the manual classification of satellite imagery. What is 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, or both. The advent of low cost drones has the potential to supplement the need for 3D data. 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 multiview images.

To address this issue, 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. This campaign, which included 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 are available as well. 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. Further research will focus on optimizing acquisition and processing parameters for improving the 3D point cloud data quality. One aspect will be the development of a dedicated 3D point cloud quality measure. The results of this research will be condensed in guidelines and best practices for crowd based UAV data generation.