Geophysical Research Abstracts
Vol. 17, EGU2015-655, 2015
EGU General Assembly 2015

Evaluating the accuracy of orthophotos and 3D models from UAV photogrammetry

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Rapid development of unmanned aerial vehicles (UAV) in recent years has made their use for various applications more feasible. This contribution evaluates the accuracy and quality of different UAV remote sensing products (i.e. orthorectified image, point cloud and 3D model).

Two different autonomous fixed wing UAV systems were used to collect the aerial photographs. One is a mass-produced commercial UAV system, the other is a similar state-of-the-art UAV system. Three different study areas with varying sizes and characteristics (including urban areas, forests, fields, etc.) were surveyed. The UAV point clouds, 3D models and orthophotos were generated with three different commercial and free-ware software. The performance of each of these was evaluated.

The effect of flying height on the accuracy of the results was explored, as well as the optimum number and placement of ground control points. Also the achieved results, when the only georeferencing data originates from the UAV system's on-board GNSS and inertial measurement unit, are investigated. Problems regarding the alignment of certain types of aerial photos (e.g. captured over forested areas) are discussed.

The quality and accuracy of UAV photogrammetry products are evaluated by comparing them with control measurements made with GNSS-measurements on the ground, as well as high-resolution airborne laser scanning data and other available orthophotos (e.g. those acquired for large scale national mapping). Vertical comparisons are made on surfaces that have remained unchanged in all campaigns, e.g. paved roads. Planar comparisons are performed by control surveys of objects that are clearly identifiable on orthophotos. The statistics of these differences are used to evaluate the accuracy of UAV remote sensing.

Some recommendations are given on how to conduct UAV mapping campaigns cost-effectively and with minimal time-consumption while still ensuring the quality and accuracy of the UAV data products. Also the benefits and drawbacks of UAV remote sensing compared to more traditional methods (e.g. national mapping from airplanes or direct measurements on the ground with GNSS devices or total stations) are outlined.