Geophysical Research Abstracts
Vol. 15, EGU2013-9286, 2013
EGU General Assembly 2013

Roughness Estimation from Point Clouds – A Comparison of Terrestrial Laser Scanning and Image Matching by Unmanned Aerial Vehicle Acquisitions

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Recently, terrestrial laser scanning (TLS) and matching of images acquired by unmanned arial vehicles (UAV) are operationally used for 3D geodata acquisition in Geoscience applications. However, the two systems cover different application domains in terms of acquisition conditions and data properties i.e. accuracy and line of sight. In this study we investigate the major differences between the two platforms for terrain roughness estimation. Terrain roughness is an important input for various applications such as morphometry studies, geomorphologic mapping, and natural process modeling (e.g. rockfall, avalanche, and hydraulic modeling).
Data has been collected simultaneously by TLS using an Optech ILRIS3D and a rotary UAV using an octocopter from twins.nrn for a 900 m^2 test site located in a riverbed in Tyrol, Austria (Judenbach, Mieming). The TLS point cloud has been acquired from three scan positions. These have been registered using iterative closest point algorithm and a target-based referencing approach. For registration geometric targets (spheres) with a diameter of 20 cm were used. These targets were measured with dGPS for absolute georeferencing. The TLS point cloud has an average point density of 19,000 pts/m^2, which represents a point spacing of about 5 mm.
15 images where acquired by UAV in a height of 20 m using a calibrated camera with focal length of 18.3 mm. A 3D point cloud containing RGB attributes was derived using APERO/MICMAC software, by a direct georeferencing approach based on the aircraft IMU data. The point cloud is finally co-registered with the TLS data to guarantee an optimal preparation in order to perform the analysis. The UAV point cloud has an average point density of 17,500 pts/m^2, which represents a point spacing of 7.5 mm.
After registration and georeferencing the level of detail of roughness representation in both point clouds have been compared considering elevation differences, roughness and representation of different grain sizes. UAV closes the gap between aerial and terrestrial surveys in terms of resolution and acquisition flexibility. This is also true for the data accuracy. Considering these data collection and data quality properties of both systems they have their merit on its own in terms of scale, data quality, data collection speed and application.