



Towards digital terrain modeling with unmanned aerial vehicles and SfM point clouds

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Unmanned Aerial Vehicles (UAVs) are excellent tools for the acquisition of very high-resolution digital surface models using low altitude aerial photography and photogrammetric, 'Structure-from-Motion' (SfM), processing. Terrain reconstructions are produced by interpolating ground points after removal of non-ground points. While extremely detailed in non-vegetated areas, UAV point clouds are less suitable for terrain reconstructions of vegetated areas due to the inability of aerial photography to penetrate through vegetation for collecting ground points. This hinders for example detailed modeling of sediment transport on hillslopes towards vegetated lower areas and channels with riparian vegetation. We propose complementing UAV SfM point cloud data with alternative data sources to fill in the data gaps in vegetated areas. Firstly, SfM point clouds are classified into ground and non-ground points based on both color values and neighborhood statistics. Secondly, non-ground points are removed and data gaps are complemented with external data points. Thirdly, the combined point cloud is interpolated into a digital terrain model (DTM) using the natural neighbor interpolation technique. We demonstrate the methodology with three scenarios of terrain reconstructions in two study areas in North and Southeast Spain: i.e. a linear slope below sparsely distributed trees without the need of supplementary data points (1), and a gully with riparian vegetation combined with 5 m LiDAR data (2) or with manually measured dGPS data points (3). While the spatial resolution is significantly less below vegetated areas compared to non-vegetated areas, the results suggest significant improvements of the reconstructed topography, making the DTM more useful for soil erosion studies and sediment modeling.