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Surface Roughness from Point Clouds – A Multi-Scale Analysis

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Roughness is a physical parameter of surfaces which should include the surface complexity in geophysical models. In hydrodynamic modeling, e.g., roughness should estimate the resistance caused by the surface on the flow, or in remote sensing, how the signal is scattered. Roughness needs to be estimated as a parameter of the model. This has been identified as main source of the uncertainties in model prediction, mainly due to the errors that follow a traditional roughness estimation, e.g. from surface profiles, or by a visual interpretation and manual delineation from aerial photos. Currently, roughness estimation is shifting towards point clouds of surfaces, which primarily come from laser scanning and image matching techniques. However, those data sets are also not free of errors and may affect roughness estimation.

Our study focusses on the estimation of roughness indices from different point clouds, and the uncertainties that follow such a procedure. The analysis is performed on a graveled surface of a river bed in Eastern Austria, using point clouds acquired by a triangulating laser scanner (Minolta Vivid 910), photogrammetry (DSLR camera), and terrestrial laser scanner (Riegl FWF scanner). To enable their comparison, all the point clouds are transformed to a superior coordinate system. Then, different roughness indices are calculated and compared at different scales, including stochastic and features-based indices like RMS of elevation, std.dev., Peak to Valley height, openness. The analysis is additionally supported with the spectral signatures (frequency domain) of the different point clouds.

The selected techniques provide point clouds of different resolution (0.1–10cm) and coverage (0.3–10m), which also justifies the multi-scale roughness analysis. By doing this, it becomes possible to differentiate between the measurement errors and the roughness of the object at the resolutions of the point clouds.

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