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Segment based shape matching in terrestrial laser scanning point clouds

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Change detection of dynamic surface elements is an important application in geomorphological analysis. In order to be able to investigate such changes, the high spatial resolution and accuracy of the laser scanning technology is exploited. Dealing with laser scanning data, most change detection approaches are aiming at the assessment of volumetric changes due to erosion and deposition by geomorphologic processes. In these cases the areas of erosion and deposition are spatially separated and can be investigated in a cut-and-fill analysis.
Where slow changes are controlled by interior deformation of material mixtures due to gravity, surface changes are mostly due to slight movements of objects and not to absolute material losses and gains. In complex terrain an object-based approach for the reconstruction of 3D change vectors is required.
Depending on the level of scale, terrain can be subdivided into a large number of small planar patches. Using 3D point cloud data from terrestrial laser scanning, this can be done by a planar segmentation procedure grouping laser points of flat surfaces. Rotating each point cloud segment into its best fit plane, its 2D footprint shows specific local surface characteristics. Thus, each surface patch has a unique fingerprint that can be described by a variety of segment features.
In an experimental framework we test the capability of shape based matching for the derivation of change vectors on dynamic surfaces. To consider different data characteristics such as varying point densities and scan perspectives, terrestrial laser scans of a rock glacier are acquired from three positions with an Optech ILRIS3D terrestrial laser scanner. Additionally, the point density is manipulated in order to simulate three different levels of point density. For the matching of surface patches, we test various non-metric shape features such as roundness, concavity and elongation. Besides, we use metric shape features such as patch area, perimeter and the modified Hausdorff-Distance for the detection of similar patches.
Comparing metric and non-metric segment features the non-metric features show a more robust matching of surface patches in point clouds with differing point density and perspectives. However, with high point densities and similar scan perspectives, a combination of non-metric and metric features shows the best matching results.