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# Automatic derivation of natural and artificial lineaments from ALS point clouds in floodplains

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Water flow is one of the most important driving forces in geomorphology and river systems have ever since formed our landscapes. With increasing urbanisation fertile flood plains were more and more cultivated and the defence of valuable settlement areas by dikes and dams became an important issue. Today, we are dealing with landscapes built up by natural as well as man-made artificial forces. In either case the general shape of the terrain can be portrayed by lineaments representing discontinuities of the terrain slope.

Our contribution, therefore, presents an automatic method for delineating natural and artificial structure lines based on randomly distributed point data with high density of more than one point/m2. Preferably, the last echoes of airborne laser scanning (ALS) point clouds are used, since the laser signal is able to penetrate vegetation through small gaps in the foliage. Alternatively, point clouds from (multi) image matching can be employed, but poor ground point coverage in vegetated areas is often the limiting factor.

Our approach is divided into three main steps: First, potential 2D start segments are detected by analyzing the surface curvature in the vicinity of each data point, second, the detailed 3D progression of each structure line is modelled patch-wise by intersecting surface pairs (e.g. planar patch pairs) based on the detected start segments and by performing line growing and, finally, post-processing like line cleaning, smoothing and networking is carried out in a last step.

For the initial detection of start segments a best fitting two dimensional polynomial surface (quadric) is computed in each data point based on a set of neighbouring points, from which the minimum and maximum curvature is derived. Patches showing high maximum and low minimum curvatures indicate linear discontinuities in the surface slope and serve as start segments for the subsequent 3D modelling. Based on the 2D location and orientation of the start segments, surface patches can be identified as to the left or the right of the structure line. For each patch pair the intersection line is determined by least squares adjustment. The stochastic model considers the planimetric accuracy of the start segments, and the vertical measurement errors in the data points. A robust estimation approach is embedded in the patch adjustment for elimination of off-terrain ALS last echo points. Starting from an initial patch pair, structure line modelling is continued in forward and backward direction as long as certain thresholds (e.g. minimum surface intersection angles) are fulfilled. In the final post-processing step the resulting line set is cleaned by connecting corresponding line parts, by removing short line strings of minor relevance, and by thinning the resulting line set with respect to a certain approximation tolerance in order to reduce the amount of line data. Thus, interactive human verification and editing is limited to a minimum.

In a real-world example structure lines were computed for a section of the river Main (ALS, last echoes, 4 points/m2) demonstrating the high potential of the proposed method with respect to accuracy and completeness. Terrestrial control measurements have confirmed the high accuracy expectations both in planimetry (<0.4m) and height (<0.2m).