Adaptive Stopping Criterion for Normalized Cut Segmentation of Single Trees in ALS Point Clouds of Temperate Coniferous Forests

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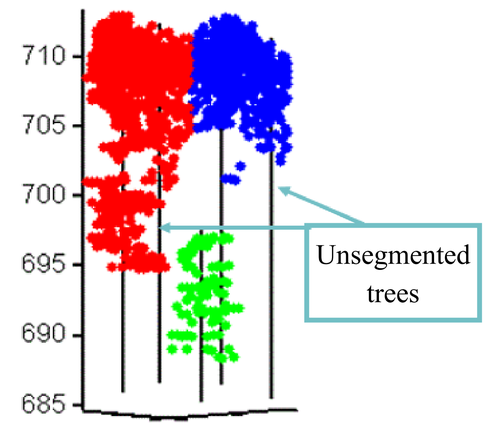
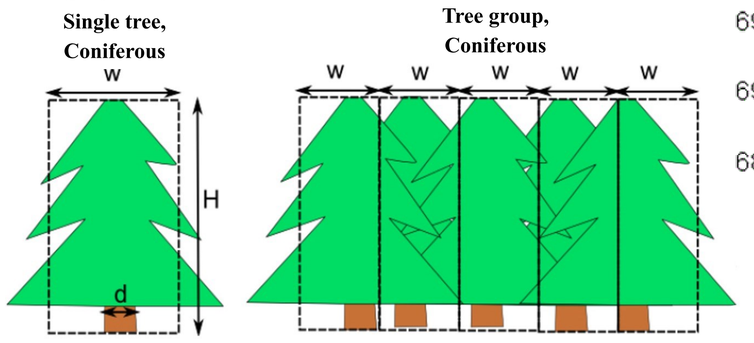
Problem:

Normalized Cut segmentation is an established approach for 3D delineation of single trees in ALS point clouds. However, overlapping crowns and branches of many close-by trees may cause over- and under-segmentation due to the difficulty of defining an appropriate criterion for stopping the partitioning process.



Contribution:

- to investigate the stopping criterion based on a classifier which replaces the static Ncut value
- to adaptively detect tree crowns by the classifier which is trained based on spatial relationships of paraboloids fitted to candidate tree tops
- to determine whether the currently processed point cluster represents a single tree or multiple trees.

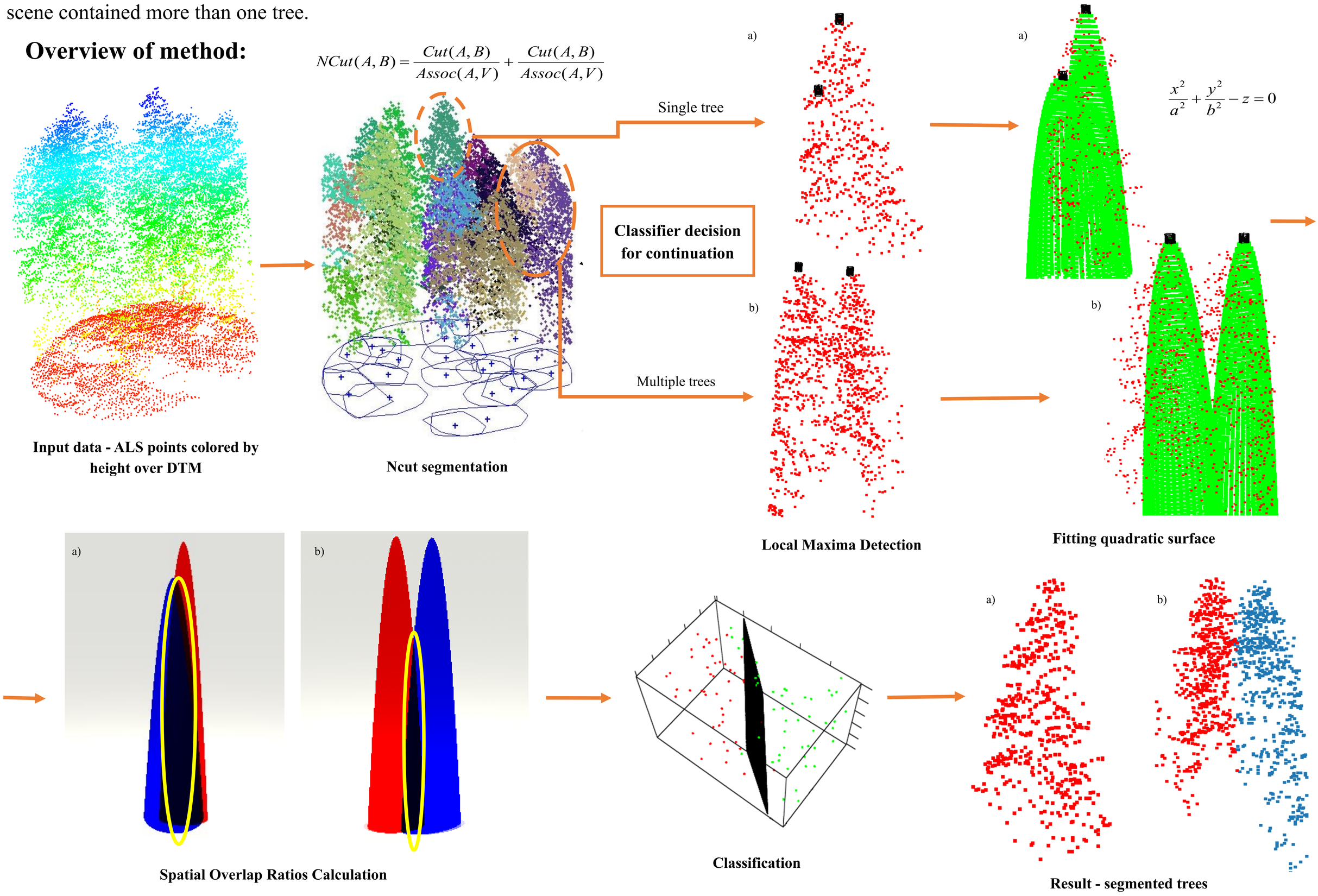


Test Plots:

The airborne full waveform data were acquired using a Riegl LMS-680i scanner in 2012 in a leaf-on condition with a nominal point density of 30 pts per m^2. We prepared 100 point cloud clusters covering two scenarios of a single tree vs. multiple trees within the scene. The multiple tree clusters are chosen from erroneous results of the normalized cut segmentation which uses the static Ncut stopping criterion, i.e. where the partitioning was stopped although the scene contained more than one tree.

Overview of method:

$$NCut(A,B) = \frac{Cut(A,B)}{Assoc(A,V)} + \frac{Cut(A,B)}{Assoc(A,V)}$$



Results:

We utilized 40 of the 100 clusters for training an SVM as the tree top classifier by manually labeling the surfaces fitted to a subset of extracted local maxima. The remaining clusters were processed according to the described pipeline, yielding 'stop' or 'continue' decisions for every test case. The overall accuracy of the proposed adaptive stopping criterion was 0.8, with a weighted Cohen's κ of 0.59.

Outlook:

- to continue the experiment on the deciduous trees as well,
- to incoporate other information into decision process (e.g. concave hull).