Fully-automated Occlusion-insensitive Norway Spruce Tree Reconstructions from 3D Point Cloud Data

1. Introduction and Motivation

- Trees play an important role in various ecosystem simulations and analyses
- Results strongly depend on the correctness and precision of the input parameters
- Extensive (and destructive) field work is often required to obtain the data
- Certain applications specifically require 3D models of the trees

- LIDAR (Light Detection And Ranging) technology captures only individual points
- New method for automatic reconstruction of 3D models of trees from given point clouds
- Aimed at Norway spruce trees
- Exceptionally difficult—frequent trunk occlusions caused by a high leaf density
- Results in large gaps in the scanned data (existing methods fail in such reconstructions)

2. Proposed Algorithm

- Three phases of the reconstruction:
  - Component identification: Spatially-related clusters of the points are identified
  - Component analysis: Branch structure is reconstructed in each identified component
  - Component connecting: All the components are interconnected to form the final tree branch structure

2.1 Component identification

- The input data consist only of the isolated points
- The algorithm constructs a neighborhood graph to introduce basic spatial relationships
- Close points connected, but no edges between different branches
- Results in a set of components, each consisting of spatially related points
- Points in one component belong to the same branch or trunk part

2.2 Component analysis

- Branch structure in each component has to be reconstructed
- The algorithm constructs a geodesic graph
  - Characterizes how the lengths of shortest paths from the designated source point gradually increase throughout the component (Figure 1 (right; warm colors))

2.3 Component connecting

- Extraction of a clean and reduced skeleton of every component is desirable
  - The algorithm ‘collapses’ points with similar distances from the source point, unless they clearly belong to different subbranches (Figure 1 (right; blue lines))

3. Conclusions and subsequent work

- Existing methods fail on sparse and non-uniform 3D point clouds
- We have proposed a novel, fully automated method for tree reconstructions
  - Does not require high-resolution data
  - Fairly insensitive to occlusion-induced artifacts in the point clouds
- Reconstructed models were used to derive branch statistics
  - Branch counts for different branch orders
  - Biomass volume estimations for individual branches

References