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A spectral clustering approach of vegetation components for describing plant topology and geometry from terrestrial waveform LiDAR data

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Computer models that treat plant architectures as a collection of interconnected elementary units (internode, petiole, leaf lamina), which are spatially distributed within the above- and/or the below-ground space, have become increasingly popular in the FSPM scientific community (DeJong *et al*. 2011). The core of such 3-D plant architecture models deal with contrasting reconstruction methods generally based on stochastic, fractal or L-system approaches, or by describing accurately the geometry of each plant component *in situ* using 3-D digitizing technology. These methods can approximate the geometry of many species for understanding and integrating plant development and ecophysiology, but have generally been applied at a small scale.

High-resolution terrestrial Light Detection And Ranging (tLiDAR), a 3-D remote sensing technique, has recently been applied for measuring the 3-D characteristics of vegetation from grass to forest plant species (Dassot et al. 2011). The resulting data are known as a point cloud which shows the 3-D position of all the hits by the laser beam giving a raw sketch of the spatial distribution of plant elements in 3-D, but without explicit information on their geometry and connectivity.

In this study we propose a new approach based on a delineation algorithm (Fig. 1) that clusters a point cloud into elementary plant units. The algorithm creates a graph (points + edges) to recover plausible neighbouring relationships between the points and embed this graph in a spectral space in order to segment the point-cloud into meaningful elementary plant units (Fig. 2). Our approach is robust to inherent geometric outliers and/or noisy points and only considers the *x*, *y*, *z* coordinate tLiDAR data as an input.

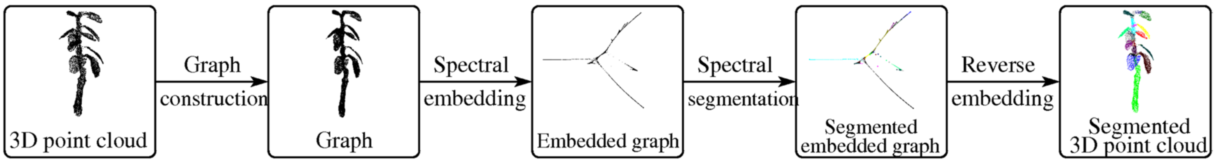

Fig. 1. Pipeline of the segmentation method proposed in this study.

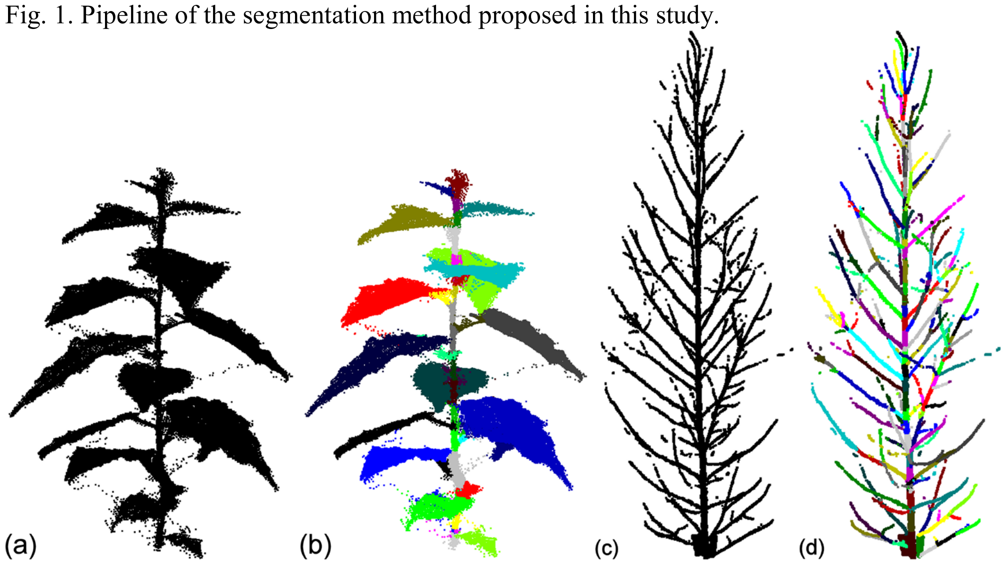

Fig. 2. Comparison of raw (a, c) and segmented (b, d) point clouds for a 0.4 m height poplar seedling (a, b) and a 3.7 m height eucalyptus tree.

Dassot M, Constant T, Fournier M. 2011. The use of terrestrial LiDAR technology in forest science: application fields, benefits and challenges. *Annals of Forest Science* **68**: 959-974.

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