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Radiometric and Geometric Approach for Major Woody Parts Segmentation in Forest LiDAR Point Clouds

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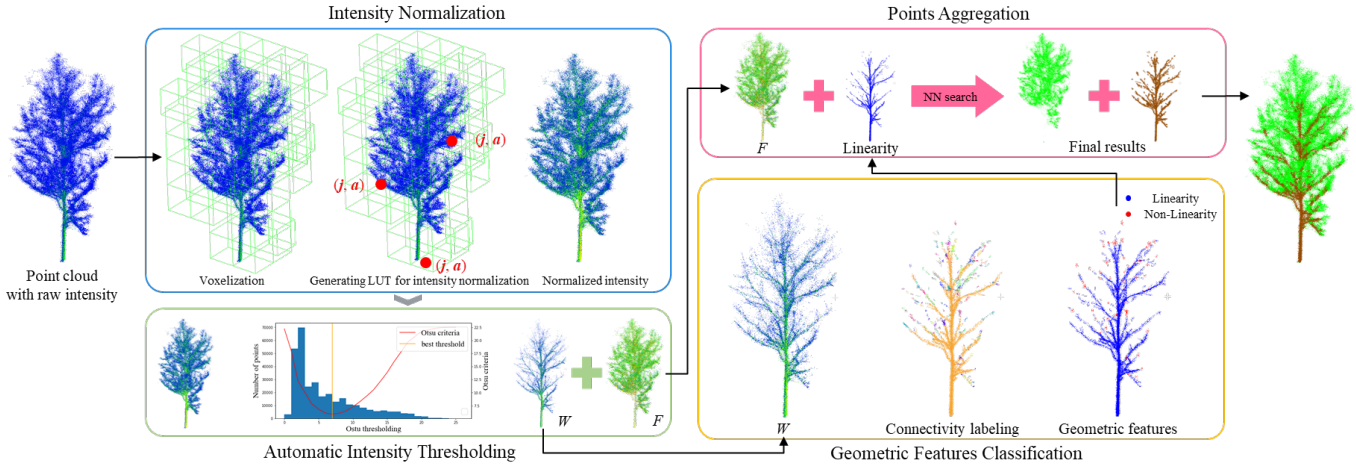

Abstract: We present a fast method for segmenting major woody parts using LiDAR data from a backpack Mobile Mapping System (MMS). Our method combines automatic thresholding of normalized radiometric and geometric features to extract major woody parts in point clouds. Compared to existing methods, our approach achieves higher performance on 14 trees with different sizes and species in both leaf-on and leaf-off seasons. Unlike static Terrestrial Laser Scanning, our MMS LiDAR data is more efficient and accurate due to its non-destructive and dynamic scanning capabilities. Our results demonstrate the potential of our method for deriving structural and biophysical attributes of trees. This research has been accepted by IEEE International Geoscience and Remote Sensing Symposium (IGARSS).

Introduction

Major woody parts dominate the majority of biomass and timber and so play an important role in a tree. Terrestrial Laser Scanning (TLS) has been used for major woody parts segmentation in recent years. However, TLS is slow and not scalable to capture large areas in a reasonable time. LiDAR intensity hasn't been fully exploited; it shows significant differences between major woody parts, twigs, and foliage. By using backpack LiDAR point cloud data, we propose a fully unsupervised method that combines normalized radiometric and geometric information.

Method

The proposed approach is described below:

1. Unsupervised intensity normalization (laser beam-based intensity normalization)1
2. Automatic intensity thresholding (Otsu's method, minimize intra-class variance)2
3. Geometric features classification (eigenvalue decomposition)
4. Major wood points aggregation (nearest neighbor search)

Results

Table 1. Comparison between the proposed method and prior works

Methods	Execution time	Precision	Recall	F1-score
[1]	3.5 h	0.46	0.55	0.50
[2]	15 s	0.68	0.72	0.70
Ours	**8 s**	**0.87**	**0.86**	**0.86**

Conclusions:

- Our approach is able to improve the accuracy of major woody parts segmentation across different tree species in different seasons.
- This research provides new potential for quick data acquisition and segmentation.
- We plan to expand this approach to major woody parts segmentation at the plot-level and stand-level.

FOR FURTHER READING:

[1] Moorthy, Sruthi M. Krishna, et al. "Improved supervised learning-based approach for leaf and wood classification from LiDAR point clouds of forests." IEEE Transactions on Geoscience and Remote Sensing 58.5 (2019): 3057-3070.
[2] Tan, Kai, et al. "Leaf and wood separation for individual trees using the intensity and density data of terrestrial laser scanners." IEEE Transactions on Geoscience and Remote Sensing 59.8 (2020): 7038-7050.