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Voxel-Based Automatic Tree Detection and Parameter Retrieval from Terrestrial Laser Scans for Plot-Wise Forest Inventory

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摘要 This paper presents a fully automatic method addressing tree mapping and parameter extraction (tree position, stem diameter at breast height, stem curve, and tree height) from terrestrial laser scans in forest inventories. The algorithm is designed to detect trees of various sizes and architectures, produce smooth yet accurate stem curves, and achieve tree height estimates in multi-layered stands, all without employing constraints on the shape of the crown. The algorithm also aims to balance estimation accuracy and computational complexity. The method’ s tree detection combines voxel operations and stem surface filtering based on scanning point density. Stem diameters are obtained by creating individual taper models, while tree heights are estimated from the segmentation of tree crowns in the voxel-space. Twenty-four sample plots representing diverse forest structures in the south boreal region of Finland have been assessed from single- and multiple terrestrial laser scans. The mean percentages of completeness in stem detection over all stand complexity categories are 50.9% and 68.5% from single and multiple scans, respectively, while the mean root mean square error (RMSE) of the stem curve estimates ranges from ±1.7 to ±2.3 cm, all of which demonstrates the robustness of the algorithm. Efforts were made to accurately locate tree tops by segmenting individual crowns. Nevertheless, with a mean bias of ?2.9 m from single scans and ? 1.3 m from multiple scans, the algorithm proved conservative in tree height estimates.

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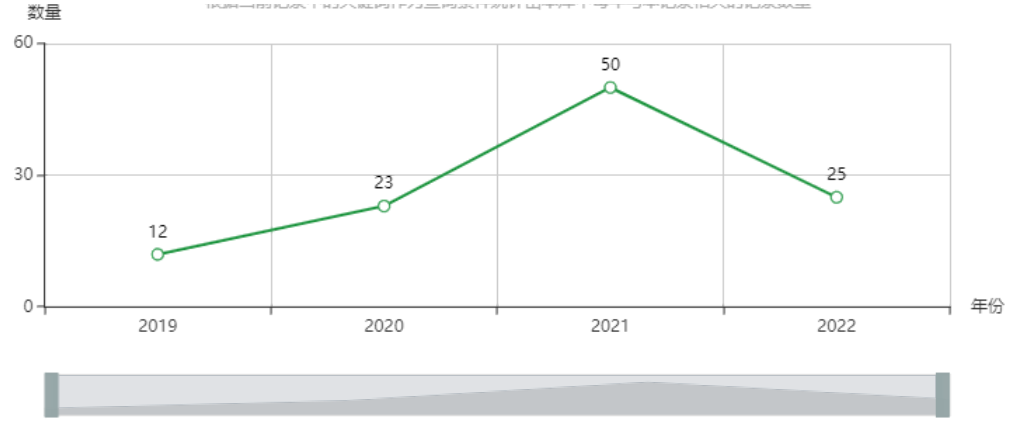
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