Repeatability of TLS-based tree diameters on permanent sample plots

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1. Introduction

Time series of traditional tree diameter measurements on permanent forest inventory sample plots may comprehend several decades, especially in NFI time series. Under such circumstances, the exact position on the stem, where a calliper is positioned to measure diameters (e.g. DBH) is critical. Stems cross sections are not perfectly circular, more often elliptic or irregular, especially regarding deciduous tree species. A slightly dislocated calliper can produce a significant failure which sometimes exceeds the annual increments between the measurements. For this reason, in a NFI-compliant TLS solution the scan accuracy and the scanner placement is critical for single stem related repeatability.

A second issue is the method of diameter extraction. Most often, stem related point clouds are fitted to cylinders. In this case, noise influences from sensor, multi-station-adjustment, bark and wind influences can hardly be separated. The method of arc-detection within single scan-lines (Eric Hyyppä et al 2020) allows more accurate and robust diameter extraction. However, arc-detection in scan-lines requires roughly horizontal scan lines and therefore a tilt mount for TLS devices.

This study investigates the influence of scan patterns, scan resolution and scan-line direction on repeatability of diameter results from point-clouds recorded with a Riegl VZ400i using a tilt mount.

2. Study area and data

The test site is an old-grown beach-dominated mixed stand near Vienna. In total, 6 circular sample plots with 20m radius were defined and the center points were permanently marked to follow up with future measurements. The trees are scanned from 12 scan positions using different patterns of scan positions, different scan resolutions and different direction of scan lines (vertical vs. horizontal). To estimate repeatability, the 12 scan positions are split into two sub-sets of 6 scan positions per sample plot per method (uneven and even numbers of scan positions). The results of the corresponding sub-sets are compared and evaluated regarding repeatability of tree diameters.

The data (point clouds as LAZ) will be made available for open access.

3. Methods

The scanner recordings and diameter extraction are currently in progress.

The method of diameter extraction is chosen to best fit to the scan method.
Three variants are investigated:

a) Vertical scan lines in 40x40 mdeg resolution, scan-positions in radius 20m round centre point; tree diameter by cylinder fitting

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b) Horizontal scan lines in 10x100 mdeg resolution, scan-positions in radius 20m round centre point; tree diameter by arc detection
c) Horizontal scan lines in 5x100 mdeg resolution, scan-positions in radius 2m round centre point; tree diameter by arc detection

We expect an enhanced diameter-related repeatability with horizontal scan lines and arc detection methods for diameter extraction. The results will be evaluated until the conference.

Outlook

Horizontal super-dense scan-lines from TLS scanning in forest environment in combination with arc-analysis for stem detection has a high potential for enhanced repeatability, especially regarding an accurate derivation of annual increments by time series of point clouds.

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