Production of valuable wood - determination of wood quality of standing trees using terrestrial laser scanners

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Introduction

Often comprehensive and very accurate information about trees and logs are indispensable. In the Flexwood project a system is being established to provide this kind of information by use of air and space born measurement techniques, terrestrial laser and detailed CT scanning. We present here a part of our results dealing with quality information of single trees out of terrestrial laser scan data.

Data basis

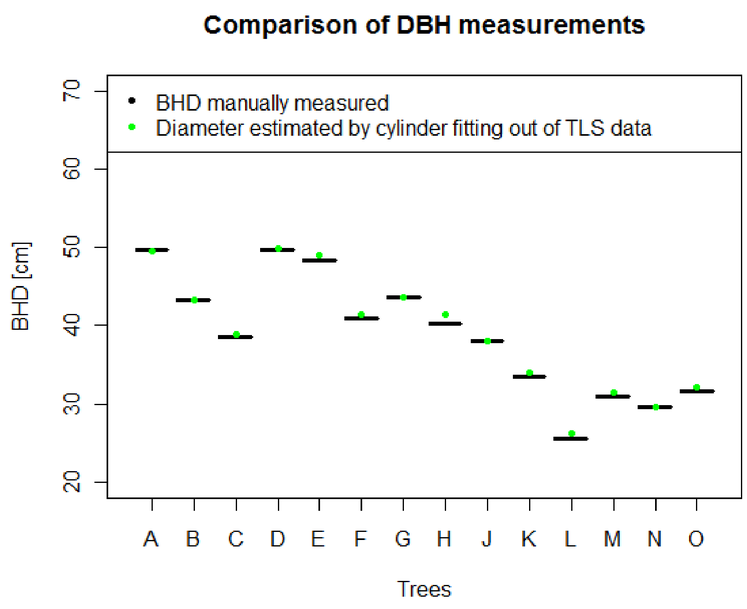
One of the Flexwood testsites is located in the Rhine-valley in south-west Germany close to the town Karlsruhe. Here, 14 beech trees (*Fagus sylvatica* L.) were scanned by a terrestrial laser scanner, all of them from four different sides. These scans were registered and in all the scans the stems up to the crown were extracted.

Stem quality

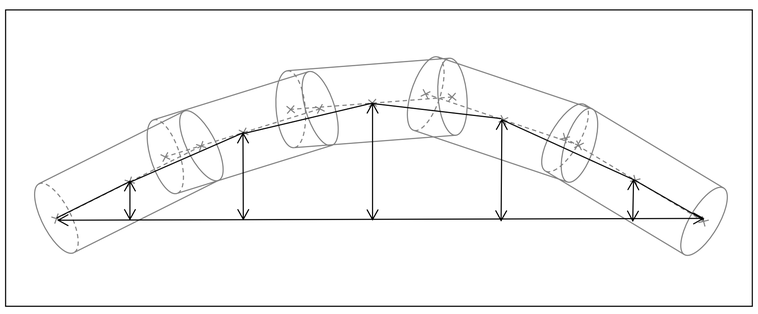
From these three-dimensional information the shape of the tree can be acquired. It can be used to deduce information about diameters in different heights and also sweep and taper. To allow for easier data handling all stems were approximated by consecutive cylinders.

Cylinder approximation of a tree stem visualized in one of the intensity images

The results show that the difference between the results gained by both methods lie between -1.19 cm and 0.25 cm. The maximum difference with more than one centimetre deviation can be regarded as an outlier and may be due to bad scanning data caused by obscuring vegetation. Even with this outlier the standard deviation is 0.36 cm.



Taper and sweep can be determined out of the cylinder approximation of the tree stem. To get the latter the middle axis of the stem is approximated by the axes of the fitted cylinders. Sweep can then be calculated in cm/m.



Bark characteristics

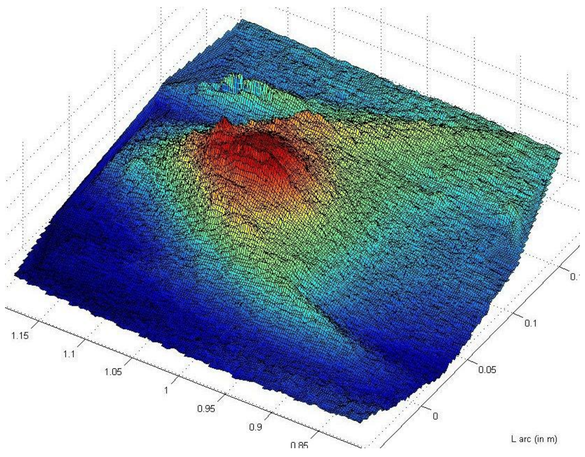
To get information about the interior quality of the tree stem bark characteristics were identified within the terrestrial laser scan data. Additional to existing algorithms a new approach was deduced to visualize the characteristics as a height model based on the flat bark as the ground surface.

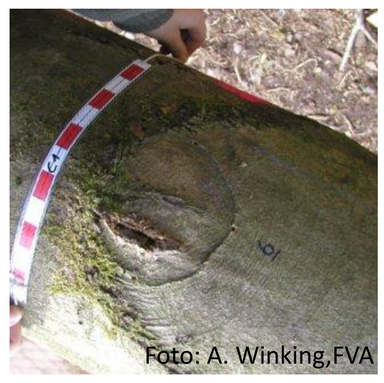
To do so, the coordinates x, y, and z were replaced by L, $z_{Cylinder}$, d:

$$L = R \cdot \phi - 2 \cdot \pi \cdot R$$

$$d = \sqrt{(x - x_P)^2 + (y - y_P)^2} - R$$

Where R is the distance of point xP, yP and zP to the tree axis. Together with $z_{Cylinder}$ being the distance on the tree axis it is calculated by a cylinder approximation of the stem. Φ is the angle in this polar coordinate system.





Three-dimensional shape of a bark characteristic

Height and width of the bark characteristic were measured by use of terrestrial laser scanning and manually. The deviations are below one centimetre.

Connection to interior information

All 14 trees were also interiorly scanned by a CT device by one of the project partners. Within this project a connection of the exterior scanned data to the CT data will be established which allows to deduce interior information of standing trees by analyzing data gathered prior to felling the tree.

Acknowledgement

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