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USE OF TERRESTRIAL LASER SCANNING IN THE PRECISE DETERMINATION OF GEOMETRICAL FEATURES CHANGES OF *GINKGO BILOBA* L.

Ľuboš MORAVČÍK

Slovak University of Agriculture in Nitra, Slovakia

This contribution is aimed at utilization of terrestrial laser scanning for geometrical feature extraction of the single tree, whereby the basic geometrical properties like tree height, shape and volume of the stem and crown, orientation and length of primary branches were under examination. Modern computer graphics like point clouds postprocessing and 3d vector graphics was used for precise determination of spatial and geometrical changes of the tree parameters in the period of two years.

Introduction

High speed 3D-laser scanners measure up to 1 million points/second between the instrument and its surrounding at regular horizontal and vertical angles (Shan and Thoth, 2008), which increased the resolution of the resulting 3D-point clouds dramatically, so this method can be used for measuring of complete tree structure from both terrestrial and mobile equipment.

Data acquisition with remote sensing is coming to the front of attention, because technics based on laser and optical sensors like laser scanning and photogrammetry provide spatial and metric data for further extraction and derivation of various information.

The objective of this contribution is an extraction of precise geometric data from single tree point model obtained from high resolution ground laser scanning. Following parameters of the tree models were evaluated: (1) Diameter of the trunk at breast height; (2) Height of the tree; (3) Canopy shape and volume; (4) Primary branches layout and length.

Material

The terrestrial laser scanning (TLS) was performed on the single *Ginkgo biloba* L. whereby tree point model acquisition in two different period of time 04/2012 and 03/2014 was done. The scanning was accomplished on 360°/270° degree (horizontal/vertical field of view with a "high" resolution (0.05 m/0.05 m on 100 m). The data acquisition (scanning/picture taking), registration, point cloud cleaning and multi image applying were done by author.

Method of Reconstruction and Modeling

Single tree parameter estimations are commonly based on points height above the ground. The crown shape can be described by the set of horizontal and/or vertical sections in closed forms like polygons (Wezyk et al., 2007) or circles (This and Spiecker, 2004). The trunk detection in this contribution is based on horizontal cross-sectional slices derivated from the point cloud model of the tree. The tree height can be calculated as the vertical distance between the projected ground point and highest point of the tree.

The acquisition of the point model of *Ginkgo biloga* L. tree was performed by 3D laser scanner Leica C10, whereby the 2 measurements from two opposite sides were taken (Fig. 2). The particular scans were registered

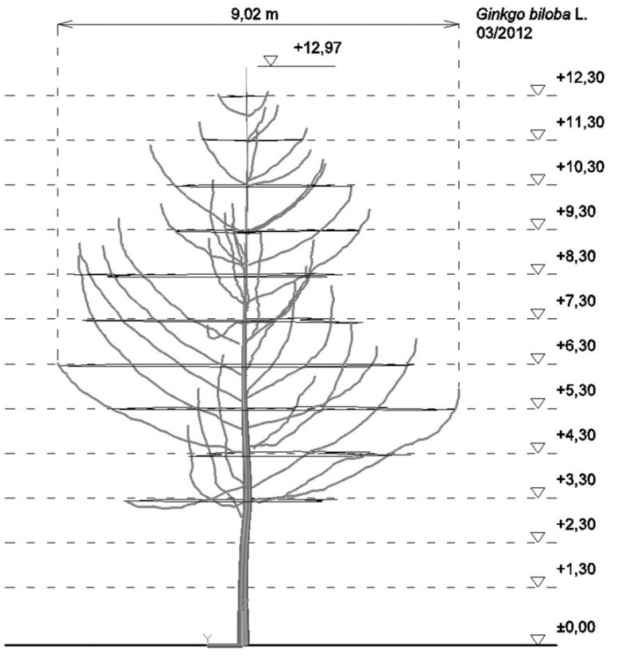

Figure 1 Vector model of the *Ginkgo biloba* L. tree (crown shape modeling by the set of closed horizontal polygons)

*Correspodence: Ľuboš Moravčík, Slovak University of Agriculture in Nitra, Faculty of Horticulture and Landscape Engineering, Department of Garden and Landscape Architecture, Tulipánová 7, 949 01 Nitra, Slovakia

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Figure 2 Southern-side view on the registered point cloud model of the *Ginkgo biloba* L.

in HDS-Cyclone/Register software and the final point cloud was cleaned and cut around the tree. A binary form of point cloud *.PTS was exported from HDS Cyclone software and trough Autodesk RECAP utility prepared for importing into AutoCAD vector editor for final postprocessing.

The horizontal sections of the final point cloud were performed at the bottom of the trunk, brest height (+1.30 m above the ground) and at additional elevations in the vertical distance of +1.00 m (Fig. 1).

The vector model of the tree trunk was created by the means of lofting function applied on the block of

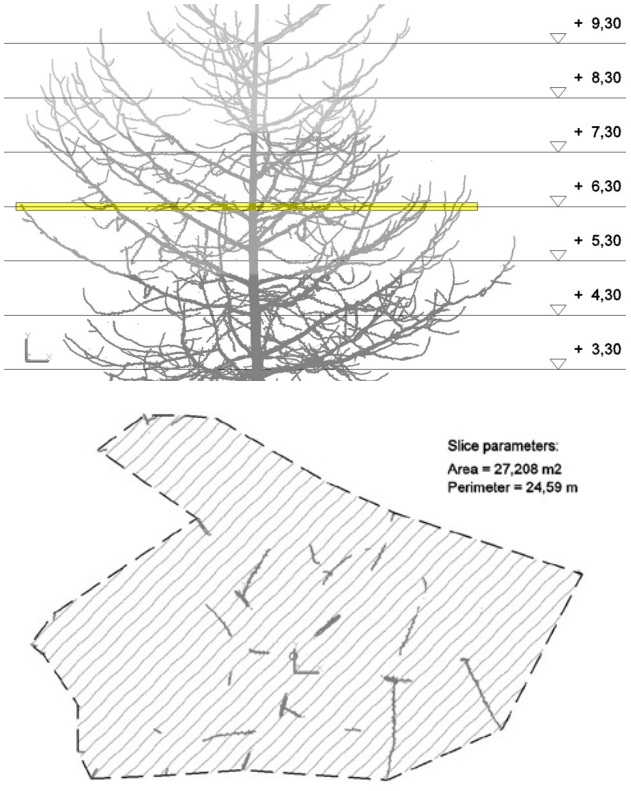

Figure 3 Horizontal slice of the point cloud model of the *Ginkgo biloba* L. (03/2012) at the +6.30 m height front view (above) and top view (below)

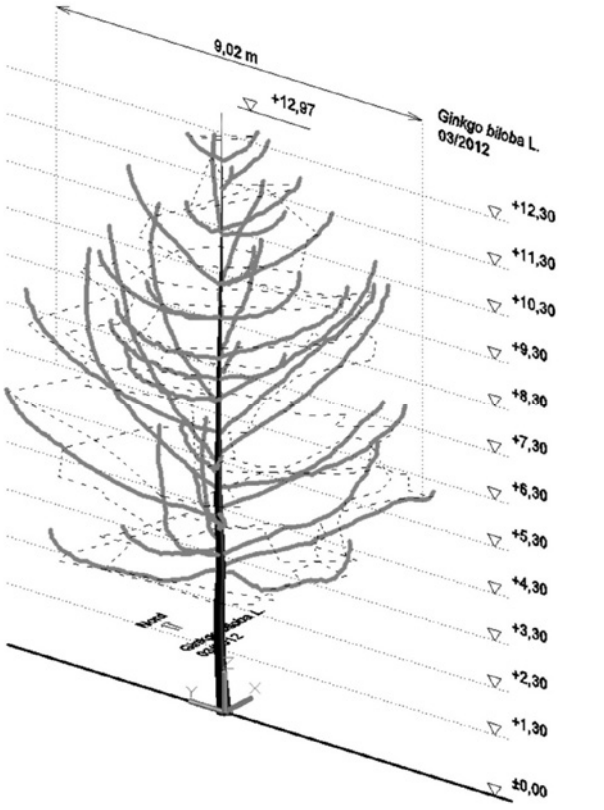

Figure 4 Axonometric view on vector model of *Ginkgo biloba* L. tree (consisting of stem and primary branches)

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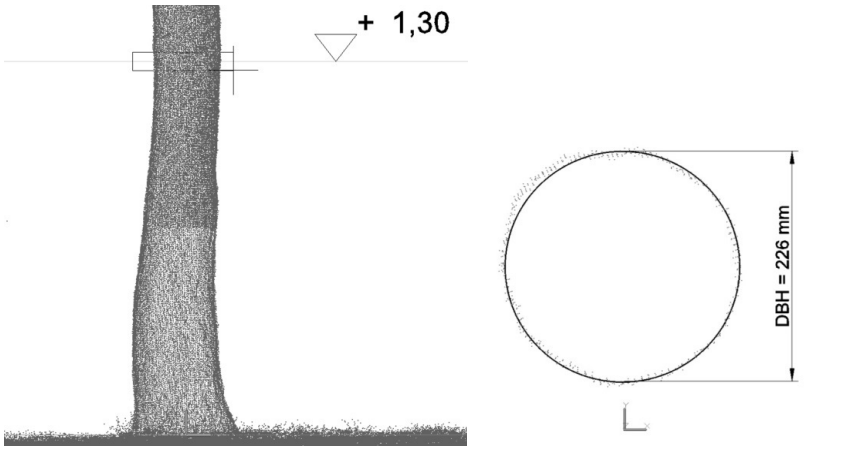

Figure 5 Extraction and modeling of the trunk diameter at the breast height (DBH)

Table 1 Evaluation of derivated and calculated geometrical features changes of the *Ginkgo biloba*

Geometrical parameter	Value of parameter		Increase 2012–2014	
	03/2012	03/2014	absolute	relative
Tree hight in m	12.97	13.33	0.36	2.78%
DBH in mm	226	236	10	4.42%
Stem volume in m³	0.14405	0.14577	0.00172	1.19%
Crown volume in m³	128.18	137.12	8.94	6.97%
Total primary branches length (summary in m	127.87	128.79	0.92	0.72%

12 circles. The CAD-model of the tree crown is represented as a group of horizontal polygons forming the envelopes of the points cloud at corresponding elevations (Fig. 3). The primary branches were generated manually and represented in the form of 3d-polylines connected to trunk model (Fig. 4).

Results and discussion

The basic feature extracted from the registered point cloud model was the diameter of the trunk at brest height (Fig. 5). Additionally other geometrical parameters like tree height, stem and crown volume and length of primary tdifference between the highest measurement point and the ground height at trunk location. In order to get the ground height, DTM was used.

The result is a compared parameters of the reconstructed tree stem, crown and primary branches. The differences in evaluation of specified parameters are shown in Table 1, which contains compared parameters of the investigated tree graphically derivated from high resolution point models. The differences are given in both relative and absolute values.

Conclusions

This paper presents an approach to extract geometrical parameters (like primary branch lengths, stem and crown volume, etc.) from precise single *Ginkgo biloba* L. tree model based on the terrestrial laser scanning and graphical postprocessing. On selected tree measurements were taken in time interval of two years (03/2012 and 03/2014).

This contribution deals with use of modern information technologies like terrestrial laser scanning and 3d graphical postprocessing in the process of geometrical changes investigation of single tree. The measurements of leafless *Ginkgo biloba* L. tree were taken in time-period of 2 years (03/2012 and 03/2014), whereby the specific geometrical parameters like primary branch lengths, stem diameter and heading, crown volume, etc. were compared. For the graphical postprocessing of point clouds the vector editor AutoCAD 2015 and point cloud software HDS Cyclone were used. Further research will be aimed at automated extracting of geometrical parameters from point model of single tree obtained by terrestrial laser scanning.

Acknowledgements

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