Can Handheld LiDAR Replace Traditional Forest Inventory?
Insights for Individual Tree Volume Estimation in a Mediterranean Mixed Forest, Northern Spain

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Background

Efficient and accurate estimation of stem volume at the single-tree level is crucial for effective forest management, including biomass and timber production. In this communication we insight into the potential of LiDAR Handheld Laser Scanner (HLS) technology for automating single-tree stem volume measurements in mixed forest stands, aiming to replace traditional forest inventory (FI).

How does it work?

The goal was to assess the accuracy of tree attributes, such as tree height and diameter at breast height (dbh), and also stem volume derived from LiDAR HLS data.

A mixed forest stand dominated by pinewoods (*Pinus halepensis* and *Pinus pinea*) with oak (*Quercus faginea*) and cypress (*Cupressus sempervirens*) trees in Castilla and León region (Spain) was chosen as the study area. The study was carried out with 160 reference trees throughout 9 plots located in the same stand. The data was processed using two different open-source tools; Forest Structural Complexity Tool (FSCT) and Cloud Compare (CC) to determine the most suitable tool for tree identification, and attribute measurements. Subsequently, the results were compared with traditional forest inventory data.

Figure 01: Handheld Laser Scanner (HLS)

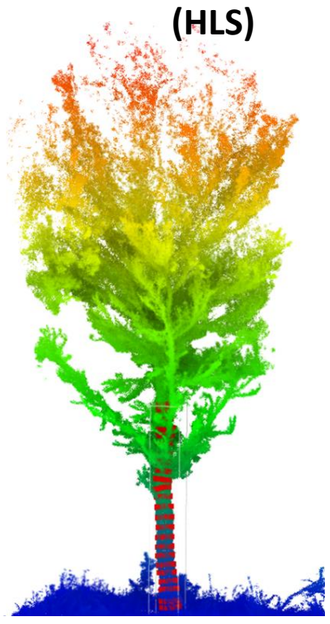


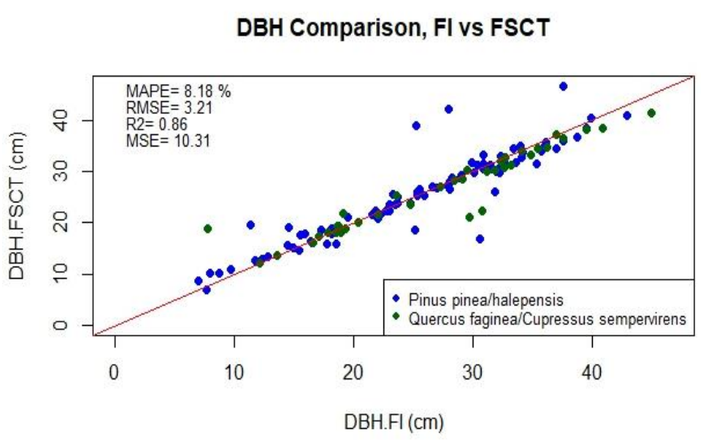
Figure 02: Stem volume measurement using FSCT

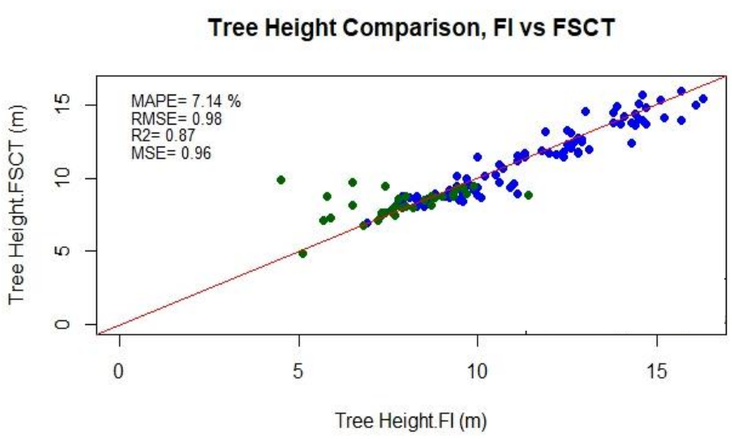
Table 01: Tree Species Identification by FSCT and CC

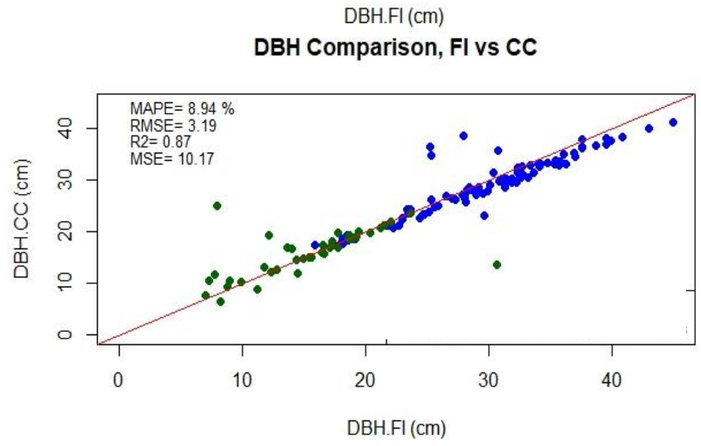
Tree Species	FSCT	CC
Pinewood	95.6%	96.7%
Oak & Cupressus	52.2%	64.1%
Total	77.5%	83.1%

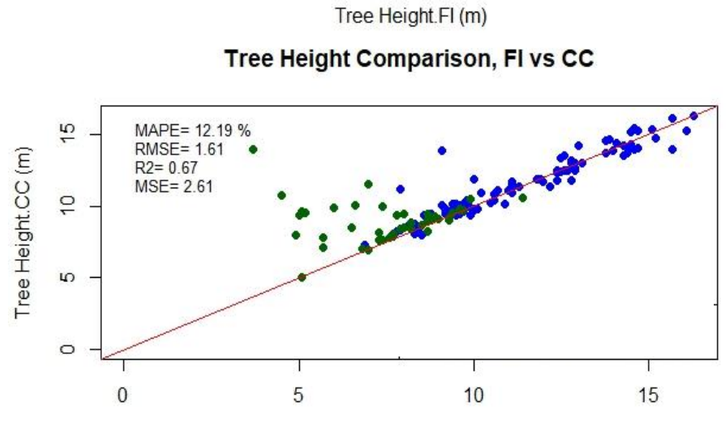
Table 02: Mean Absolute Percentage Error (MAPE) Values

Attributes	FSCT	CC
dbh	8.81%	8.94%
Tree Height	7.14%	12.19%









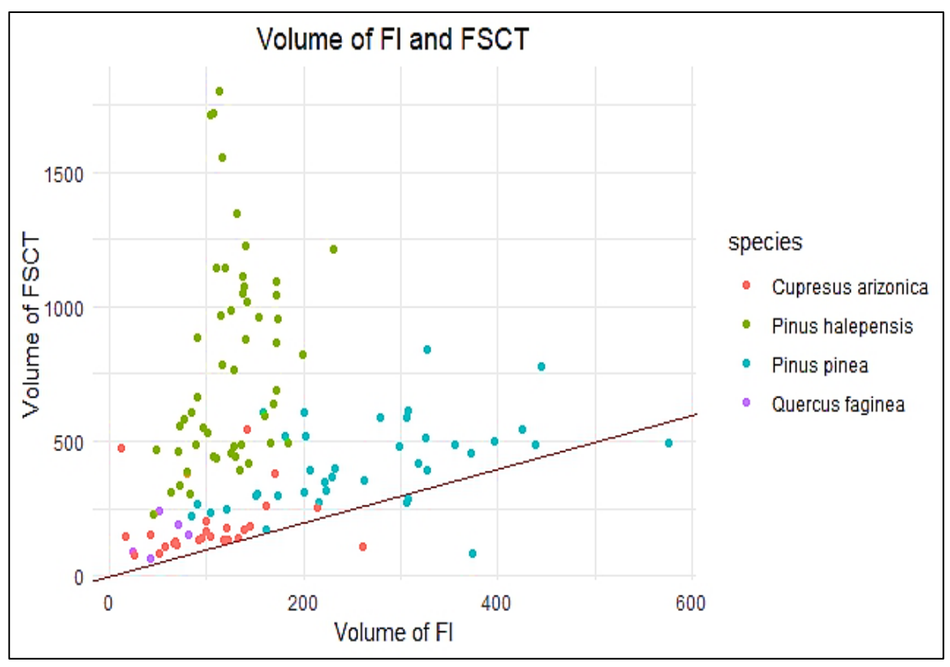


Figure 03: Comparison of SNFI equation volumes and FSCT volume measurements

Conclusions

Upon closer examination, we observed that both FSCT and CC exhibited better performance in identifying and estimating attributes of pinewoods, while it`s poor in oak and cypress trees within the mixed forest stand. Volumes calculated from SNFI equations were underestimated than FSCT volume measurements. There is a clear deviation of *Pinus halepensis* volumes derived from the SNFI equation and FSCT.

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