vEGU 2021

A stepwise approach for deriving timber assortment of trees from Terrestrial Laser Scanning data

Alvites C., Santopuoli G., Hollaus, M., Pfeifer, N., Mauro M., Moresi F.V. , Marchetti, M., Lasserre,B..

Introduction

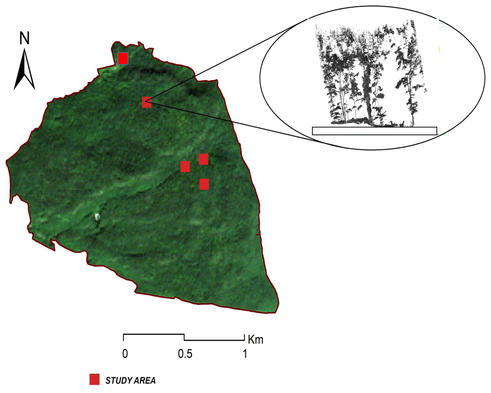
Providing accurate and reliable approach for extracting the timber assortment information from tree stands became crucial in forestry sector, especially in managed forests (Marchetti et al. 2018; SoEF 2020). Recent studies using TLS have reported a great capacity for reconstructing the trees for upper, intermediate and lower canopy layers, however, its accuracy was conditioned by the operational (i.e. sampling design), the technical (i.e. automatically), the weather condition (i.e. wind) and the forest structure (i.e. stem density) (Dassot et al. 2011; Liang et al. 2018; Wan et al. 2019). In 2004, the cylinder-fitting approach was introduced as useful tool for measuring the diameter at breast height of trunks on TLS point cloud; while now this approach proved to be efficient for reconstructing the trunk section on TLS point cloud, namely stem curve. However, to date, the use of the cylinder-fitting approach for retrieving quantitative and qualitative information of the logs belonging to the trunk section on TLS point cloud has not been investigated. In this context, this study introduces a stepwise approach for timber assortment assessments using TLS point cloud in a mixed tree-species and multi-layered Mediterranean forests

Aim

The aim of this study is to introduce a stepwise procedure for timber assortment assessment from standing trees using Terrestrial Laser Scanning (TLS) data in a mixed-forest and multi-layered Mediterranean forest.

Materials and Methods

Study area and Ground truth field data

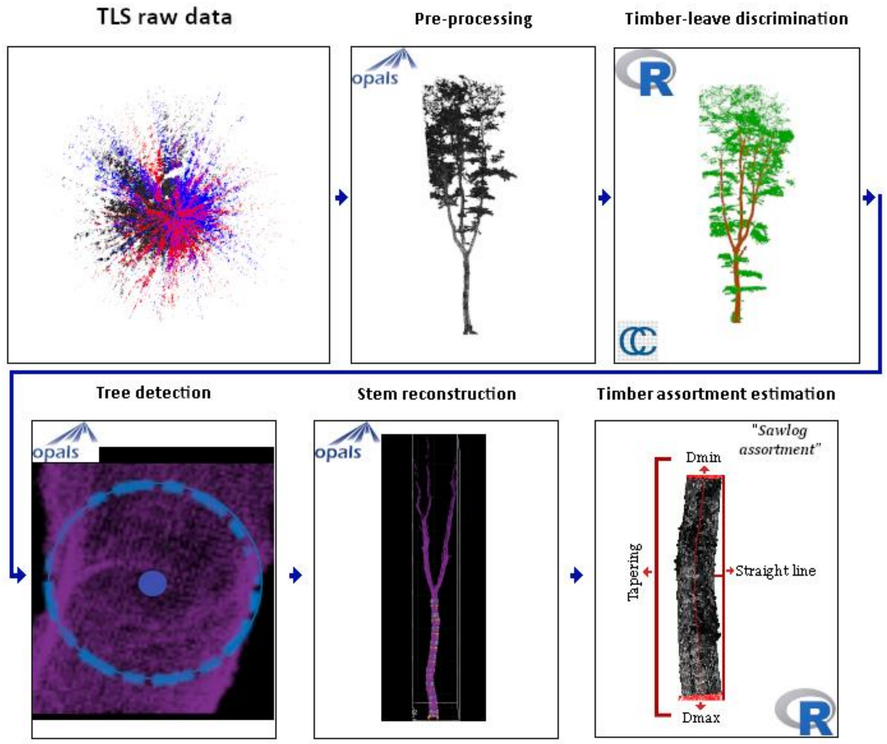


The work is carried out in 5 square areas covering 530m² located in the “Bosco Pennataro”. This natural forest area is dislocated in the north-western part of Molise Region in central Italy. Forest species dominant are mainly deciduous such as *Q. cerris* (40%), *F. sylvatica* (21%), *A. obtusatum* Mill. (9.6%), and other broadleaves tree species (Santopuoli et al. 2019). Nowadays, Bosco Pennataro is recognized as a core area of Man and Biosphere (MaB) reserve (MaB reserve of Collemeluccio-Montedimezzo Alto Molise) and also is a Site of Natura 2000 network.

Terrestrial Laser Scanning (TLS) data

The TLS device (Leica ScanStation P30/40) was used to collected the point density in Bosco Pennataro. The collection was carry out on July 2018, by the collaboration with University of Tuscia. Accuracy of pulse was equal to 2mm of standard deviation at 50 meters (Leica Geoystems, 2015). The co-registration was supported by the GPS Trimble GeoXT with Hurrican Antenna. The scanning registration was supported by four reflector dislocated on several points within to study area to calibrate the point cloud. The LiDAR device was mounted on a tripod enabling to collect an average density of 50 million for each study area.

Workflow of the processing of TLS data



Results

Timber-leaves discrimination of TLS point clouds was highly accurate, reaching an average accuracy of 0.98. We were able to detect 151 out of 178 reference trees, accounting for 84.4 % (SD± = 4.7 %). An improved detection accuracy was observed for trees with a DBH higher 30 cm due to all trees were correctly identified. As concern the stem reconstruction, we were capable to reconstruct 47 out of 70 large reference trees. The performance of the reconstruction proved to be accurate due to more than three-quarters of the trunk section was reconstructed for these 47 reconstructed trees, in details 88.1% (SD = ±16.7%). The stepwise approach allowed us to quantify 134 out of 179 reference merchantable logs, reaching an accuracy equal to 75% (134 out of 179 reference merchantable logs). These 134 merchantable logs were classified in 11 out of 15 type of assortments. The classification of merchantable logs was more accurate for eight assortment types (i.e. some sawlog, pulpwood and other industrial roundwood), which was ± 2 merchantable logs.

Conclusion

This study proposes, for first time, a stepwise approach for retrieving the qualitative and quantitative information of the timber assortment on TLS point cloud in mixed-species and multi-layered forests. Our stepwise approach proved to be efficient for separating the timber from leave points. This outcome allowed us to better identify and reconstruct the trunk of trees. In fact, all tree with a DBH higher than 30 cm were correctly identified. Moreover, the cylinder-fitting approach proved to be accurate in the reconstruction of eight trees species with a DBH higher 20 cm, especially for *Q. cerris*. The cylinder-fitting approach proved to be competitive in comparison with several similar algorithms, it allowed us to accurately reconstruct the trunk section of trees, regardless the stem form, presence of bulges, microhabitats.