A preliminary analysis of *Eucalyptus* stand density from a high-density uav laser scanning data

João Marcos Rebessi de Sousa[1]; Saulo Philipe Sebastião Guerra[2]; Romain Silberger[3]; Nicolas Seube[4]; Louise Berger[5]; Humberto de Jesus Eufrade-Junior[6].

* Forest Engineer; Master student in São Paulo State University, UNESP, Botucatu (SP); jmr.sousa@unesp.br
[2] Forest Engineer; Professor; São Paulo State University, UNESP, Botucatu (SP)
[3] Master Engineer; Managing Director; Microdrones; São Paulo (SP)
[4] Applied Mathematics; Director R&D; Mdinfinity; França
[5] Master; Geomatics R&D engineer; Mdinfinity; França
[6] Forest Engineer; Professor; São Paulo State University, UNESP, Botucatu (SP)

Remote sensing using Light Detection and Ranging (LiDAR) technology has been increasingly used to quantify forest resources. The survey of the quantitative characteristics of trees and stands is essential for forest planning and management. When the laser scanning is embedded in an unmanned aerial vehicle (UAV-LS), a dense three-dimensional (3D) point cloud is obtained and has presented as an alternative to terrestrial scanning systems. The UAV-LS technology has not yet been thoroughly evaluated at homogeneous *Eucalyptus* plantation forests managed with total density, and the challenges are still vast, ranging from UAV flight procedures and the extraction and modelling of LiDAR point cloud metrics. Thus, the objective of this study was to test algorithms already described for counting the number of trees in UAV-LS data. The study was performed in a six-year-old stand of *Eucalyptus* sp., planted at 3 m x 2 m spacing in 1.26 ha. The census of the experimental area and the counting of trees (1,292 trees) were carried out. The point cloud was obtained using the mdLiDAR1000LR sensor coupled to a drone, which flew over the area 50 meters above the ground at 4 m s^{-1}. LiDAR data was processed and analyzed in Rstudio software (Version 4.1.3) using the “lidR” package. To proceed with the data analysis, the digital terrain model (DTM), the digital surface model (DSM) and the canopy height model (CHM) were classified. The algorithms li2012 and dalponte2016 were used to segment the trees and to extract individual trees, we used the function "locate_tree”. In order to preliminary evaluate the algorithms for the quantification of individual trees, the number of predicted individuals in the area was compared with the number observed in the field, using some equations: (1) Absolute error (AE) = Nº tree. Predicted - Tree No. observed; (2) Relative error (RE) = AE / Tree No. Observed *100. The li2012 algorithm that performs the segmentation of the trees taking advantage of the relative spacing between the trees and presented a count of 1,279 trees (RE of 1% and AE equal to - 13 trees). For the dalponte2016 algorithm, there was a relative error of - 6.3% (AE = -81 trees). Although the algorithms presented relative accuracy in the count number, the next analyzes are being directed to evaluate the different types of segmentation generated in the point cloud processing (such as the presence of undetected trees and the false detection of trees).

Keywords: remote sensing, LiDAR, forest inventory, unmanned aerial vehicle.

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