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Accuracy of estimated geometric parameters of trees depending on the LIDAR data density

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The estimation of dendrometric variables has become important for spatial planning and agriculture projects. Because classical field measurements are time consuming and inefficient, airborne LiDAR (Light Detection and Ranging) measurements are successfully used in this area. Point clouds acquired for relatively large areas allows to determine the structure of forestry and agriculture areas and geometrical parameters of individual trees.

In this study two LiDAR datasets with different densities were used: sparse with average density of 0.5pt/m2 and the dense with density of 4pt/m2. 25 olive trees were selected and field measurements of tree height, crown bottom height, length of crown diameters and tree position were performed. To determine the tree geometric parameters from LiDAR data, two independent strategies were developed that utilize the ArcGIS, ENVI and FUSION software. Strategy a) was based on canopy surface model (CSM) slicing at 0.5m height and in strategy b) minimum bounding polygons as tree crown area were created around detected tree centroid. The individual steps were developed to be applied also in automatic processing.

To assess the performance of each strategy with both point clouds, the differences between the measured and estimated geometric parameters of trees were analyzed. As expected, the tree height were underestimated for both strategies (RMSE=0.7m for dense dataset and RMSE=1.5m for sparse) and tree crown height were overestimated (RMSE=0.4m and RMSE=0.7m for dense and sparse dataset respectively). For dense dataset, strategy b) allows to determine more accurate crown diameters (RMSE=0.5m) than strategy a) (RMSE=0.8m), and for sparse dataset, only strategy a) occurs to be relevant (RMSE=1.0m). The accuracy of strategies were also examined for their dependency on tree size. For dense dataset, the larger the tree (height or crown longer diameter), the higher was the error of estimated tree height, and for sparse dataset, the larger the tree, the higher was the error of estimated crown bottom height. Finally, the spatial distribution of points inside the tree crown was analyzed, by creating a normalized tree crown. It confirms a high concentration of LiDAR points inside the central part of a tree.