An image segmentation approach for improving the accuracy of individual crown delineation

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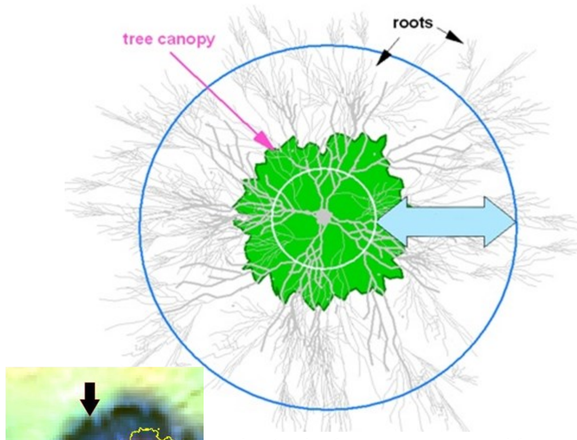
Introduction :

Sustainable forest management requires accurate information on **individual tree structure and crown concentration.** Remote sensing technologies have significant implications in forestry application. Isolating individual trees and extracting relevant tree structural parameters from the combination of high resolution multispectral satellite imagery and airborne LiDAR-derived Canopy Height Model (CHM) have significant implications in a variety of forest activities.

Earlier low resolution satellite imagery was not suitable for single tree approaches because of pixel size which was much bigger than the normal tree crown size. However, one of the main challenges of using multispectral imagery is the effect of tree crown shadows, branches and crown cluster gaps which normally cause a lower accuracy on the result of segmentation. The integration result of both datasets combined with normalized difference vegetation index (NDVI) layer by Marker-Controlled Watershed segmentation algorithm were slightly better, especially for crowns with poor spectral contrast with their shadows which is not easy to identify by only multispectral data layer. Although the proposed scheme would provide the better definition of the object homogeneity, the implementation increases the time of processing with the number of layers due to the individual segmentation of each layer. The method improved the tree crown delineation accuracy by 2.8% in comparison to using each data source independently, only in spares forest which consists more crown shadows and canopy gaps.



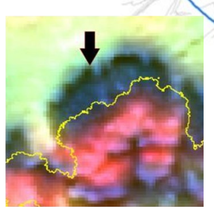


Fig. 1, single tree structure with branches and shadow

Investigate on different segmentation schemes:

Study area

- The Bois Noir (black wood) forest
- part of the Barcelonnette basin
- located in the southern French Alps
- mainly covered by coniferous plantation.

Airborne LiDAR data

- Airborne laser scanning system (RIEGL VQ-480)
- the mean point density was 160 points/m2

Multispectral GeoEye-2

- acquired in June 2012
- Obtained during cloud free and near nadir conditions
- 50 cm in panchromatic band and 2 meters in multispectral bands.

Field data

- Collected in 2012
- Selective 3 differnt canopy density (low-medium and high)

Fig. 2, Map of study area in south France, Barcelonnette.

Fig. 3, The forest predominantly consists of mountain pine (Pinus uncinata) and scots pine (Pinus sylvestris).

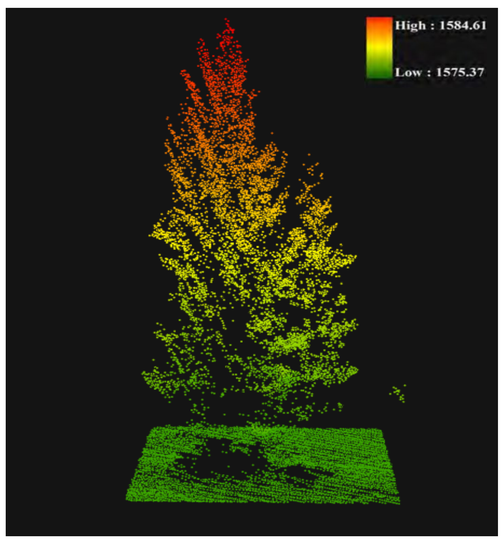
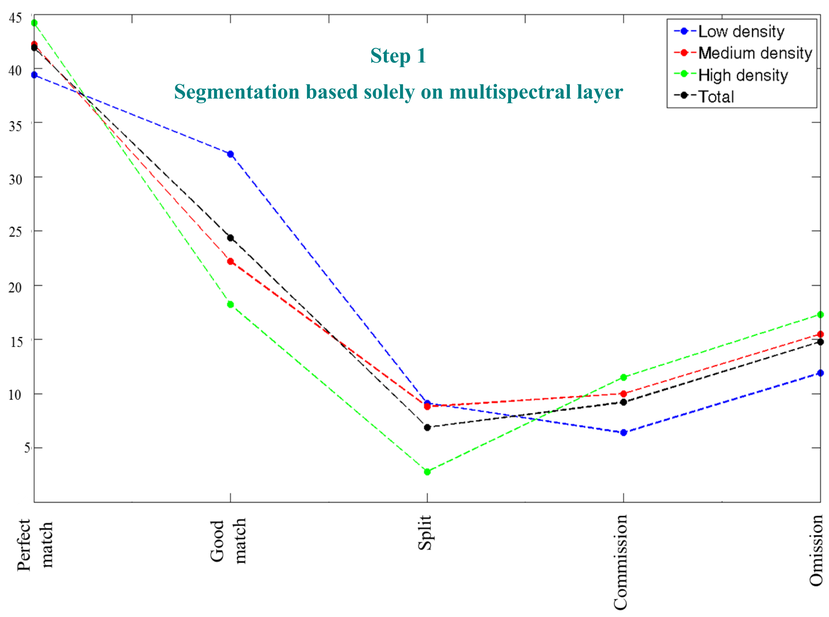
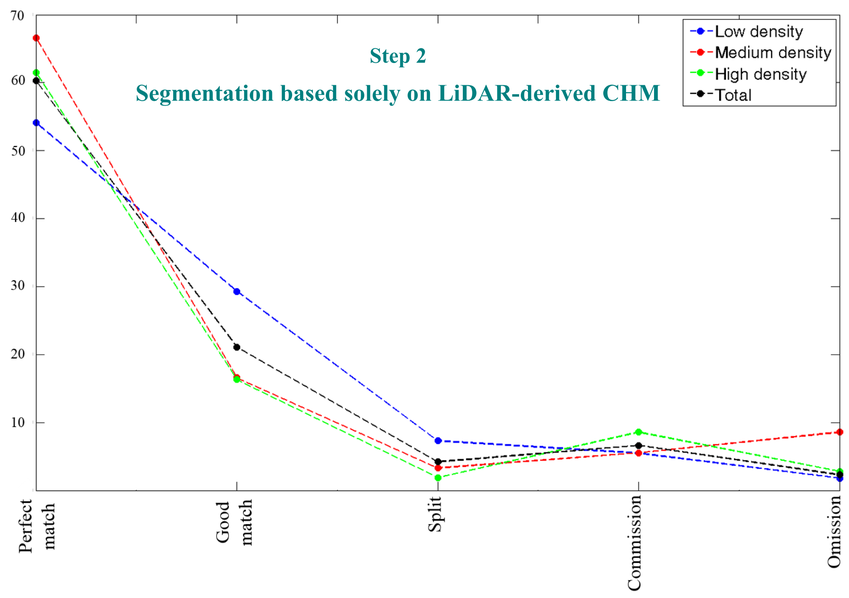


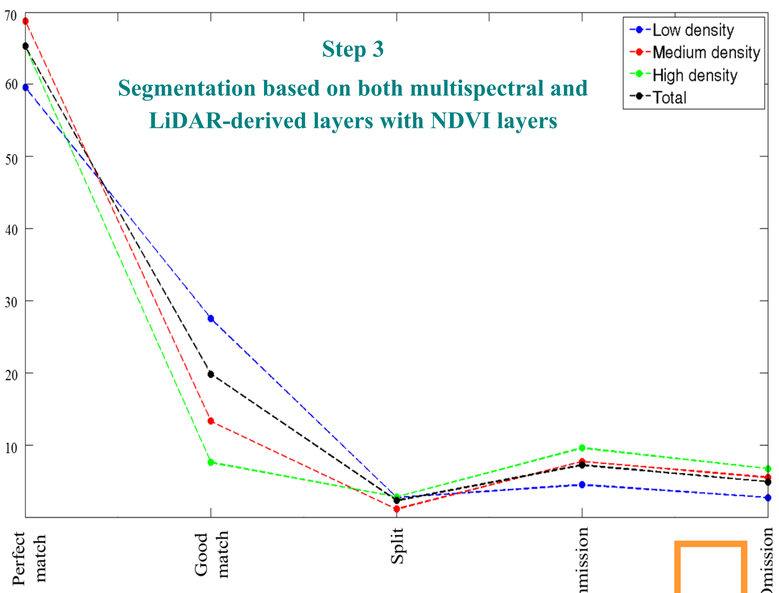
Fig.4, 3D visualization of a single tree from LiDAR point cloud.

Three diffferent crown delineation approaches with Marker-Controlled Watershed segmentation algorithm:

(1) segmentation based solely on multispectral layers (GeoEye-2 image), (2) segmentation based solely on LiDAR-derived CHM layer, (3) segmentation based on both multispectral and LiDAR-derived layers with NDVI layer.







Accuracy assessment for individual crown delineation:

a) Perfect match, b) Good match, c) Split d) Omission and e) Commission. Yellow polygons are ground reference crowns and green polygons are segmentation algorithm results (Figure 5).

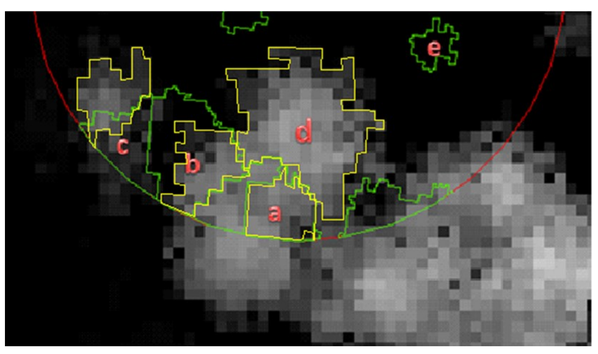


Fig.5, Individual crown delineation results vs. ground reference crowns

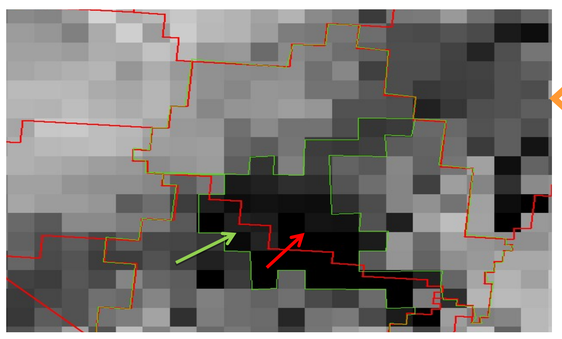


Fig.6, NDVI layer contribution to reduce the shadow effect for individual crown delineation

- Improvement of crown delineation accuracy in spares forest significantly with P-value of 0.016 from Chi-square test
- NDVI contribution decrease the effect of shadows and within gaps
- Potentials of very high resolution multispectral imagery and high point density LiDAR data integration
- Multispectral data produced better crown segmentation results in more dense plots
- LiDAR have a better elimination of omission errors which often happens in open canopies.

Further investigation on:

- Other segmentation methods
- Reduce the effect of noise on the canopy height model
- Object based methods for accuracy assessment
- Other indices such as RVI (ratio vegetation index), SAVI(soil-adjusted vegetation index).

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