Scikit-image for trees local maxima detection

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Highlights: Tree top detection using laser scanner data is very important when tree modeling and measurement are concerned. However, software used for this purpose are expensive and scarce. This project aimed to assess Scikit-image for tree local maxima detection. Scikit-image is a Python based package using Numpy and Scipy.

Key words: *local maxima, LiDAR, scikit-image, python.*

Introduction

Due to the diffusion of LiDAR (Light Detection and Ranging) technology, new methodologies are necessary to support this advance. There are software available with the capacity to detect local maxima in forest areas. Although, some are expensive and others limited in their options. Scikit-image ([1]) is a Python based algorithms package for image processing created from the association between Numpy and Scipy packages. With it, the user is not limited to what a software can offer and it is possible to create algorithms based on each necessity. This paper aimed to assess the applicability of Scikit-image for trees local maxima detection. As a hypothesis, we believe with the right configuration Scikit-image can be a valuable tool to be used in forestry allied with LiDAR data. However, this is the first time Scikit-image is been tested for forest applications in local maxima detection context. There is the necessity for more tests to assess Scikit-image's performance and robustness.

Material and Methods

The study area is located in the city of Painel, Santa Catarina state, Brazil. It is inserted in the Araucaria forest with the presence of high density forest fragments and open field. Tree height was the variable measured on the field to compare with the local maxima automatically calculated. LiDAR data had an average point density of 7 point/m². Local maxima detection was calculated in two different forms, through TreesVis and Scikit-image local maxima detection algorithms. Both methods used the digital surface model (DSM) for treetop detection. DSM was calculated in TreesVis with a geometric resolution of 0,5m. In Scikit-image, the local maxima detection used several python packages including Numpy, Scipy, GDAL and Matplotlib. Total height measured in the field was compared with the treetops calculated in TreesVis and Scikit-image to assess the method used. The reason to use TreesVis in this project is to compare the results of Scikit-image with an already established algorithm for local maxima detection.

Results and discussion

Table 1 shows there are enough statistical evidences to state that field tree height, TreesVis and Scikit-image local maximas do not differ. Both TreesVis and Scikit-image showed a lower tree height average. That can be explained due to the filtering necessary to smooth the DSM before treetop detection. Nevertheless, difference stood between 0,09 and 0,17m for TreesVis and Scikit-image, respectively.

Table 1: Average local maxima for each method

	Total Height (m)	Number of trees detected	Commission	Omission	Hit rate
Field (F)	11,70a	66	-	-	100%
TressVis (T)	11,61a	60	0,0%	9,1%	90,9%
Scikit-Image (S)	11,53a	66	7,6%	7,6%	92,4%
F - T	0,09	6	-	-	-
F - S	0,17	0	-	-	-

Average height values followed by the same letter in the line do not differ statistically according to Dunnet's test at 90% of reliability

Evaluating the hit rate, both TreesVis and Scikit-image showed good results. TreesVis had no commission error and 9,1% of omission. Scikit-image was unable to detect 6 trees, resulting in an omission of 7,6%.

Omission in both algorithms was result of low density LiDAR data, which is a critical factor in DSM calculation and posterior treetop detection. Commission for Scikit-image also resulted in 7,6% due to the presence of small bushes and the configuration used in Scikit-image's algorithm. Further studies may reduce this value when a better configuration is found. Hit detection reached 90,9 and 92,4% for TreesVis and Scikit-image, respectively. Increasing the density of LiDAR data could improve this results, achieving a hit rate close do 99%.

Consulting other references, [2] achieved a hit rate of 96% using Thiessen Polygon method, [3] reached a 61% hit rate, [4] detected 70% of the trees correctly and [5] located 87,3% of the trees in the analysed area. Thus, is possible to say Scikit-image and TreesVis reached a satisfactory and coherent result compared to the literature.

Figure 1 shows the performance of both algorithms tested. Figure 1a shows the result of Scikit-image processing. Blue arrows indicate errors of commission, caused by the algorithms configuration and very low vegetation occurrence. Yellow arrow shows one of the omission cases caused by the close proximity from small trees to big trees. Besides that, Scikit-image algorithm for local maxima detection proved efficient. All high trees were correctly detected, showing the potential of this package. Further tests should be made to assess the behaviour of this package with other forest formations. Scikit-image, due to its flexibility, can also be implemented in different software solutions. TreesVis, for example, could implement this algorithm along with the already existing one.

Green arrows in Figure 1b emphasize the omission errors with TreesVis. Although, the omission's reason with TreesVis is important to quote. All misdetections happened with low trees and/or trees close to each other. This behaviour is common in low density LiDAR data, causing the omission due to lack of information from tree crowns in the DSM model.

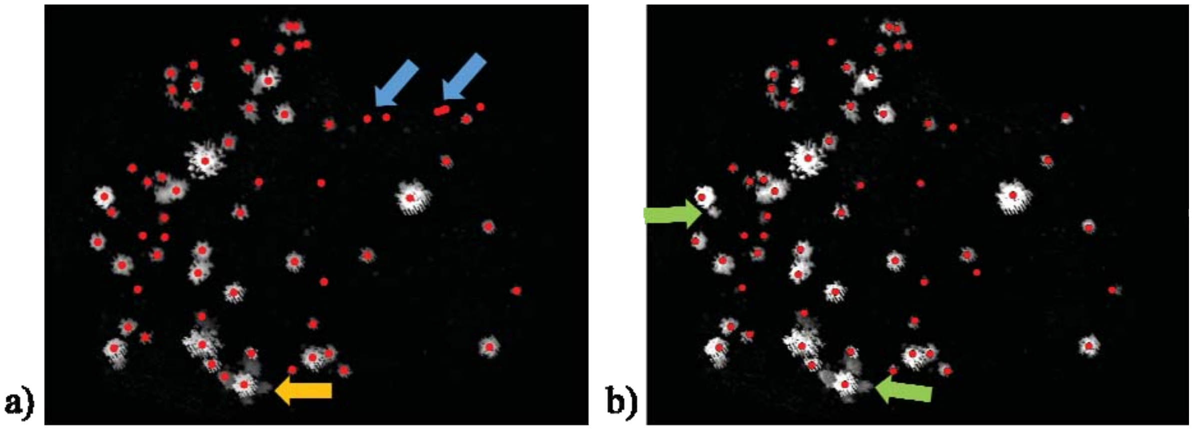

Figure 1: Local maxima detection. a) local maxima calculated with Scikit-image; b) local maxima calculated with TreesVis.

Conclusion

Scikit-image is a promising tool for local maxima detection using LiDAR data. It presented good behaviour and has shown good results under the appropriated configuration. Although, further studies are necessary to improve the results and to adapt the algorithm to different kinds of forests (i.e. coniferous and dense coniferous forests; broad leafs dense forests).

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