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Palm-trees detection with very high resolution images, comparison between Geoeye and Pléiades sensors

Laurent DEMAGISTRI, Danielle MITJA, Eric DELAITRE, Ehsan YAZDANPARAST, Hamidreza SHAHBAZKIA, Michel PETIT



Framework

Managing rainforests implies preservation of biodiversity particularly by maintaining, within agro-ecosystems, trees and palm-trees that are useful for the local people. These species are likely to be overexploited and to disappear. The monitoring of their extent, implies: identify areas of occurrence and characterize on these, the impacts of human activities. For this purpose, nowadays, Remote Sensing techniques play an important part to set up suitable indicators.

This study focuses on a Brazilian project dedicated to the installation of small farmers in some places of Amazonian deforestation areas: the "PA-Benfica" (10 000 ha), in the Itupiranga municipality (southeast Pará). This study is funded by CNES-TOSCA Project "CIC-TOOB": « Chaîne d'Intégration des Capteurs de Télé-détection pour le suivi de l'Occupation du sol et l'extraction automatique d'objets ressources : le cas du palmier Babaçu en Amazonie » (CNES/IRD agreement No. 130318).

1 Palm-trees and their detection by photo-interpretation

Babassu is an endemic palm-tree in those rainforests. It can reach 30m high and its crown mean diameter is 8m. When clearing forests for new crops and pastures, lots of stems of this species are preserved and resist many years.

Crowns of palm-trees, their trunks and shadows, in pastures areas, can be seen on very high resolution satellite images; it is possible to mark each single palm-tree. However, even if it counts for 93.6% of palm-trees in pastures, the babassu is mixed with other species with similar crown size.

Firstly, the crowns of palm-trees are detected and marked manually by an expert (photo-interpretation) on a GeoEye image (spatial resolution: 0.5m, merged XS+P). A particular sampling protocol is used: it is based on a regular grid with 1ha cells. Out of the 17526 cells, 2354 cells have been analyzed by the expert. For this study, only "100% pasture" cells are considered (1075). This data base of marked palm-trees by photo-interpretation of a VHR image will be used to verify and extrapolate the detection rate of the object recognition algorithms.

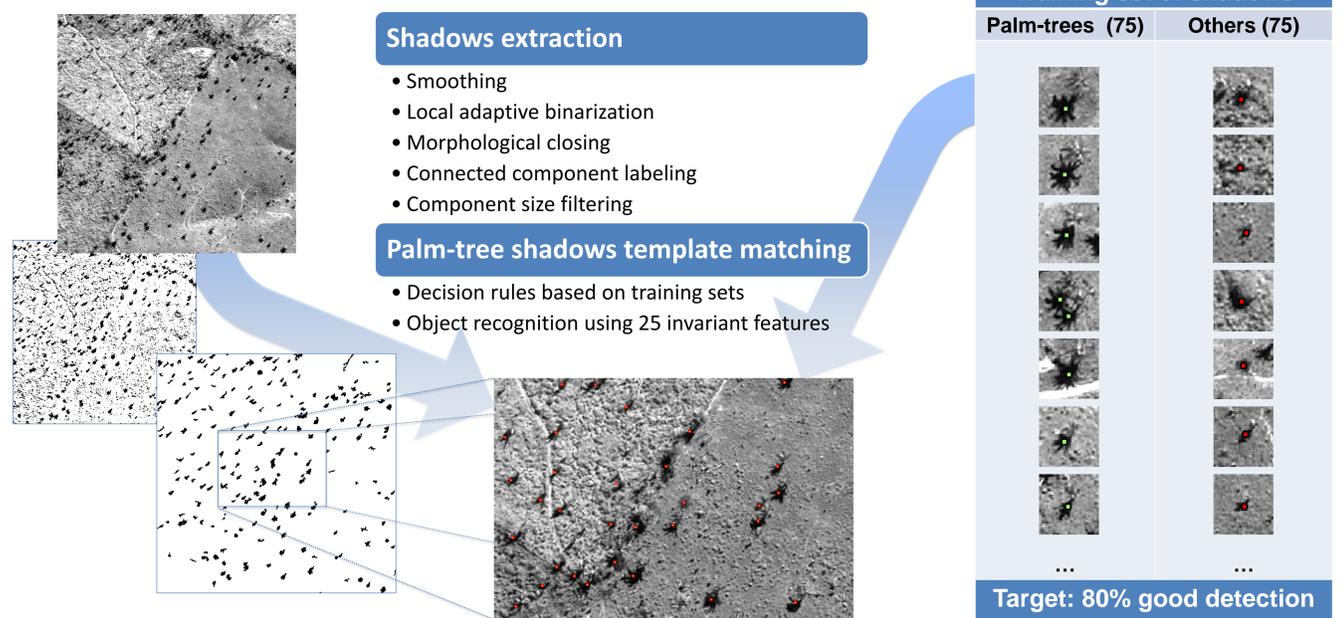
2 Palm-tree recognition algorithm in pastures and model fit

A palm-tree detection algorithm on VHR panchromatic images have been developed for "opened" areas (pastures).

Image filtering and mathematical morphology processes are used to extract from the images the pixels corresponding to shadows.

The shadows classification model uses training data : a set of thumbnails of palm-tree shadows and another set of non palm-tree shadows.

The model is based on 25 invariant features computed from the shape of the shadows.

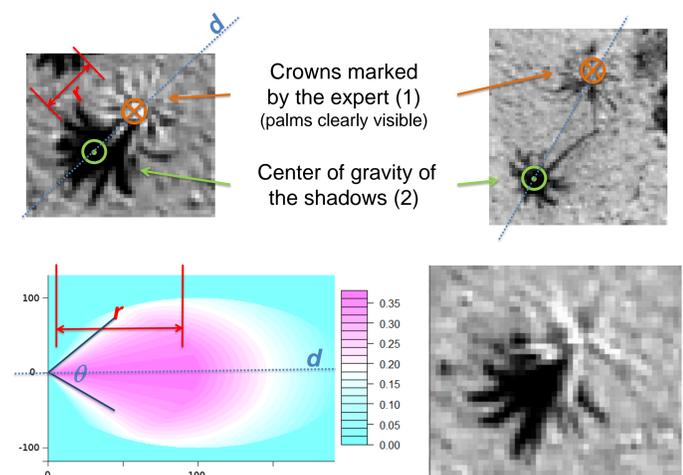


3 Automatic validation

Given the great number of analyzed cells for validation, estimating the good-detection rate for the whole studied area implies automating the matching between (1) manually marked palm-trees (the crowns) and (2) detected targets (the shadows).

The two sets of points are mapped together by setting a search direction (θ) and a radius (r). Both parameters depends on the mean location of the shadows in the image.

For each detected point (shadow), the potential targets from the crown set are sorted using a weight function of the distance and the angle between the points.

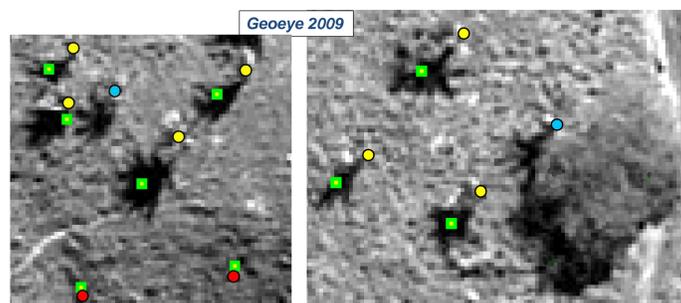


4 Test of the algorithm with Geoeye and Pléiades images

The last results obtained after fitting the parameters of the palm-trees detection algorithm on a 2009 Geoeye image lead to 75.5% of good-detection rate. (the target rate is 80%)

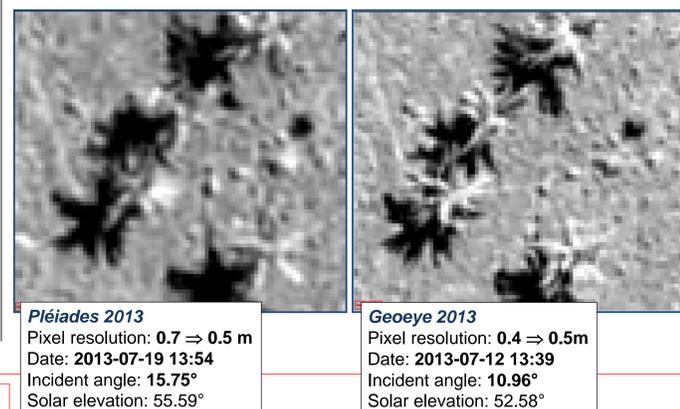
Detected palm-trees			
by expert	by algorithm	Nb	%
1	1	252	75.5
0	1	55	16.5
1	0	27	8.0
Total:		334	100

(16 cells analysed)
1 : palm-tree
0 : non palm-tree



Caption:
● true positive (1 | 1)
● false negative (1 | 0)
● false positive (0 | 1)
■ automatically detected objects

We are still in a comparing and testing phase of the algorithm with Pléiades and Geoeye images of July 2013, acquired at a one week offset dates. The difference between the sensors intrinsic resolutions clearly appears: objects outlines and picture grain are finer on Geoeye.



Pléiades 2013
Pixel resolution: 0.7 \Rightarrow 0.5 m
Date: 2013-07-19 13:54
Incident angle: 15.75°
Solar elevation: 55.59°

Geoeye 2013
Pixel resolution: 0.4 \Rightarrow 0.5m
Date: 2013-07-12 13:39
Incident angle: 10.96°
Solar elevation: 52.58°

Conclusions and work in prospect

- VHR images (spatial resolution less than 1m) are well adapted for palm-trees detection; particularly because palm leaves are clearly visible.
- In pastures, photo-interpretation is performed analysing both the crowns and the shadows of the crowns whereas the automatic detection algorithm works only on the shadows of palm-trees.

- Automatic validation is used to match palm-trees detected by the algorithm to the one marked by photo-interpretation
- A good detection rate of 80% is targeted. More than 75% is obtained with Geoeye images. The tests are under progress with Pléiades images.

The next steps of the study are :

- The development of a new algorithm for palm-trees detection in closed areas (forests / fallow lands)
- Trying to distinguish between different palm-trees species.

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