Toward a Global Tuamotu Archipelago Coconut Trees Sensing Using High Resolution Optical Data

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1. INTRODUCTION

French Polynesia government wants to improve the coconut tree field exploitation in order to develop the extraction of the Coprah oil as an alternative fuel and also the use of senile trees wood. The Coprah oil exploitation already constitutes one of the principal financial resources of the inhabited atolls on which any pearl-bearing activities are listed, its improvement could develop the economy of these isolated atolls. The production control requires a precise enumeration of coconut trees over the 80 Tuamotu atolls and the human access into these isolated islands has a high financial cost. Remote sensing technics minimize the costs of these ground studies by automating this task. The goal of this work is to provide an efficient algorithm for coconuts enumeration over high resolution optical data such as Ikonos data. Several steps are required to perform the automatic enumeration of coconut trees: a coconut field segmentation keeping the area of interest, a coconut field classification among a set of classes describing the different type of coconut fields encountered in Tuamotu using texture features, and finally a robust segmentation process of coconut trees crown. An enumeration is now possible and an identification / segmentation of these trees according to some objective criteria such as the size of canopy, the average color, local density of the coconut trees fields. Finally, a ground truth validation is performed in order to estimate the detection rate and error in each coconut trees class type leading to a precise extrapolation of the global number of trees.

2. DATA

IKONOS optical data is widely available through the whole Tuamotu archipelago and its high spatial resolution (about one meter resolution at ground level) is sufficient to carry out our objective. The study focuses on the atoll of Tikehau that is well-known from the specialists and easily accessible from Tahiti as a validation study area before extending the method to the rest of the Tuamotu atolls. Tikehau data set was acquired by IKONOS2 on July and August 2003 and is already ortho-rectified and registered in the WGS84 projection. As the complete mosaic of the atoll of Tikehau has a resolution of 22032 by 15614 pixels, the original image is cut out into sub-images, each one locating a *motu* (a small island constituting an atoll). A motu is then selected in order to validate the proposed method.

3. TREE FIELDS CLASSIFICATION

The coconut trees crown segmentation process must be applied in coconut fields areas to avoid false alarms. In the images, several structures are distinguished such as the sea, the sand, the coral and some dwellings as well as the vegetation (coconut trees and other atoll vegetation types). First, it's necessary to generate high vegetation masks before applying the segmentation process. Due the lack of the near infra-red band (not available in our database), it is not possible to compute the well known NDVI vegetation index. An alternative solution has been tested and chosen: a Bayesian classification using a Maximum Likelihood algorithm. However, this implies a manual selection of the training sets for each different available structures in the image. Then, a texture analysis [1, 2] is performed on the vegetation class to separate the high vegetation (which has been proved to be exclusively coconuts in Tuamotu) from the low vegetation. Once the segmentation is completed, the areas are classified in three types of plantings: natural (non spatial organization), artificial (trees are positioned on a grid spaced by 8 meters) and mixed fields (artificial fields where activities were dropped). The tree crown segmentation process depends on a pixel's neighborhood to compute the minimal network of darker pixels. First, the planting type classification is needed to adjust the size of the research window. For this case, a supervised Maximum Likelihood classification is used to segment these fields based on some training sets representing each kind of these fields that were selected in order to extract features like texture information [3, 1]

4. TREE CROWN DELINEATION METHODOLOGY

After an anisotropic filtering [4] of high vegetation areas on the first PCA component [5] of the RGB image, local maximums are detected and used as the markers for the watershed; these maximums are located closed to the center of crowns [6]. The assumption that there are darker pixels between each crown is used to compute a boundary crown network [7, 8]. This minimal network of dark pixels is computed by looking in pixel's neighborhood in a searching window which the size depends on the planting type the process is working on. The minimal network of dark pixels and markers are used as new minimum for the watershed segmentation process and to compute a topographic surface using the L2-distance map. Once the crowns delineation is made, the center of mass, weighted by the values of the pixels in each RGB channel, is computed to estimate the center of canopies.

5. VALIDATION AND EXTRAPOLATION

A first validation is performed by human interpretation (manual localization of the coconut trees canopy) in order to estimate the detection error for each kind of fields type. This validation provides a mean detection error of less than 5% which proves that our method locates a majority of the coconut trees visible in the images. A ground study conducted in the main *motu* and in the distant *motu* consist in counting the coconut trees in circular study places situated in a homogeneous frame. A comparison between this data and a density image of detected coconut trees crown provides the detection rate in the different classes of coconut fields. It's also provides a precise estimation of the number of coconut trees for each classes. Finally, the method is validated by counting coconuts in a small *motu* and comparing it to the number of coconut trees estimated by the method. After the validation, the proposed method will be applied to all the eighty other Tuamotu atolls.

6. REFERENCES

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