

OBJECT COUNTING IN HIGH RESOLUTION REMOTE SENSING IMAGES WITH OTB

E. Christophe

CRISP
Block SOC-1, Level 2,
Lower Kent Ridge Road
Singapore 119260

J. Inglada

CNES
DCT/SI/AP
18, Av. E. Belin,
31401 Toulouse Cedex 9, France

1. INTRODUCTION

Object counting is a recurrent challenge in remote sensing applications. Satellite observation is particularly enticing due to its large acquisition capabilities. One bottleneck in the information production chain is the ability to automatically perform image analysis. In many application fields, automatic methods do not provide the quality required by end users. To help to release constraints on the human operator, it is important to free him from repetitive tasks and focus his attention on the high level tasks for which algorithms are not suitable yet.

One of these repetitive tasks is object counting. Object counting appears in a wide range of domains: agriculture (tree stand counting), economic and development (population evaluation by building counting), biodiversity (animal population study). The problem relies mainly on identifying and locating the objects to count, once these objects have been identified, the counting itself is the trivial part.

This abstract focuses on building counting in dense areas. This work has been done in the context of the *PRRS 2008 Algorithm Performance Contest* focusing on building extraction. Data sets are Quickbird images as illustrated on figure 1(a). The processing is done using the Orfeo Toolbox[1], an open-source image processing library. The method has been adapted and successfully used in other situations, as for instance counting tree stands or tents in a refugee camp.

2. ALGORITHM DESCRIPTION

To get the best possible results, the required preprocessing is applied to the image: panchromatic and multi-spectral data are combined to get a high resolution 4-bands data set (pan-sharpening).

Usually there is some important contextual information to use to avoid obvious mistakes. It is unlikely to find a house in the middle of the water unless the goal is specifically to count houses flooded during a natural disaster. Similarly, boats are usually surrounded by water. This basic level information can be exploited by first creating a rough land cover classification. Classes such as water, vegetation, roads, shadows, bare soil and few ad-hoc classes provide a good starting point. To obtain this classification, we use a Support Vector Machine (SVM) classifier [2, 3] on a specific set of features such as the four spectral bands, the NDVI index, a local variance, and morphological profiles. This classification will be used as a mask to remove some obvious false alarms.

The next step is to segment the pan-sharpened image in order to lower the complexity of the input data. The level of details available in high resolution images can have a strong negative effect at some stages of the processing: roof superstructures are irrelevant when trying to extract the whole building for example. The mean shift algorithm [4] provides an efficient way to simplify such images.

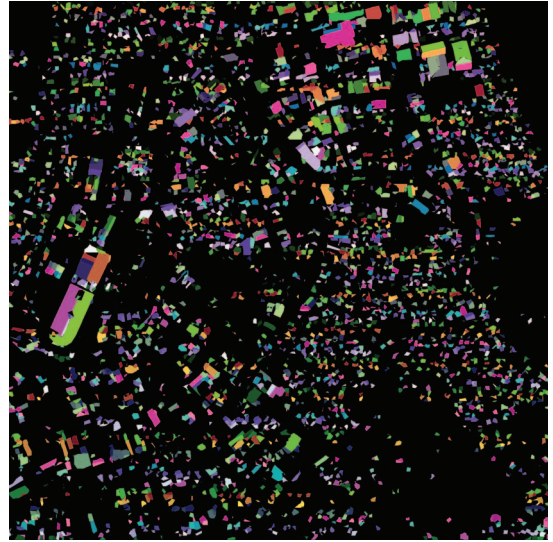
The segmented image is combined with the classification to remove irrelevant segments. This is the main step where some simple high level information concerning the object is introduced.

A very useful piece of information which allows to improve the results of the counting is the precise location of the object boundaries. Indeed, adjacent objects which are connected may induce an erroneous count. For this matter, we use the boundaries of the regions obtained in the segmented image in order to disconnect those objects.

Segments are vectorized to enable higher level processing. Finally, some adjustment of the detected object is made according to the original pan-sharpened data (precise edge adjustment). This step fits the obtained polygons to the input data by introducing shifts to the position of the vertices in order to maximize the overlap with respect to the edges of the original image.



(a) Pan-sharpened data set originally at 0.6 m (resolution is degraded on the illustration due to copyright restriction). Courtesy of European Commission, Joint Research Centre, ISFEREA Research Action; Includes material ©2005, DigitalGlobe Inc., all rights reserved.



(b) Result of the detection algorithm, the number of detected buildings is 3600.

3. RESULTS

An example of results is presented in figure 1(b). The input data is a pan-sharpened Quickbird image (60 cm. resolution and 4 spectral bands). The results have been obtained with a specific land use classification and a parameter setting which favors detection over false alarms. A main drawback of this setting is that large buildings where different parts of the roof have different illuminations, can be detected as different buildings.

The full paper will present additional results obtained on different data and operational conditions. Also, an assessment of the influence of the different parameters on the quality of the results will be presented.

4. REFERENCES

- [1] "The ORFEO toolbox software guide," <http://www.orfeo-toolbox.org>, 2008.
- [2] F. Melgani and L. Bruzzone, "Classification of hyperspectral remote sensing images with support vector machines," *IEEE Transactions on Geoscience and Remote Sensing*, vol. 42, no. 8, pp. 1778–1790, Aug. 2004.
- [3] G. Camps-Valls and L. Bruzzone, "Kernel-based methods for hyperspectral image classification," *IEEE Transactions on Geoscience and Remote Sensing*, vol. 43, no. 6, pp. 1351–1362, June 2005.
- [4] D. Comaniciu, "Mean shift: A robust approach toward feature space analysis," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 24, no. 5, pp. 603–619, May 2002.