URBAN AREA DETECTION AND SEGMENTATION USING OTB

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1. INTRODUCTION

One of the key features requested by the users of the upcoming ORFEO system is the availability of tools for urban area monitoring. The needs go from coarse urban extension delimitation to individual building detection. In this context, several algorithms have been implemented and assessed in the ORFEO Toolbox library.

The operational constrains for the algorithms are related to the volume of data to be processed and the false alarm rate achieved by the processing chain. Indeed, even if no unique figure for the false alarm rate exists for all application fields, many end users are able to specify the maximum number of false detections which can be accepted.

In this work the implementation of an algorithm for urban area extraction and its assessment in terms of quality of the results and processing time will be presented. This algorithm is developed using the ORFEO Toolbox, OTB, and will be available inside the library in version 3.0 scheduled in April 2009.

2. ALGORITHM DESCRIPTION

Depending on the resolution and diversity of the available data, different choices in terms of algorithms are available. Since we are aiming the operational use of the proposed techniques, an efficient processing framework has to be implemented.

The main constraint on the procedure is that it has to be used on large volumes of data. Indeed, images of about 30000×30000 pixels with several spectral bands are common in this application field. Therefore, a coarse-to-fine analysis seems to be appropriate. On the other hand, this kind of approach can lead to miss isolated buildings.

The approach proposed here will therefore operate in 3 steps trying to minimize miss-detections while using an efficient approach.

The first step operates at full resolution – or even with a down-sampling to about 10 m. resolution – and consists of thresholding a likelihood image. This likelihood image is very cheap to compute since it only needs the computation of 3 indices:

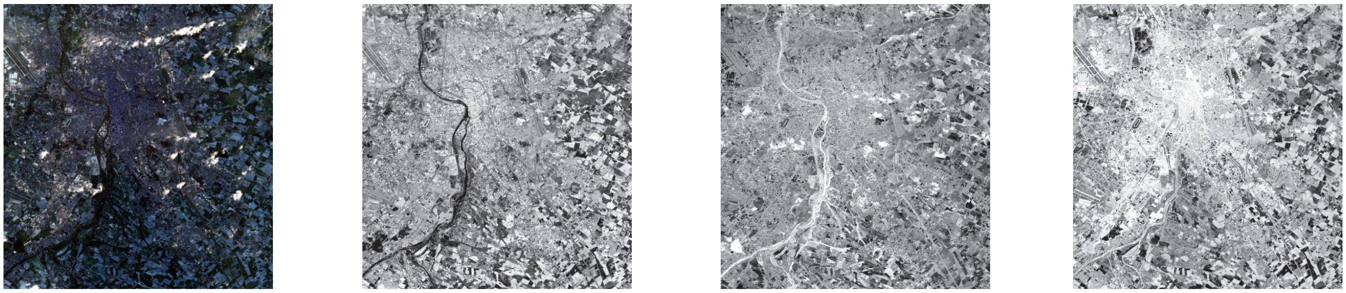
1. the Normalized Difference Vegetation Index, NDVI;
2. a modified Normalized Difference Water Index, similar to the NDWI [1];
3. a modified Normalized Difference Built-up Index, similar to the NDBI [2].

As one can see, the presence of vegetation, water and built-up structures is evaluated. Figure 1 shows some examples of index extraction. By choosing a pertinent combination of these indices, a new index can be derived. Different alternatives will be presented and evaluated in the paper.

The thresholding of this likelihood image – we choose to be conservative in the choice of the threshold – allows to eliminate a high percentage of the image extent, so more time consuming approaches can be implemented for the selected areas.

The second step will apply a more robust detection for urban areas which is based on texture indices. Indeed, several existing approaches [3], [4], have shown that texture information is very useful for the detection of artificial areas. We will use 2 sets of texture descriptors, namely Gabor filters and Haralick texture parameters in order to detect areas with high likelihood of containing urban structures. This analysis is performed between the resolutions of 2 m. and 10 m. The choice of the spectral bands for this step is crucial and will be discussed in the final paper. An example of Gabor descriptor computation is presented in figure 2.

At the end of this second step, a robust detection of urban areas is obtained. However, in many applications, there is a need for discrimination between dense urban areas, residential areas and industrial areas. This refining step can be achieved by using mathematical morphology by reconstruction with the framework of morphological profiles [5].



(a) Input image (b) Vegetation (c) Water (d) Built-up

Fig. 1. Examples of land-cover indices used in the first step of the algorithm

(a) Gabor filter (b) Input image (c) Detection

Fig. 2. Example of application of a Gabor filter for urban area detection

The final paper will present a detailed assessment of the performances of the algorithm as well as a detailed description of the parameter setting.

3. REFERENCES

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