Multi-source object-oriented classification of landcover using very high resolution imagery and digital elevation model

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Abstract

With high-resolution imagery such as ortho-photos and object-oriented software, semi-automatic mapping of urban land cover is possible. This approach allows low cost, rapid and standardized results, as shown by a pilot study carried out in Geneva area (Switzerland).

1. Introduction

In order to comply with Swiss federal requirements and to meet the needs of the Genevese Land Information System, the "Direction cantonale de la mensuration officielle" (DCMO) has commissioned a new landcover mapping of the canton. The legend consists of thirty-eight classes, representing urban, agricultural and natural objects.

2. Data

The Geneva Canton has a high-resolution orthophoto coverage taken in 2001, at a 25 cm of resolution and in 24 bit colours (visible). Other types of imagery, acquired in 2000, are the Lidar Digital Surface Model (DSM) and the Digital Terrain Model (DTM) at 1m spatial resolution, their difference (DHM) representing the height of objects (buildings, trees). Vector data representing buildings, parcels and other

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miscellaneous objects are also available from the SITG[3] (Geneva Land Information System).

3. Mapping methodology

The methodology comprises (a) road network mapping using spatially referenced video technology; (b) incorporation of pre-existing vector layers, such as buildings and (c) high resolution ortho-photos processing, chiefly used for natural and agricultural objects.

Based on the fact that classical, pixel-based classification approaches are not suitable for high-resolution imagery, we have applied a new object-oriented strategy, implemented in the trend-setting *eCognition* software. Under the supervision of the analyst, *eCognition* mimics the process of human perception which uses, to define objects, several criteria such as colour, shape, size, texture, pattern and context.

Practically, the procedure goes through a first phase of image segmentation into vector objects, followed by a second phase of thematic labelling (classification) and a third one, consisting of manual checking and editing.

3.1 Segmentation

Segmentation is the subdivision of an image into separated regions. Throughout the segmentation procedure, the whole image is segmented and image objects are generated based upon several adjustable criteria of homogeneity or heterogeneity in colour and shape (Baatz et al. 2000). It is important to experiment until obtaining the parameters that fit best the image by changing the respective weights of colour and shape, because they have an influence on the classification results.

By applying a weight of 0.9 to colour and 0.1 to shape, the image is over-segmented (too many small regions) because the algorithm is too sensitive to small differences in colour (Figure 1a). On the other hand, by giving a maximum weight to the shape and minimum weight to the colour, we obtain under-segmented compact and not meaningful objects (too few large segments, Figure 1c). The optimal result is given by an equal weight applied to shape and colour (Kressler et al. 2003) (Figure 1b).

[3] http://www.sitg.ch

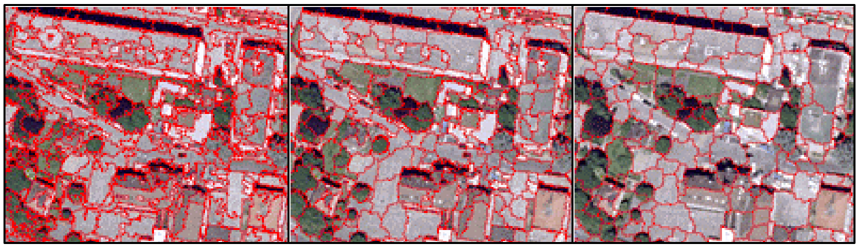

Figure 1a: Over-segmentation (colour 0.9, shape 0.1)

Figure 1b: Best parameter (colour 0.5, shape 0.5)

Figure 1c: Under-segmentation (colour 0.1, shape 0.9)

3.2 Classification

The classification process is based on fuzzy logic, to allow the integration of a broad spectrum of different object features such as spectral values, shape or texture for classification. Utilizing not only image object attributes, but also the relationship between networked image objects, results in sophisticated classification incorporating local context (Baatz et al. 2000).

The Digital Elevat ion Model has been used to discriminate the objects according to their height. For example, even if the spectral information of trees and grass is similar, they could be easily differentiated with the Digital Height Model value (DHM, Figure 2). The same ap proach could be applied to buildings vs roads.

Figure 2: The meadows appear in black as the DHM value equals 0 and the trees brighter as the values are higher

3.3 Manual Editing

Manual editing of the objects and corrections are performed in the third phase. The whole sequence of operations is recorded/edited in *eCognition*, and saved as meta-information attached to the cartographic product.

4. Results

The results are not available at the time of writing because the pilot study is still in progress. However, a classification was performed earlier in a training area using the ortho-photo and the DHM, without incorporating vector information. Figure 3 shows the good discrimination obtained between land cover types such as buildings and impervious surfaces, or various agricultural surfaces.

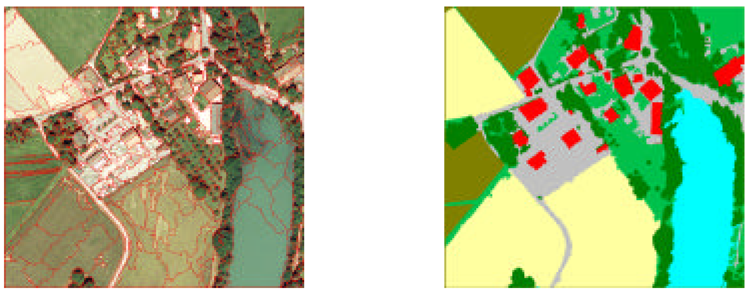

Figure 3: Segmented image on the left and classified image on the right. Blue = water; Red = buildings; Grey = impervious area; Dark Green = trees; Light green = grass land area; Yellow = field 1; Brown = field 2

5. Conclusion

This semi-automatic landcover mapping approach tries to take advantage of all available information sources, the colour aerial imagery being the key-element. It relies on recent scientific developments in image analysis and algorithms, while preserving the thematician's essential role in the information extraction processes. This methodology allows to save time and cost, witn an accuracy sufficent for most applications, such as land and water resources management.

Bibliography

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