ABSTRACT: Supervised per-pixel land-cover classification techniques, when applied to Very High Resolution (VHR) satellite images, often fail to produce a useful land-cover product due to the presence of high frequency speckle, i.e., noisy or speckled results due to high frequency variations in the spectral response. This noise ("salt-and-pepper effect") is detrimental to the classification and degrades the structural properties of the classification results, effectively resulting in a land-cover product that is more useful for further processing.

We applied a region-based filter on the original classification as well as on the intersection result after reducing the number of classes. The filter merges all regions below a 16-pixel area threshold with the largest neighbouring region.

9 context-based rules of two different types were applied on the intersection of the land-cover classification and the DSM. At intermediate steps between the sequential execution of the rules, we applied the structural filter explained above to remove high frequency speckle.

1. Introduction

Thematic maps obtained through the classification of urban surface types from VHR satellite images can in most cases not be directly used for urban and regional planning. Decision-makers typically need maps depicting urban objects (e.g. houses). They usually focus less on the characteristics of the objects (e.g. red surfaces, grey surfaces) themselves, therefore, we need techniques to derive object-level information from the land-cover classifications. We also need to deal with the inherent problems of a land-cover classification, i.e., shadows, and especially for pixel-by-pixel classifications, with the "salt-and-pepper effect", i.e. noisy or speckled results due to high frequency variations in spectral response.

2. Methods

The post-classification method we propose starts from a per-pixel land-cover classification obtained from an Artificial Neural Network (ANN) and involves three types of operations:

- Overlay of the land-cover classification with elevation data obtained from a digital surface model (DSM). The land-cover classes are split into ground-level and above ground-level classes based on an empirically derived elevation threshold.
- Application of a region-based filter that merges pixel regions below a pre-defined area threshold with the largest neighbouring region.
- Application of context-based rules that re-assign pixels belonging to a region to the likely class of the pixel's neighbours based on the identity of the first and second most likely classes of the region, or the likely class of the pixel. The first and second most likely classes are obtained for each pixel from that pixel's end-node activation levels in the ANN classification.

3. Case-study

The post-classification operations outlined above were applied on a small residential urban area located in the northern part of the city of Ghent (Belgium).

The initial land-cover classification was derived from a Quickbird image of this area using all of the multi-spectral bands, the PAN band, an NDVI image and several Haralick co-occurrence measures.

Each class of the land-cover classification was split into two new classes based on an elevation threshold. This threshold was set to 6m and held uniform over the entire area.

The DSM was created using a set of aerial photographs at a 1/12000 scale.

The 14 classes obtained after overlaying the elevation data on the original land-cover classification were reduced to 6 meaningful classes plus shadow.

4. Validation

An exhaustive visual land-cover interpretation and a delimitation of building outlines were carried out for the area. They were used for validating the original land-cover classification and the post-classification results. Mixed area and transition zones in the visual interpretation and shadows in the classification output were not included in the validation.

5. Conclusion

Structural filtering clearly improves kappa values. The use of context-based rules significantly reduces the amount of shadow (from around 24% to 10%), without reducing classification accuracy.

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