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Orthophotoplan segmentation based on regions merging for roof detection

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Summary

In this paper, we propose a strategy of regions merging for roof detection which is made on pre-segmentation results. It is based on a 2D modeling of the roof ridges and region features. The preliminary segmentation is obtained by the watershed algorithm with an optimal colorimetric invariant and color gradient. The choice of an appropriate couple invariant/gradient permits to limit illuminations changes (shadows, brightness, etc) present on several roofs and increases the segmentation results. The watershed algorithm offers satisfactory results but produces an over-segmentation due to many germs (ie. local minima). This effect is reduced by using an appropriate selection of germs but can also be improved with a post-treatment based on regions merging. The proposed merging criteria is based on the 2D modeling of roof ridges (number of segments modeling the common boundary between two regions candidates to the fusion) and on the region features (contrast on boundary of two common regions, average color of region). The proposed strategy is evaluated on 100 real roof images with the Vinet criteria using a ground truth in order to demonstrate the effectiveness and the reliability of the proposed approach .

Problem statement and motivation

The works presented in this paper appear in a global approach that consists in recognizing a roof of aerial images among a knowledge database and bending out 3D models automatically generated from geographical data. Previous works have shown that a segmentation based on a watershed algorithm with an optimal colorimetric invariant and color gradient gives promising results. Indeed, the choice of an appropriate couple invariant/gradient such as maximum-intensity/DiZenko permits to limit the illuminations changes (shadows, brightness, etc) present on several roofs and increases the pre-segmentation results (see [1] for more details). Nevertheless, the roof is generally over-segmented, that is why, a regions merging procedure can be suitable.

Proposed method

Then, we propose a strategy of regions merging for roof detection based on a 2D modeling of the roof ridges and region features. The first step of this approach concerns the 2D modeling of the roof ridges of the pre-segmented image. More precisely, we propose a strategy that : 1/ extract edges of the pre-segmented image; 2/ extract all segments and intersection points characterizing a roof; 3/ subdivide the segments which do not characterize the real shape of the roof by modifying/optimizing the position of the intersection points. In a second step, a regions merging procedure using the region adjacency graph of the pre-segmented image is proceeded. The proposed merging criteria is based on the 2D modeling of roof ridges (number of segments modeling the common boundary between two regions candidates to the fusion) and on the regions features (contrast on boundary of two common regions, average color of region). Figure 1 illustrates an example of the treatment: an initial image (a), the pre-segmented image based on the watershed algorithm with an appropriate couple invariant/gradient (b), the segments model of the pre-segmented image (c), the segmented image after the regions merging procedure (d).

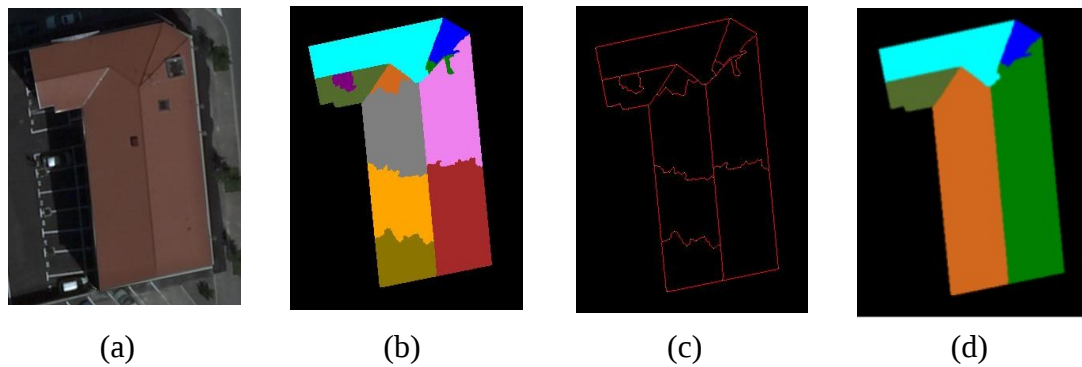


Figure 1: an example of the treatment (an initial image (a), the pre-segmented image based on the watershed algorithm with an appropriate couple invariant/gradient (b), the segments model of the pre-segmented image (c), the segmented image after the regions merging procedure (d)).

Experimental results

The proposed strategy has been evaluated on 100 real roof images in order to demonstrate the effectiveness and the reliability of the proposed approach. The Vinet criteria using a ground truth is used to provide the quality index of the segmented images. One can conclude that the quality of the segmentation is very satisfactory : 94,5 % with the proposed region merging VS 82,7% without region merging (directly calculated on the pre-segmented image). If we consider a segmented database (composed of 100 images segmented by the watershed algorithm with and without regions merging procedure) and ground truth database (composed of the same 100 images manually segmented by an expert), one can show that 82 segmented images using regions merging strategy are recognized in the ground truth database VS 59 images without regions merging procedure.

References

- [1] Y. El-Merabet and C. Meurie and Y. Ruichek and A. Sbihi and R. Touahni. "Orthophotoplan segmentation and colorimetric invariants for roof detection", 16th International Conference on Image Analysis and Processing (ICIAP), September 2011, Italy (accepted)