EROSION AFTER GRADIENT (ERAGRAD) MORPHOLOGICAL PROFILE

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1. INTRODUCTION

Morphological profiles [1, 2] have been proven useful for classification and segmentation of remote sensed images. A morphological profile contains information about the size and shape of objects in an image. However, the profile of a pixel not only depends on the geometry of the object it belongs to, but also on whether it is a bright, dark or gray object. Moreover, morphological profiles are not easily extendable to color images. Different attempts have been made, but they either require an artificial ordening of the colors or create profiles for every color band. This makes it more difficult to interpret the morphological profile. In this paper we propose a new kind of morphological profile, the ErAGrad profile. This profile contains a single value for each pixel on each scale. The ErAGrad profile is easily interpretable and does not depend on the color of the object or the color of the background, but only on the difference between both.

2. MORPHOLOGICAL PROFILE

A morphological profile consists of openings and closings with different sized structuring elements. An opening deletes small bright objects from an image, while a closing deletes small dark objects from an image if the object is smaller than the structuring element. Because different sizes of the structuring element are used, the morphological profile of a certain pixel gives an indication of the size of the object that pixel belongs to. As such, a morphological profile contains information about the geometry of objects and is useful to distinguish between different types of objects.

3. ERAGRAD PROFILE

As mentioned before, openings act on bright objects and closings on dark objects. This means objects brighter or darker than their surrounding. However, some objects are surrounded by both darker and brighter objects. In this case, the object is not deleted from the image when the structuring element is larger than the object. Therefore, we propose a new kind of morphological profile, the ERosion After GRADient (ErAGrad) profile. This profile contains, what we call ErAGrads with different sized structuring elements. An ErAGrad is the morphological gradient followed by an erosion. A morphological gradient with structuring element B is defined as the difference between the erosion and dilation of an image with structuring element B. The morphological gradient thus represents the maximum difference between any pair of pixels within the structuring element. After applying a morphological erosion with the same structuring element B on the gradient, the ErAGrad is achieved. This ErAGrad highlights objects smaller than the structuring element regardless of whether they are bright, dark or in between. The magnitude of the value depends on the contrast between the object and its background.

4. COLOR ERAGRAD PROFILE

In the past some attempts have been made to extend morphological profiles to color images. They are based on artificial ordenings of colors [3] or they process different color bands separately, possibly preceded by a transformation like PCA [4]. Processing different bands separately produces many more variables which might cause problems of dimensionality in classification algorithms and makes it more difficult to interpret the morphological profile. The ErAGrad profile on the other hand can be easily extended to color images without producing extra variables or changing the interpretation. It only requires to extend

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the morphological gradient to color images. The color morphological gradient (CMG) [5] is defined as the maximum euclidean distance between any pair of pixels within the structuring element.

A CMG however is quite computational expensive as for each pixel we need to compute N^2 euclidean distances and order them, with N the number of pixels in the structuring element. Moreover, since CMG is not based on erosions and dilations, we can not make use of fast algorithms for erosions and dilations. Therefore we propose a method to derive an upper and lower bound of the CMG, which only uses erosions and dilations. If applied directly on the color image, the upper and lower bound can be quite far apart. Therefore, we first apply an orthogonal linear transformation on the color space. This kind of transformation preserves distances and therefore will produce another lower and upper bound. If a good transformation is chosen, this upper and lower bound will be closer together than the one based on the unprocessed color bands. Since Principal Component Analysis (PCA) produces an orthogonal linear transformation and maximizes the variability on the first dimensions, PCA is a good choose. Experiments show that PCA indeed substantially decreases the difference between lower and upper bounds.

5. REFERENCES

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