THRESHOLD -CONSTRAINED MINIMUM SPANNING TREE REGION MERGING METHOLD OF FOREST INVENTORY PATCHES

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ABSTRACT: The manual delineation of forest patches is a costly and crucial stage in any forest stand mapping project of forest inventory based upon photo interpretation. Following the development of high spatial resolution remote sensing image, the object-oriented approach contributes to the automation of this interpreter. This paper presents the Threshold -Constrained Minimum Spanning Tree Region Merging method based on watershed segmentation; In essence this method transforms a satellite image into many polygons which satisfy the requirement of forest patches. This paper provides the back information and workflow, and illustrate its application on SPOT5 2.5m panchromatic data.

1. Introduction

In the recent years, we have seen the development of high spatial resolution satellite imagery. These data with flexible source of information satisfy the forest inventory (culvenor, 2003). The forest inventory polygons are generally developed from manual interpretation, the polygons represent the forest stand units are bases upon a desire to group into units with similar characteristics (Michael & David, 2003).the forest stand is an image object of the image, object-based approaches refer to image-processing techniques that when applied either result in the segmentation (i.e., partitioning) of an image into discrete non-overlapping units based on specific criteria, or are applied to define specific multiscale characteristics—from which segmentation may then be based (Hay et al., 2002 and Hall and Hay, 2003). After segmentation, attributes can be assigned allowing for forest stands, class designation (Schneider and Steinwender, 1999) and topological relationships between segments (Burnett and Blaschke, 2003). Segments refer to segmented image-objects. Blaschke et al. (2004) provide an overview of numerous segmentation techniques used in the remote sensing .in this paper，we present the threshold - constrained minimum spanning tree region merging method to segment the forest image satisfy the requirement of forest inventory.

2. Method

The watershed transformation is a powerful tool for gray image segmentation. Unfortunately, this transformation often leads to an over-segmentation of segmentation. To overcome this problem, Threshold -Constrained Minimum Spanning Tree Region Merging method has been proposed, the major steps of the algorithm are shown in Figure 1. The first step calculates image local energy (Morrone &Owens, 1987) and filters the low energy, the second step is Watershed partition, and the third step is region merging.

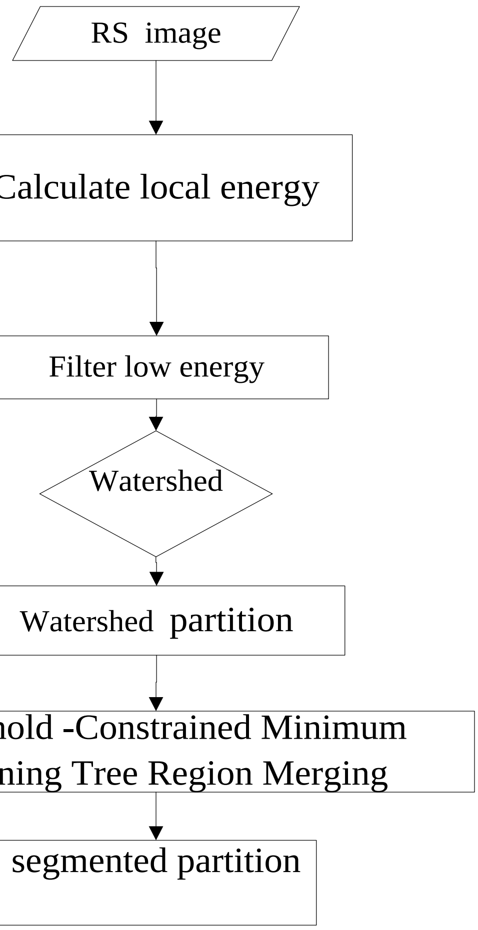


Figure 1. Threshold -Constrained Minimum Spanning Tree Region Merging method

2.1 calculate image local energy

The performance of Watershed transformation is heavily dependent on the gradient of image, the traditional morphological gradient operator vulnerable to the impact of noise and quantization error, and result in too many local minima of homogeneous areas, there are large number of small areas after watershed transformation, leading to more division. Therefore the image has to be filtered so that gradient minima produced by noise and boundary Fuzzing are controlled. Such process is calculated image local energy using odd and even symmetric filters, and filter the low energy, the output is gradient of image. The Segmentation results based on local energy and multi-scale morphological gradient are shown in Figure 2.

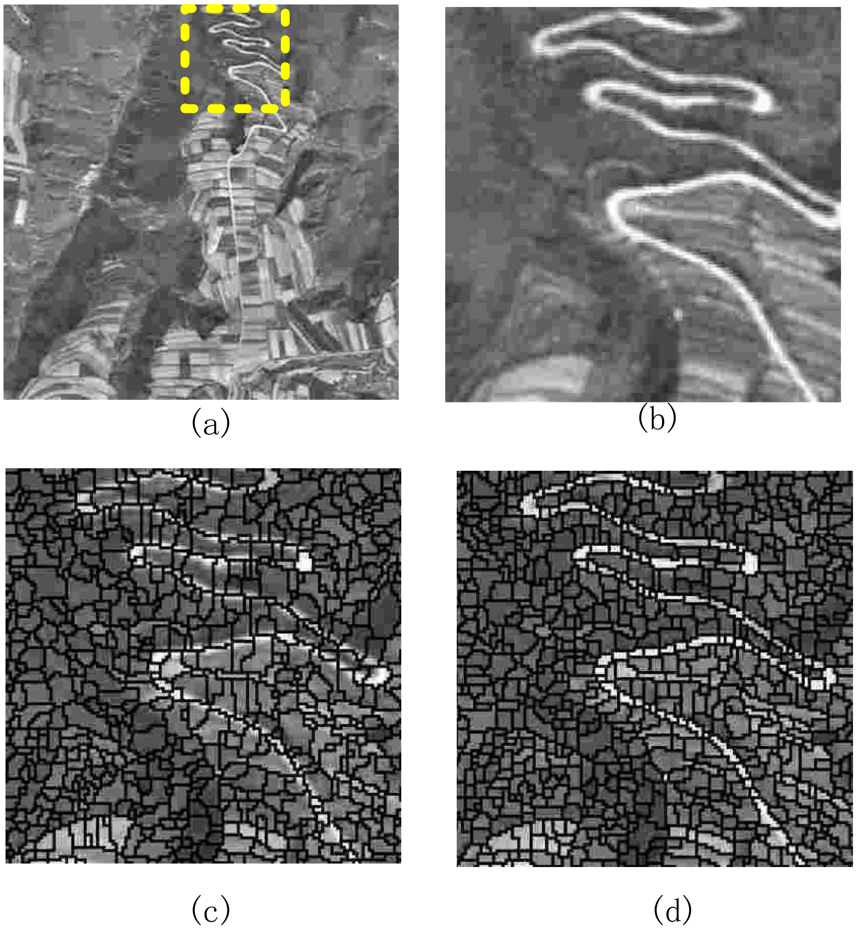


Figure 2

(a) image; (b)enlargement(c) segmentation results based on multi-scale morphological gradient(d) segmentation results based on local energy

2.2 Watershed partion

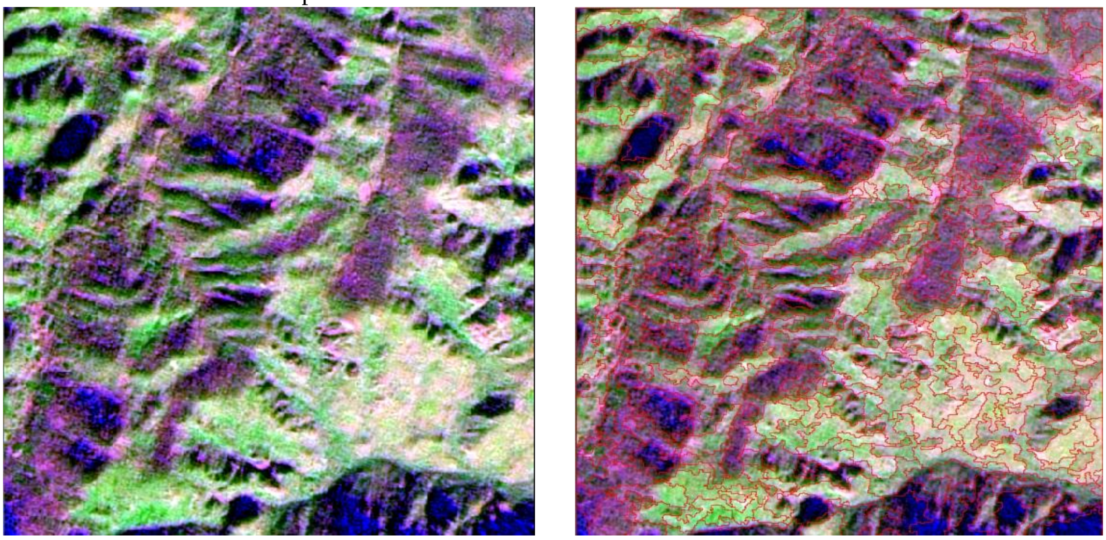
The application of the topographic concept of watershed to the field of image analysis was introduced in the 70s (Beucher&Lantuejoul, 1979) and implemented into an efficient algorithm in the 90s (Vincent & Soille, 1991). The watershed is one of the classic descriptions of Topography. For example, the U.S. Rocky Mountains watershed, which divided the United States into two regions. If a drop of water fell on the one side of the watershed, then flow into the Pacific; if a drop of water fell on the other side of the watershed, then flow into the Atlantic this drip flow. Rocky Mountain is a typical example of the watershed lines, which segment two regions, which are called the Pacific Basin and the Atlantic basin, the Pacific and Atlantic basins are two bottoms. The gray value of each pixel represents the point of elevation, this representation is quite useful. First, it makes some people better understand the transformation. For example, the morphological opening operation from the "clipping" effect, form closing operation from the "valley filling" role. Secondly, due to this representation that can be well defined gray bottom, basin and watershed concepts.

2.3 Threshold -Constrained Minimum Spanning Tree Region Merging method

There is a lot of over-segmentation after watershed segment, in this step the regions of watershed partition are aggregated into segments. The dissimilarity criterion used to merge segments is the Euclidean distance between signatures in a feature space, the signature of a new segment is the weighted –by size mean of the signatures of the two merged segments. In this way, segment signatures are computed from the original image only once, at the beginning of the merging procedure. The same can be said about the weighted non-direction graph (vertexes of graph are the segments, edges of graph are adjacent regions, the weight values of edges are dissimilarity of the two adjacent regions), the merging sequence is confirm by minimum spanning tree (Boruvka) (Haxhimusa etal., 2006), and threshold –constrain the two merging regions in each iteration proceeds, then the regions are updated, and new iteration proceeds. The process continues this way until the sum of i) the number of segments currently larger than *minimum unit*, plus ii) the result of dividing by MSS the area currently occupied by segments smaller than *minimum unit*, is less than the result of dividing the area of the image by MSS(the desired mean size of output segments)(Castilla, 2004).

3. Experimental Results

Threshold -Constrained Minimum Spanning Tree Region Merging method has been implemented in c# and tested in several SPOT5 2.5m panchromatic image. Preliminary results seem to adapt reasonable well to the spatial structure of the image. As an example, Figure3 shows a 500*500 SPOT5 2.5m image, the segmentation was produced 625 polygons selecting the minimum unit=100pixels, the desired mean size unit=400 pixels.



(a) original image (a) segment result

Figure 3

4. Discussion and Conclusions

After having applied the Threshold -Constrained Minimum Spanning Tree Region Merging method to many forest images, most of the output partitions produce good visual impressions and the segment result satisfy the forest maping,but some images with low contrast lead to some 'bad segmentation' (the segment is non-homogeneous),in the next step we will enhance the low contrast locations of the image before segmentation.

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