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A MORPHOLOGICAL MULTIGRADIENT WATERSHEDS FOR SEGMENTATION OF REMOTE SENSING COLOR IMAGES

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Abstract

Image segmentation is one of the most important in satellite imaging technology. Remote sensing satellite images are more precise. The objects of these images contain several pixels provide a value information of the area on earth. A segmentation method is applied to form a group of pixels that fit in the same objects before classification. The quality of such a segmentation method is essential to achieve good classification results. Watershed transform is region-based segmentation method. The watershed transform finds watershed ridge lines and catchment basins in an image by considering it, as a surface where light pixels are high and dark pixels are low. Watershed transforms can be accurate if the foreground objects and background locations are to be marked with suitable operations. Mathematical morphological techniques are popular in image processing. A combination of these operations can be marked the neighbor pixels with the similar properties. The inclusion of gradient operators the morphological operations are more efficient analysis of ridge lines and mark the regions. The present work is to design and implementation a new algorithm based on watershed transform using Gradient morphological operations. The algorithm is implemented in MATLAB 2012 and experimented on various remote sensing satellite images. It performs well both in retaining the weak boundary and reducing the undesired over-segmentation. The results shown the proposed method has a good generality in producing segmentation results.

Keywords: *edge detection, morphological multi gradients, watershed transform, remote* sensing images.

1. INTRODUCTION

Image segmentation is normally used to locate objects and boundaries such as lines, curves in images. The process of assigning a label to every pixel in an image, the pixels with same label share certain visual characteristics. In remote sensing images the objects appears typically mean areas of similar land wrap or land purpose, comprising lesser landscape features and artificial facilities. To be more precise, crop mapping in ten picked sample areas of India has been taken as an example to exhibit the methods, evaluated and to compare their results. Similarly, the methods are applied to other areas in the remote sensing. [1, 4, 5]

Morphology is a set theory to study the shapes and structure of various images. In image processing, morphology is the name of a specific methodology for analyzing the geometric structure inherent within an image [2]. The morphological filter which can be constructed on the basis of the underlying morphological operations, are more suitable for shape analysis than the standard linear filters since the latter sometimes distort the underlying geometric form of the image.[12]

Unlike the typical morphological filters, the watersheds transformation is not composed of the primitive morphological operations. The initial concept of the watersheds transformation as a morphological tool was introduced by H. Digabel and C. Lantuéjoul. Later, a joint work of C. Lantuéjoul and S. Boucher led to the ‘inversion” of this original algorithm in order to extend it to the more general framework of grayscale images, [7, and 8]. Later, watersheds were studied by many other researchers and used in numerous grayscale segmentation problems. In this thesis, the

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efficient algorithm for watersheds suggested by Luc Vincent and Pierre Soille is reviewed briefly and used throughout the entire simulation.

As an interpretation in topography, the watershed can be imagined as the high mountain that separates two regions. Each region has its own minimum and, if a drop of water falls on one side of the watershed, it will reach the minimum of the regions. The regions that the watershed separates are called catchment basins [2]

Coming to the details section 2 deals with morphological gradient operators, applications and methods of image segmentation methods, section-3 deals with watersheds transformation in digital space, watershed transformation algorithm, section-4 deals with design and implementation of morphological watershed algorithm. Chapter-5 deals with results and section-6 conclusion is given.

2. MORPHOLOGICAL OPERATORS

Some of the salient features of the morphological approach are as follows

1. Morphological operations offer a systematic alteration of the geometric area of an image while sustaining the stability of the important geometric characteristics.
2. Morphological algebra is well developed for image processing applications that can be employed for demonstration and optimization.
3. It is feasible to express image algorithms in terms of a very small group of modern morphological operations.
4. The primitive morphological operations are generated an expression of morphological filters is to exist accurate demonstration.

Morphological operations can be employed for many purposes, including edge detection, segmentation, and enhancement of images. Structure elements are acting as accurate role in process of operations. These are classified in to Omni directional and multi scaled elements is one way to plot out square windows [14]. In general consider α is the angle of rotation. Let us consider N is a value then order of the SE is (2N+1) X (2N+1). The equation of the structure element is represented as

$$W = \{\frac{s(n1+s1n2+s2)}{\theta s} = s\alpha - N \leq s1, s2 \ll N . \qquad (1)$$

For all s=0, 1 --- 4N-1 and α is the angle of the rotation expressed as $\alpha = 180^0/ 4N$.Suppose N=2 then dimension of the SE is 5 x5, the angle value is obtained as α=0, 22.5, 45,135,157.5.

Morphological operators transform the original image into another image through the interaction with structuring element. Geometric features of the images that are similar in shape and size to the structuring element are preserved, while other features are suppressed. Therefore, morphological operations can simplify the image data, preserving their shape characteristics and eliminate irrelevancies.

The most basic morphological operations are dilation and erosion. Dilation adds pixels to the boundaries of objects in an image, while erosion removes pixels on object boundaries. The number of pixels added or removed from the objects in an image depends on the size and shape of the *structuring element* used to process the image. In the morphological dilation and erosion operations, the state of any given pixel in the output image is determined by applying a rule to the corresponding pixel and its neighbors in the input image. The rule used to process the pixels defines the operation as dilation or erosion [11].

Edge detection is a basic tool in image segmentation which carries valuable features of the image. Initially, the original image is transformed into a gradient image which represents the edge strength of each pixel. To classify each pixel to the edge point or non-edge point a threshold is then applied. Usually, the gradient image can be obtained by means of first-order differential operators or a Laplacian operator which can enhance the spatial intensity changes in the image.

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Morphological edge detectors have also been proposed for their robustness under noisy conditions and some of them are discussed in the following section. [10]

2.1 Morphological gradients

To mark the dynamic changing of the intensity levels the mathematical morphology is used [11]. Gradient morphology will show a very good efficiency to marks intensity

$$Ge(x) = x - (x \ominus B)$$
$$Gd(x) = (x \oplus B) - x$$
$$G(x) = (x \oplus B) - (x \ominus B) \qquad (2)$$

Region is given in equation 1. B is the structure element, Ge(x) is gradient erosion, Ge(x) gradient dilation and G(x) is morphological gradient.

If B is chosen as the rod structure element with flat top whose domain is the origin and its 4-neighbor, then gradient by erosion and dilation are also called erosion residue edge detector and dilation residue edge detector respectively. Here extracted masses obtained with the G(x).The series of operations are applied with watershed along with morphological gradients to train the algorithm and generate optimum results.

3. Watershed transform

Watershed transform is applied on gradient image; consider the image surface exhibits topographic property. Physical explanation of watershed is to apply an image contain minimum and pixel values. The transform start at minimum level that is the flood water enters at minimum surface a hole is drilled in each minimum of the surface, and water is flooded into different catchment basins from the holes. The water start filling at lower surfaces called catchment basins. Maximum level of the dam is visible above the waterline; the flooding process will eventually reach a stage to the top. Different catchment basins are formed each is given a unique label [2].

A watershed is defined for the continuous case can be based on distance functions. Let us consider an image '*f*' is an element of the space C (D) of real twice continuously differentiable functions on a connected domain D with only isolated critical points. Points p and q in D, Then the topographical distance expressed as

$$T_f\ (p, q) = inf_\gamma \int_\gamma \|\nabla f(\gamma(s))\|\, ds \qquad (3)$$

The equation (2) shows infimum is over all smooth curves inside D with (0) = p, (1) = q. Let minima f∈c(D) $\{m_k\}Ikk$, for some index set I. The catchment basin of a minimum *mi* is expressed as the set of pixels, those are topographically closer to *mi* than to any other regional minimum mj:

$$CB(mi) = \{x \in D \mid \forall j \in I\{i\}: f(mi) + Tf(x, mi) < f(mj) + Tf(mj)\} \qquad (4)$$

The watershed of *f* is the set of points which do not belong to any catchment basin

$$W_{SHED}\,(f) = D \cap [\cup_{i=1} CB(mi)] \qquad (5)$$

So the watershed transform of *f* assigns labels to the points of D, such that i. different catchment basins are uniquely labeled, and a ii. special label W is assigned to all points of the watershed of *f*.

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4. Proposed method algorithm

The main drawback of the watershed transform is to generated an over segmentation image. To overcome the problem a marked-based watershed segmentation algorithm is proposed. The marker image is created from gradient image by binary processing. The markers of the image is obtained by morphological gradient operators, a linearization process is used to calculate a threshold of image, Because it considers the complex grey level distribution of remote sensing image, the extracted makers are more coincide with the real objects. As shown in the fig 1 a color image is applied to converts into a gray scale image. Apply the morphological gradient operator with multilevel structure elements. Here the more importance is given the selection of structure elements. Multiple structure element also used depends on the robust of the remote sensing image. The algorithm performance also checked MXNX3 dimension of the image. The Best suited dimension the algorithm performed well is 256x256x1. Choosing the thresholding value is a statically nature, which depends on the ridgelines in the output images. An adaptive thresholding used to perform good results. Adaptive thresholding with differential operator's markers are generated. The extraction of marker image and the labeling of pixels is obtained. Markers are a set of components marking flat regions of an image, i.e., each marker indicates the presence of an object. Depending upon whether the pixel inside or outside of marker label '0' and '1'.

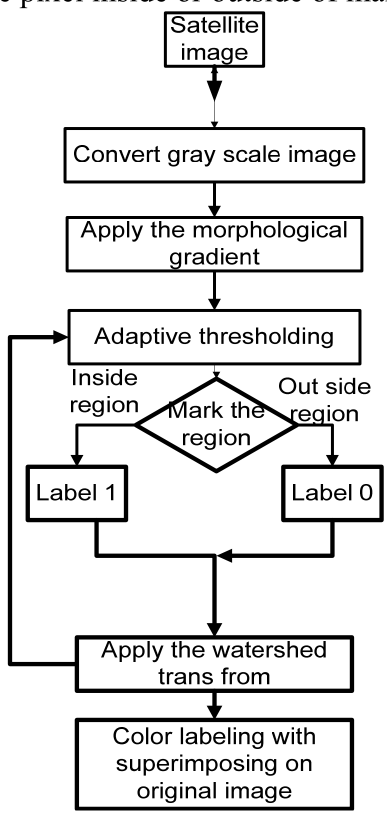

Fig 1: Proposed method flowchart

The labeling the pixels are adopted in two methods. One is consider an individual marker, which is extracted with morphological gradient image. It is remove the unwanted minima of the image, then segmented with watershed transform. Other one is to smooth undesired minima during label naming process. The marker based immersion type watershed algorithm proposed in the literature, which performs the flooding process directly on the original gradient image. It was modified with a series of morphological operations with multi structure elements.

Apply the watershed transform to the marked image and avoid the over segmentation. The final partition and label the unassigned pixels by the extended watershed algorithm dealing with markers to get. In order to obtain the better segmentation result converts the image in RGB color

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space. It has the advantage that segmented results can have coherent regions, link edges, no gaps due to missing edge pixels.

5. RESULTS AND DISCUSSION

The proposed algorithm is implemented in MATLAB 7.8 software the results are obtained and discussed [14]

First we have to read the satellite image. Fig 2 reads the image.

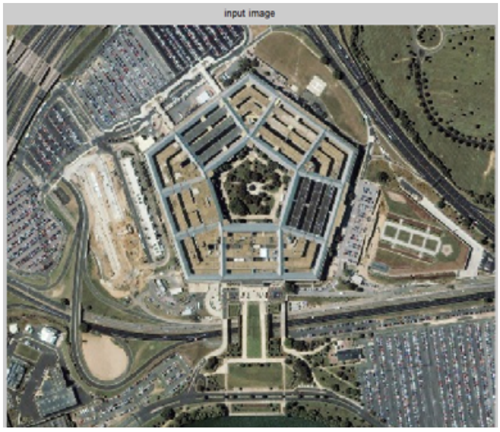

Fig 2: input image

Fig 3 describes about Morphological Gradient Magnitude as the Segmentation Function. Use the canny edge masks, and some simple arithmetic to compute the gradient magnitude. The gradient is high at the borders of the objects and low (mostly) inside the objects.

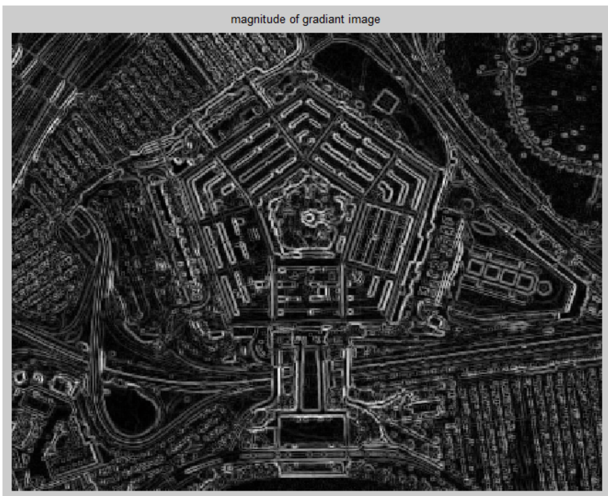

Fig 3: magnitude of gradient image

Fig 4 describes watershed of gradient magnitude segment. The image by using the watershed transform directly on the gradient magnitude. Opening is an erosion followed by a dilation, while opening-by-reconstruction is an erosion followed by a morphological reconstruction. Let's compare the two. First, compute the opening.

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Fig 4: markers and object boundaries superimposed on original image

It computes a label matrix identifying the watershed regions of the input image, which can have any dimension. The elements labeled 0 do not belong to a unique watershed region. These are called watershed pixels. The elements labeled 1 belong to the first watershed region, the elements labeled 2 belong to the second watershed region.

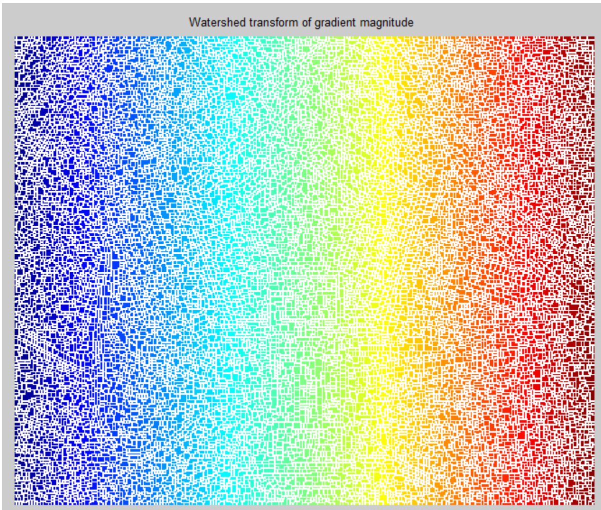

Fig 5: watershed of gradient magnitude

Without additional preprocessing such as the marker computations below, using the watershed transform directly often results in "over segmentation."

To avoid the over segmentation we have to select the particular markers these are based on foreground and background markers. So we have to find the foreground and background markers for this we use image erosen with opening by reconstruction and closing by reconstruction. These are called morphological techniques. These operations will create flat maxima inside each object that can be located using imregionalmax. Fig 6 describes the colored watershed label matrix. The above result shows, how the locations of the foreground and background markers affect the result. In a couple of locations, partially occluded darker objects were merged with their brighter neighbor objects because the occluded objects did not have foreground markers. Another important result is to display the label matrix as a color image. Label matrices, such as those, can be converted to true color images for visualization purposes.

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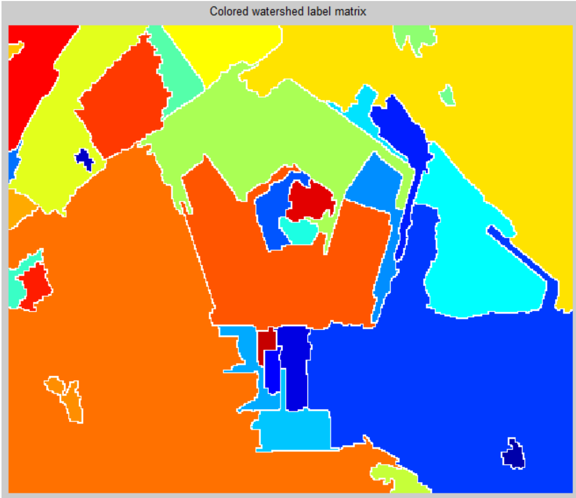

Fig 6: colored watershed label matrix

Fig 7 describes the superimposed transparently on original image. Now finally we can use transparency to superimpose this pseudo-color label matrix on top of the original intensity image.

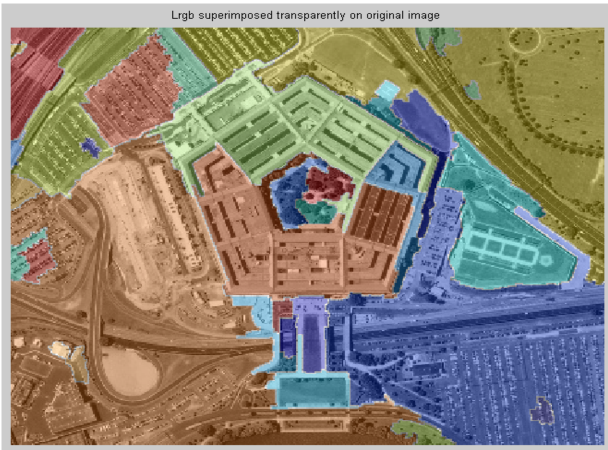

Fig 7: superimposed transparently on original image

6. **Conclusion**

A morphological gradient watershed transform method is applied to segment the remote sensing images with accurate objects boundaries and reduce false boundaries. The presented method can be divided into two stages. A morphological gradient operator is used to extract the boundary of the objects in binary form and marked the each region with specific label 0 or 1.An adaptive thresholding is applied to calculate the exact boundary, this is obtained by considered a histogram and calculate extract gray value using statistical measures. To integrate the edge of the each marker using canny edge operator. Boundaries can be obtained with more accurate regions with high level edge pixels. The remote sensing images are in robust in nature and contain more information for a certain area, the proposed is shown more effective to identify or separate the regions and reduce the over segmentation. Segmentation results are with more accurate region boundaries, which match with the identified edges reasonably good, when integrating the edge information. The method is simplification for integrating edge information into segmentation, and can show an efficient result for remote sensing images with various objects sharing and structure features. In future design a 3-D representation of automatic marker gradient operators along with watershed transform for segmentation of 3-D medical images.

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