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An Approach of Segmentation Technique of SAR Images using Adaptive Thresholding Technique

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Abstract

Segmentation is an essential matter in synthetic aperture radar (SAR) image analysis. When contrast results against the true forest, ocean, and hills etc SAR images can afford more information, and obtain more acceptable segmentation than only single polarization SAR image. In this paper a novel methodology has been carried out to segment a SAR image based on the Adaptive Thresholding Technique. This technique composes of three main processes: firstly, selecting training samples i.e. mean value for every region in the SAR image. Secondly, training these samples using 5X5 window, and obtain variance of every region. Finally, the segmentation of SAR image with respect to group threshold value i.e. generated automatically.

Keywords
SAR image , Gray Image, Adaptive Thresholding.

1. Introduction

A SAR image does not depend on specification or light conditions and images can be taken at any part of the day and in any specification. During the processing of SAR image, a correct segmentation lays the foundation for the following analysis, such as feature extracting, classifying and extracts the information of geographical areas. A large number of algorithms have been proposed to contend with the segmentation problem in SAR images.

2. Related Work

The problem related to the segmentation of SAR images is depending on the intensity correlation. There are many scholastic researches, who have paved their ways for SAR images segmentation. Yongmin Shuai , Hong Sun, Ge Xu proposed SAR image segmentation Based on Level Set i.e. is the computational expense inherent to solving the proposed nonlinear parabolic partial differential equation [1]. Xiaolin Tian, Shuiping Gou and Licheng Jiao developed SAR image segmentation technique based on spatially adaptive weighted Possibilistic c-means clustering [2]. Ming Li Yan Wu Shunjun Wu proposed Segmentation technique based on Mixture Context and Wavelet Hidden-Class-Label Markov Random Field [3]. Sun Li, Zhang Yanning, Ma Miao, Tian Guangjian proposed infinite mixture model can simulate the intrinsic property of SAR image and the segmentation method can determine the cluster number automatically [4]. Haiyan Li, Zhengyao Bai describes a new PCNN-Based method for Segmentation of SAR Images [5]. Ting Liu, Xian-Bin Wen, Jin-Juan Quan and Xue-Quan Xu integrate the multi-scale technology, mixed-model information and support vector machines (SVM) for SAR image segmentation [6]. Xueying Yan, Licheng Jiao, Shuwen Xu proposed segmentation method based on gabor filters of Adaptive window of SAR image [7]. Fucheng Li, Jin Zhang, Lili Zhou, Jianping Du, Bin Yan used a new segmentation method of SAR image based on multi-polarization information fusion [8]. Han Ping, Zhang Rui, Su Zhi-gang, Wu Ren-biao proposed segmentation method based on Support Vector Machine [9].

In this paper a novel methodology has been carried out to segment a SAR image based on the Adaptive Thresholding Technique. This technique composes of three main processes: firstly, selecting training samples i.e. mean value for every region in the SAR image. Secondly, training these samples using 5X5 window, and obtain variance of every region. Finally, the segmentation of SAR image with respect to group threshold value i.e. generated automatically.

3. Proposed Methodology

Since the unexpected changes in intensity pixel value indicates class, its detection in binary or segmented image is quite straightforward. However, the process of class is less complex in the case of SAR images. As an initial approximation, the number of segments is pre-defined as '*W*', and as many different, equally spaced mean values are obtained based on the maximum and minimum gray level values in the image, as given in the following equation $U_{SAR}=(r*c)+min_{SAR}$, -------------(1)

Where, μ, is the mean of the i^{th} class, Q_{SAR}=(max-min)/(W-1) ---------------(2)

max is the maximum gray level intensity value, and min is the minimum gray level intensity value. Each of the pixel values in the image is now assigned to the bin of the corresponding class based on their distance from the mean value of each class. As a measure to identify the distance, the linear distance is calculated as:

$$dist_{SAR} = Y_{r,c} - Q_{SAR} \text{ ----------------(3)}$$

Where $Y_{r,c}$, is the pixel intensity at the location (r,c).

3. A. Mean: The statistical mean gives us the average value of all the pixels for a particular feature. Mathematically, the statistical mean of a set of variables is expressed as:

$$\mu_{SAR}=\sum Q_{r,c} P\left(Q_{r,c}\right) - - - - - - - (4)$$

The summation is carried out over all the gray level values in the set. It is important to notice that, even though the mean gives a good estimate of the characteristics of a feature, it might not give a good representation of the damage or change in the region.

3. B. Variance: Variance is the second moment of a matrix and is a measure of gray-level contrast that can be used to establish descriptors of relative smoothness. Mathematically, it is defined as the mean of squares of differences between respective samples (gray-level intensities) and their mean and is expressed as:

$$\delta^2_{SAR}=\frac{\sum\left(Q_{r,c}-\mu_{SAR}\right)^2}{w} - - - - - - - - - (5)$$

Where δ^2_{SAR} the variance or square of the standard deviation, and w is the number of samples in the region. An estimate of the difference in the variance values of the region between the predicator and post-disaster images is an indication of the level of change. In our methodology first we have convolute the image with a five order mask according to the X and Y direction respectively to obtain the gradient of each points. Then the ultimate gradient is obtained by the following formula: $\Delta f(r,c) = [\ G_r \ \ G_c\ ] = [\ \Delta f/\Delta x \ \ \Delta f/\Delta y\ ]$ --------(6)

The weight of the vector is: $\Delta f(r,cy) = mag(\Delta f(r,c)) = \sqrt{(G^2_r+G^2_c)}$ ---------(7)

Gradients of points give the maximum location at the center of the original signal thus removing the noises from SAR images. Then the gradient of the pixels is calculated as:

$$V(r,c)=\frac{1}{15}\sum_{h=-5/2}^{5/2}\sum_{k=-5/2}^{5/2} Q_{SAR}(r,c) * F_{SAR}(r-h,c-k) - -(8)$$

Where * indicates a discrete convolution, Q_{SAR} is the 5X5 mask, and $F_{SR}(r,c)$ is a hXk SAR image.

3. C. Adaptive Thresholding

Image classification based on thresholding is a greedy technique because it classifies pixels into two categories.

Category1: Pixels whose values fall below the threshold.

category2: Pixels whose values are equal or exceed the threshold.

If T is a threshold value, then any pixel (r, c) for which $f(r,c) \geq T$ is called a class point. For thresholding we compute adaptive threshold of local intensity variations as:

1. First the overall mean value of the SAR image is calculated. So the pixels having lower class strength

than this mean value are already discarded.

$$T1 = \frac{1}{9}\sum_{k=-1}^{1}\sum_{h=-1}^{1} V(r+h, c+K) ----(9)$$

Threshold1 = mean (G).

2. Then a 3 X 3 window is splits over the SAR image where the mean and variance of the SAR image within this window are calculated.

$$\delta_{SAR} = \sqrt{\frac{1}{9}\sum_{k=-1}^{1}\sum_{h=-1}^{1} G(r+h, c+k) - T1} ---(10)$$

Then taking the sum of this mean value and standard deviation and this is considered as the threshold value of that pixel. Now if the gradient of this image exceeds this threshold then the pixel is treated as a class. At last this mean and standard deviation is summing up to generate the ultimate threshold for the candidate pixel,

$$T_{SAR}=T_1+\delta_{SAR}. ---------------(11)$$

In this way threshold value is generated dynamically and region wise for each pixels so that the possibility of data loss or noise is quite reduced. If the pixel value is greater than or equal to this adaptive threshold then only the pixel is treated as class otherwise it is discarded.

4. Proposed Algorithm

- Input: SAR Images of variable size.
- Output: Classification of SAR image.

1) Start.

2) Taken a SAR images.

3) Consider a 5X5 window.

4) calculate the mean, variance of that SAR Images.

5) Segmentation is obtained using adaptive threshold change.

6) Stop.

5. Experiment and Analysis

In this thesis work, we have considered synthetic aperture radar images. The SAR images are segmented by using Adaptive Thresholding Technique. The figure (Fig 1 to Fig 3) shows the original SAR images and segmented SAR images based on Adaptive Thresholding Technique.

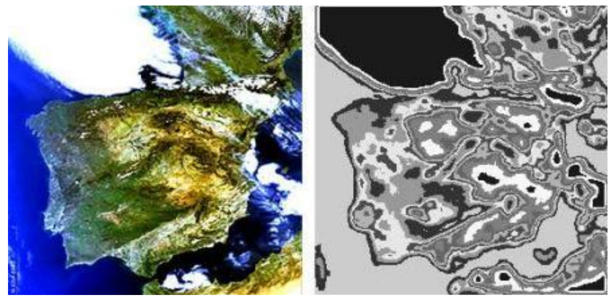

Figure 1. Input SAR image and Segmented SAR image

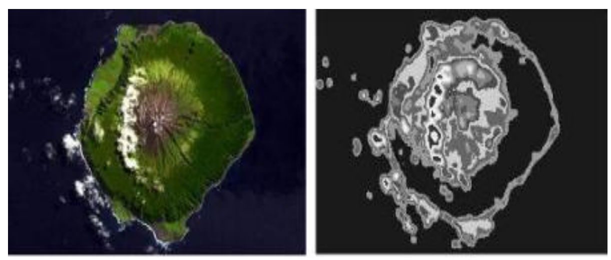

Figure 2. Input SAR image and Segmented SAR image

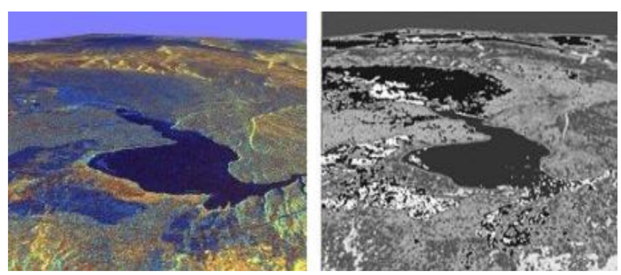

Figure 3. Input SAR image and Segmented SAR image

6. Conclusion

In this paper, we proposed a novel Adaptive Thresholding Technique based image segmentation technique for SAR image. This technique based on considering a window and calculates the mean, variance of that SAR Images then store the color feature for Adaptive Thresholding. Next, Segmentation is obtained using Adaptive Thresholding value using region merging. For this reason, our algorithm did not make inaccuracy; that is, a segmented SAR image very different to get the originality of the SAR images. This may be extended to the color image segmentation. The results from this preliminary study indicated that the proposed strategy was effective.

7. References

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