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SEGMENTATION OF SAR IMAGES USING FUZZY C MEANS WITH NON LOCAL SPATIAL INFORMATION

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ABSTRACT

The Segmentation of the Images refers to extracting the needed region from the image based on some specified methodologies. Thresholding Approach, Model-based Approach, Level Set Approach are some of the segmentation methodologies. The clustering methodologies can provide accurate results for most of the cases. As the number of clusters separated from the image increases, the segmentation accuracy also increases. The fuzzy c means is one of the clustering based methodologies. It has been extensively used for segmentation of images. Even FCM has some drawback. The main drawback is that the performance is degraded by noise. This problem can be overcome by Fuzzy C Means with Non Local spatial Information which can be derived from the pixels with similar neighborhood configuration to the current pixels so that impact of Noise level in the Image is reduced. Experimental results obtained for synthetic and real SAR (Synthetic Aperture Radar) Images demonstrate the improved robustness and effectiveness.

Keywords: sar images, fuzzy C means, segmentation, non local spatial information.

1. INTRODUCTION

Synthetic Aperture Radar (SAR) scans the earth's surface to create the Image. This image can be 2D or 3D images. It can be widely applied in military and civil application. SAR images consist of polarimetric SAR and single polarimetric SAR image. SAR image can be segmented by using four general categories graph partitioning techniques, clustering algorithm, model-based methods, and morphological strategies. In this paper SAR image is segmented by using the Fuzzy C Means clustering algorithm. Fuzzy C Means was introduced by Bezdek [1]. It is one of the segmentation methods which assign the membership degree value to one or more number of clusters. The disadvantage of Fuzzy c means is that the performance is degraded by noise. The most well-known methods for clustering is Hard C Means developed by Mac Queen. The simplicity of Hard C Means is that it is a partition clustering method that separates data into a K number of clusters. The number of cluster K is chosen randomly. Hard C Means calculate the distance from each data to its cluster. The Non Local Means are introduced by Buades *et al*. [4] and it is derived from the pixels with similar neighborhood configuration to the current pixels. This spatial information is derived from the window of large size for every pixel. An edge preserving Non Local method fuzzy C Means algorithm is introduced [9] in which ratio distance based on SAR multiplicative speckle is defined. Spectral clustering Ensemble is proposed [8] for the segmentation of SAR images in which the gray-level occurrence matrix-based statistic features and the energy features from the undecimated wavelet decomposition is extracted for each pixel and is used as input. SAR Image Segmentation based on Gabor filter bank and active contours is proposed in [6]. Fuzzy C Means Clustering with thresholding is applied to Iceberg image segmentation for SAR images [15].

In this paper a new method for segmentation of sar image using fuzzy c means with non local spatial information is proposed.

2. FUZZY C MEANS

Fuzzy C Means was introduced by Bezdek. It is a soft segmentation method which is mainly used for segmentation. FCM generates the membership degree value during each iteration step. Let X= $\{x_1 , x_2 ,\ldots. x_n\}$ be the set of data points to be partitioned into clusters.The Objective function of FCM is defined as follows:

$$J_m = \sum_{k=1}^{c}\sum_{i=1}^{n} u_{ki} \|X_i - V_k\|^2 \quad (1)$$

$$\sum_{i=1}^{n} u_{ki} \leq n \quad (2)$$

To update the membership value and cluster center.

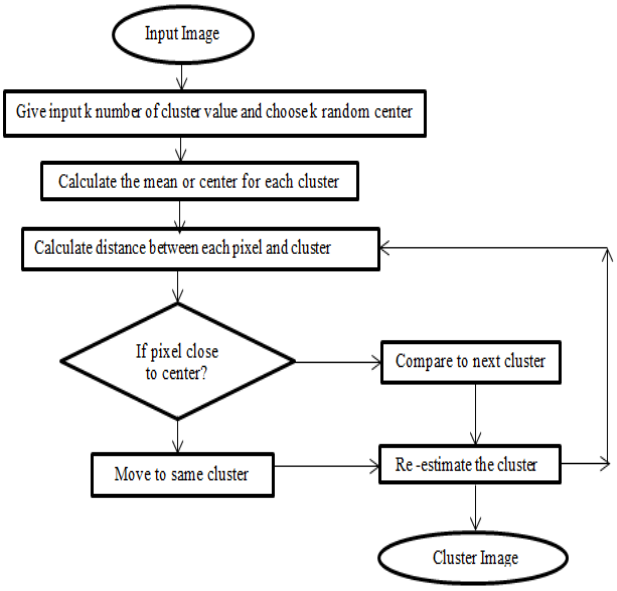
$$u_{ki} = \frac{1`}{\sum_{l=1}^{c}\left(\frac{\|X_i - V_K\|^2}{\|X_i - V_l\|^2}\right)^{\frac{1}{m-1}}} \quad (3)$$

where m is the membership function weighting exponent.

$$V_k = \frac{\sum_{i=1}^{n} u_{ki}^m X_i}{\sum_{i=1}^{n} u_{ki}^m} \quad (4)$$

3. HARD C MEANS

Hard C Means is the unsupervised learning algorithm. In this Hard c Means algorithm initially K number clusters are defined. Then K-cluster centers are chosen randomly. Then the mean or center of each cluster is calculated. Based on the distance between each pixels and cluster center, if the distance is close to the center, then move to that same cluster. Otherwise, compare to the next cluster. Then Re- estimate the center.Repeat the process until the center doesn't move.



4. PROPOSED METHOD

The major problem for SAR image segmentation is sensitive to noise due to the presence of speckle noise.This problem is addressed in this paper by segmentation of SAR Image using Adaptive Non Local Spatial Information. First, Non Local Spatial Information is constructed and then the Fuzzy C Means segmentation is applied.

In Non Local method, for every Pixel in an Image, there are many pixels having a similar neighborhood configuration. When compared to using the adjacent pixels, it is reasonable to utilize pixels with similar neighborhood configuration to this pixel to obtain the required spatial Information. For the ith pixel, its spatial information is calculated by

$$v_i = \sum_{j \in W_i^r} W_{ij} X_j \qquad (5)$$

Where W_i^r is r x r search window centered at the ith pixel. The weight W_{ij} is similarlity between the neighborhood configuration of ith pixel and jth pixel.

$$W_{ij} = \frac{1}{Z_i} exp(- \|X(N_i) - X(N_j)\|_{2,\sigma}^2 / h^2 \qquad (6)$$

Where x(N_i) is a gray level vector of the pixels within an S x S square neighborhood N_i centered at the ith pixels. $\|x(N_i) - x(N_j)\|_{2,\sigma}^2$ Denotes a Gaussian weighted Euclidean distance, where $\sigma > 0$ is the standard deviation of the Gaussian kernel. The weight W_{ij}depends on the ith pixel and jth pixel.Then the filtering degree parameter h in equation (7) can control the decay, and z_i is the normalizing constant and is defined as

$$Z_i = \sum_{j \in W_i^r} exp\,(- \|X(N_i) - X(N_j)\|_{2,\sigma}^2 / h^2 \qquad (7)$$

For the ith pixel spatial Information can be derived from a larger region of the Image than small region around it. Therefore, this Spatial Information is called Non Local spatial Information.

The detail of the proposed method Fuzzy C Means with Non Local spatial Information

Step-1: Assign the number of clusters C, window sizes of non-local information r=21 and s=7, membership weighting exponent m=2.

Step-2: Set the threshold ε and the maximum iteration number T as 0.00001 and 500 respectively.

Step-3: Initialize the cluster center $V^{(1)}$and set iterative index q=1.

Step-4: Obtain the Non local spatial Information for each pixel using equation (5) - (7).

Step-5: compute the membership degree matrix using equation (3)

Step-6: Compute the new cluster center $v^{(q+1)}$ using eq.(4)

Step-7: If $\|v^{(q+1)} - v^q\| < \varepsilon$ or the number of iterative q>T, then output the clustering result, otherwise q=q+1, go to step-5.

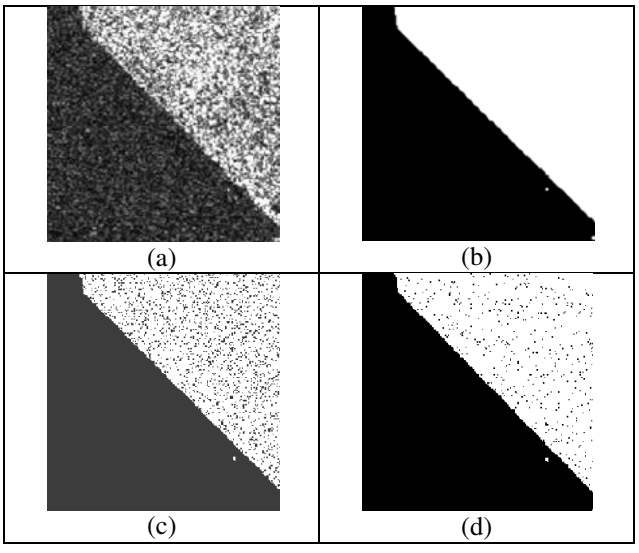
5. EXPERIMENTAL RESULTS AND ANALYSIS

The proposed method is tested on synthetic and real SAR images. The performance is compared with that of FCM and K Means. Segmentation Accuracy (SA) is used to compare the performance and is defined as

$$SA\ in\ \% = \frac{No.of\ Correctly\ Classifed\ Pixlels}{Total\ number\ of\ Pixels} x100$$

A. Synthetic SAR image

Three synthetic images are taken at a resolution of 185 x 183, 115 x 111, and 256 x 256. These three images include two clusters 60 and 255 as shown in Figure-1(a), Figure-2(a), and Figure-3(a). The ground truth image in shown in Figure-1(b), Figure-2(b) and Figure-3(b). The segmentation results for FCM, K-means and Proposed Method are shown in Figure-1 (c)-(e), Figure-2. (c)-(e) and Figure-3. (c)-(e).



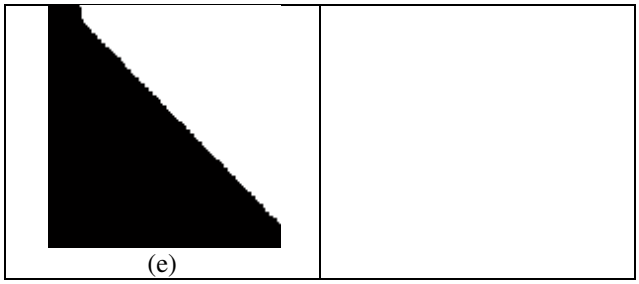


Figure-1. Segmentation results on the synthetic Image 1 (a) Original Image (b) Ground truth (c) Fuzzy C Means (SA=94.739) (d) K-means (SA=97.457) (e) Proposed Method (SA=99.944)

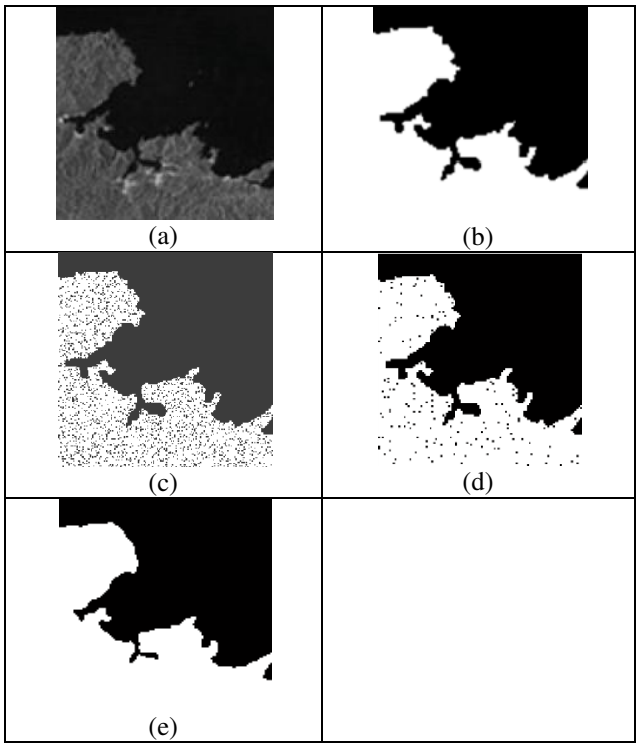
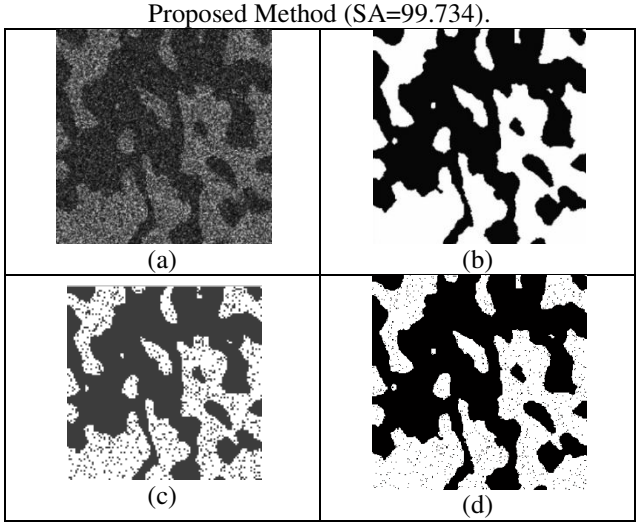


Figure-2. Segmentation results on the synthetic Image 2 (a) Original Image (b) Ground truth (c) Fuzzy C Means (SA=94.899) (d) K-means (SA=96.547) (e) Proposed Method (SA=99.734).



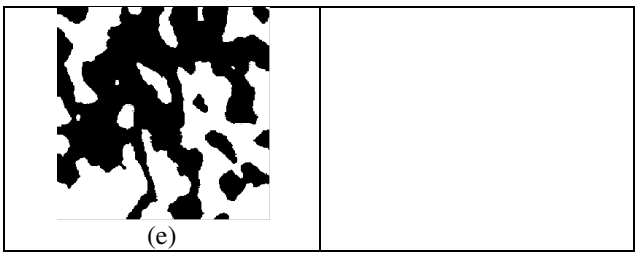


Figure-3. Segmentation results on the synthetic Image 3 (a) Original Image (b) Ground truth (c) Fuzzy C Means (SA= 93.909) (d) K-means (SA=96.219) (e) Proposed Method (SA=99.681).

B. REAL SAR IMAGE

For the real SAR Images, it is hard to obtain its corresponding ground truth.The performance of the segmentation results is based on the human visual inspection. The first real SAR image is shown in Figure-4. It is a two-look Moutain European Remote Sensing satellite (ERS-2) image. It consists of Lake and Rocks. The black region is segmented as Lake and grey region is segmented as Rock. Figure-4 (a) shows the original Image and Figure-4(b-d) shows the segmentation results for FCM, HCM, and the proposed Method.

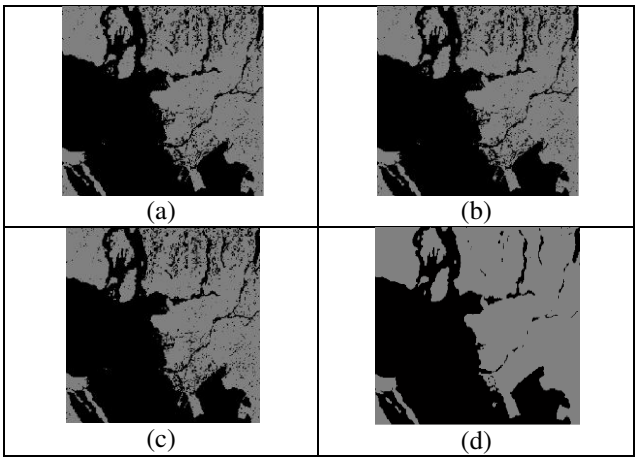
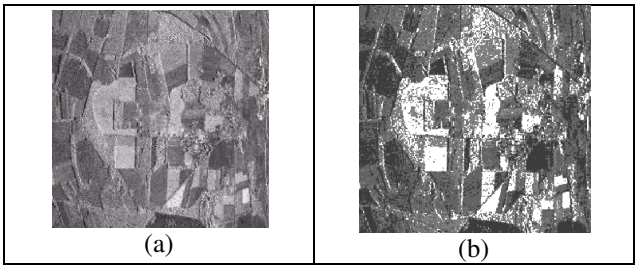


Figure-4. Segmentation results on the Real SAR Image 4 (a) Original Image (b) segmented results for Fuzzy C Means (c) Segmented results for K-Means (d) segmented results for Proposed Method.

The second real SAR image is shown in Figure-5 is a four-look resolution X-band Terra-SAR sub image of Swabian, Germany? It consists of crops, houses, land, wet land. Figure-5 (a) shows the original Image and Figure-5 (b-d) shows the segmentation results for FCM, HCM,and the proposed Method.



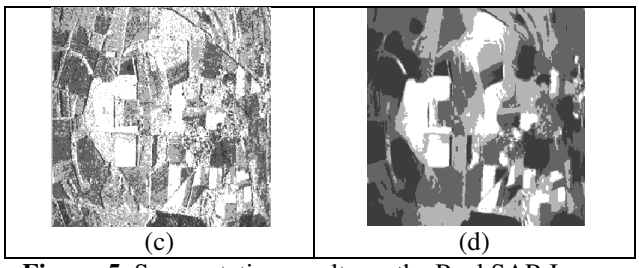


Figure-5. Segmentation results on the Real SAR Image 4 (a) Original Image (b) segmented results for Fuzzy C Means (c) Segmented results for K-Means (d) segmented results for Proposed Method.

Table-1. Comparison of SA in % of FCM, HCM and proposed method for synthetic SAR image.

Image	FCM	HCM	Method [7]	Proposed method
Image 1	94.739	97.457	99.05	99.944
Image 2	94.899	96.547	97.21	99.734
Image 3	93.909	96.219	98.14	99.681

Table-1 shows the Segmentation Accuracy (SA) of the FCM, Hard C Means and the Proposed Method. The Proposed Method provides the better result than the Existing Method.

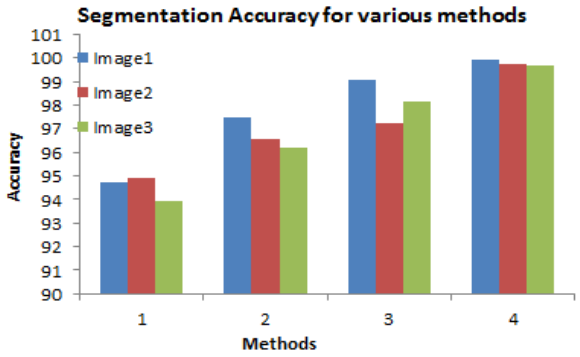


Figure-6. Shows that segmentation accuracy for varoius methods such as FCM, HCM, Method [7], proposed method.

6. CONCLUSIONS

This Paper proposes the Fuzzy C Means with Non Local spatial Information for Segmentation of SAR Images. Fuzzy C Means segmentation is sensitive to noise. Hence, in the segmentation of SAR images, the segmentation accuracy is poor due to the presence of speckle noise. To overcome this drawback of FCM, Non Local spatial Information is incorporated in segmentation. The proposed method is tested on SAR images and the efficiency is improved by around 6% over the existing methods.

REFERENCES

[1] Bezdek, J. C., Pattern recognition with fuzzy objective function algorithms. New York: Plenum, (1981).

[2] Kohei Arali, Ali Ridho Barakbah, "Hierarchical Hard C-Means: an algorithm for centroids initialization for k-means", International Journal of Intrlligent systems. Vol.36, No.1, 2007.

[3] Feng Zhao, Licheng Jiao, Hanqiang Liu "Fuzzy c-means clustering with non local spatial information for noisy image segmentation" Frontiers of Computer Science. March 2011, Vol. 5, No.1, pp. 45-56.

[4] H.Q. Liu, L.C. Jiao, F.Zhao "Non-local spatial spectral clustering for image segmentation" Neurocomputing. 74(2010) 461-471.

[5] Weiling Cai, Songcan Chen, Daoqiang Zhang, "Fast and robust fuzzy c-means clustering algorithms incorporating local information for image segmentation" Pattern Recognition. 40 (2007) 825-838.

[6] Weiping Ni, Xinbo Gao and Weidong Yan, "SAR Image Segmentation Based on Gabor Filter Bank and Active Contours" IScIDE 2012, LNCS. 7751, pp. 531-538, 2013.

[7] Buades, A., Coll, B., Morel, J. M., "Nonlocal image and movie denoising", International Journal of Computer Vision, 76, 123-139.

[8] Xiangrong Zhang "Spectral Clustering Ensemble Applied to SAR Image Segmentation": IEEE Transactions On Geoscience And Remote Sensing, Vol. 46, No. 7, July 2008.

[9] Xuezhi Yang, "A new metric for measuring structure-preserving capability of despeckling of SAR images," ISPRS Journal of Photogrammetry and Remote Sensing. 94 (2014): 143–159.

[10] Hongxiao Feng, "SAR Image Despeckling Based on Local Homogeneous-Region Segmentation by Using Pixel-Relativity Measurement," IEEE Transactions On Geoscience And Remote Sensing, Vol. 49, No. 7, July 2011.

[11] Hua Zhong, "SAR Image Despeckling Using Bayesian Nonlocal Means Filter with Sigma Preselect ion", IEEE Geoscience and Remote Sensing Letters, Vol. 8, No. 4, July 2011.

[12] Ronghua Shang, "Change detection in SAR images by artificial immune multi-objective clustering" Engineering Applications of Artificial Intelligence. 31 (2014) 53-67.

[13] Jie Feng, "Robust non-local fuzzy c-means algorithm with edge preservation for SAR image segmentation" Signal Processing. 93 (2013) 487-499.

[14] Jiulun Fan, "Spectral Clustering Ensemble Applied to SAR Image segmentation" IEEE Transactions On Geoscience And Remote Sensing, Vol. 46, No. 7, July 2008.

[15] Usman Seljuq, "Synthetic Aperture Radar (SAR) image segmentation by fuzzy c meansclustering technique with thresholding for iceberg images.

[16] www.learn-eo.org, www.earth.esa.int.