Edge Enhancement and Edge Detection for SAR Images using Daubechies Wavelet Transform and Region based Active Contour

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Edge Enhancement and Edge Detection for SAR Images using Daubechies Wavelet Transform and Region based Active Contour

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Abstract: The paper presents a new methodology of edge detection for Synthetic Aperture Radar (SAR) images. This justifies the importance of edge enhancement before to edge detection as the data is highly heterogeneous in nature. The research work is based on the implementation of edge enhancement algorithm for SAR images which is implemented with Daubechies wavelet transform. This method signifies the motive to reduce the speckle noise from the SAR images to get smooth edges. The coastline of SAR images is extracted later using region based active contour method for edge detection. This paper introduces local binary fitting energy at level set function; this proposed method is able to detect accurate recovery of desired object boundary. The performance is analyzed by applying it on different radar images.

Index Terms: Daubechies Wavelet Transform, Region based Active Contour, Synthetic Aperture Radar, Edge detection

I Introduction

SAR is a high-resolution space borne remote sensing technique for imaging remote targets on a terrain or more generally on a scene [1]. The available general methods cannot give the better image result compared to optical space borne sensor images. We have considered the properties of this speckle noise to employed Directional smoothing to reduce the noise without blurring edges or other features in SAR imager. The paper aim to for enhance an image based on stationary wavelet transform [4] for the increased efficiency then the exiting conventional methods to extract the information.

In addition, the comparison between the Haar and Daubechies wavelets [3,4] is investigated. It is useful in compression, noise abolishing and acoustic in Daubechies gives better performance than Haar. As they are not quit efficient in the case of SAR images as it is having discontinuities of edges. The robust method b a s e on region based active contour model. This algorithm using region based model [9] as it detect the earmark smooth edge and a less no of iteration before convergence to the edge then the geodesic active contour. Finally the successive use of the both proposed algorithms will tackle the subpixel level efficiency and robust even in the presence of multiplicative noise abolishing pattern in the images.

II. EDGE ENHANCEMENT ALGORITHM

The algorithm is proposed for various images i.e., either one dimensional or two dimensional. The size of the window is also not concern for the application of this algorithm. The two dimensional signal and image processing is an area of efficient applications of db-2 transforms due to their wavelet-like structure. Moreover, wavelets are considered as a generalization of the db-2 functions and transforms. Such a transform is also well suited in communication technology for data processing, multiplexing and digital filtering. In db-2 wavelet with two scaling and wavelet coefficients, and one scaling and wavelet vanishing moments [5], show in table-1.

The wavelet transform can be expressed as [3]

$$Lz(a,b) = \int_a^b z(k)\,\frac{1}{\sqrt{k}}\,\psi^*\left(\frac{k-a}{b}\right)dk$$

Table.1 scaling and wavelet functions values for db-2 wavelet transform

Scaling function	**Wavelet function**
h(0)=1/√2	g(0)=1/√2
h(1)=1/√2	g(1)= -1/√2

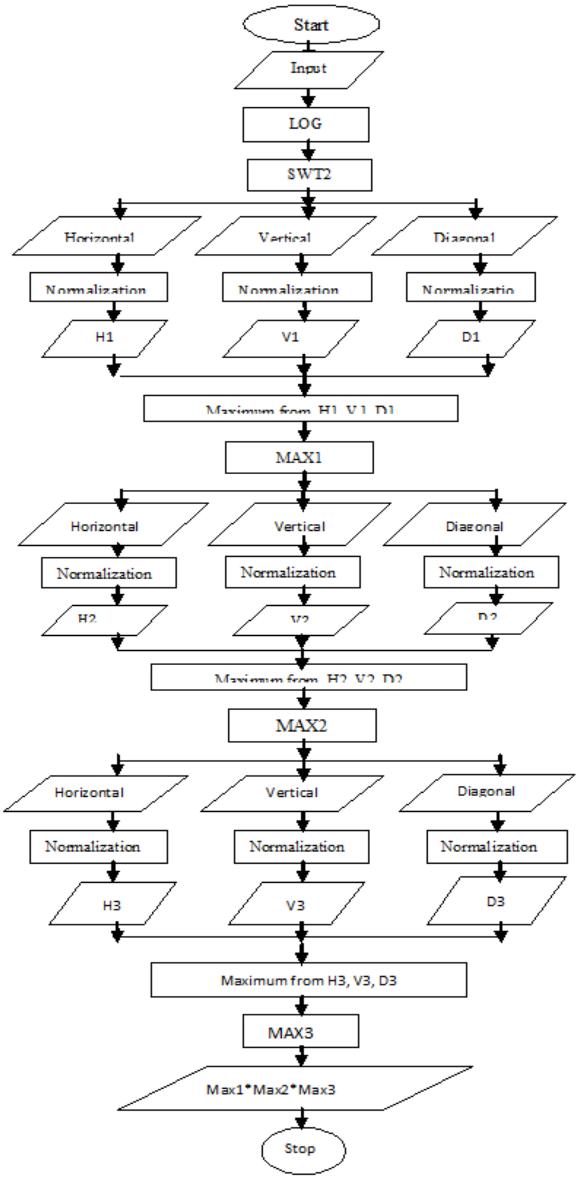
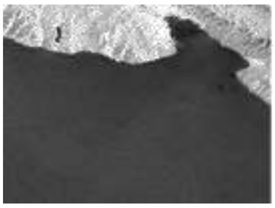


Fig.1 Flowchart for edge enhancement algorithm




(a) **(b)**


(c) **(d)**

(e)

Fig.2 the operation of multi scale outputs using edge enhancement algorithm in SAR images (a) original SAR image. (b),(c),(d) the results of proposed algorithm in first, second and third iteration. (e) final product output

III. EDGE DETECTION ALGORITHM

In this paper, we introduce a region based active contour models is use to detect the edge in coastal line areas and multiple means of pixel intensity. By local binary fitting energy (LBF) [8], local images intensity details into a region based active contour. It is able to segment images with non-homogeneous region, object boundaries. The paper proposes the LBF with a level set function and neighborhood means and dissimilarity as variables.

A. Local Binary Fitting Active Contour Method

Chan and Vese [9] developed a mean curvature flow based level set implementation, where the mean intensity of the pixels interior and external the curve are used as a smooth region of the image but they are not optimum in the case of non homogeneous intensity images. So, by considering the LBF model proposed by C.Li. which is imprecise the intensities interior and external the contour. So, by taking the out input image from the above proposed algorithm edge enhancement output image. Where C is the contour in the image domain Ω. λ 1, 2 are positive constants, and K is a weighting function with a localization property.

The energy purpose can be return as:

$$E_x = \lambda 1 \int_{inter(C)} K(a-b)\,|I(b)-f1(a)|\,2 + \lambda 2 \int_{exter(c)} K(a-b)\,|I(b)-f2(a)|\,2db$$

That K(u) decreases and approaches zeros as |u| increases, and $f_1(a)$ and $f_2(a)$ are two numbers that are fit images intensities near the point x. The above energy is LBF energy around the center point x, we denote (4) by $E_x^{LBF}(C,f_1(a), f2(a))$, since the weighting function K(a-b) is taken as larger values at the point b near the centre point a, and it dramatically decreases to 0 as y goes away from x, and the image intensities at the points y far away from the center x has almost no influence on the values of f_1 and f_2 that minimizes the $E_x^{LBF}(C,f_1(a), f2(a))$.

B. Variation Level set Formulation of the Model

In level set methods, a contour C□ Ω is represented by the zero level set of a lipschitz function □: □□□□□.[10]

The energy function E_x^{LBF} (C,f_1(a), f2(a)) can be written as

$$E^{LBF}(\emptyset, f_1, f_2) = \int_{\Omega} E_a^{LBF}\, da \quad (3)$$

$$Ef(\phi, f1, f2)=\lambda 1\iint K_{\sigma}(a-b)p1,aI(b)H(\phi(b))\, dbda+\lambda 2\iint K(a-b)p2,aI(b)(1-H(\phi(b)))dbda \quad (4)$$

Where λ1, λ2, v, μ are weighting positive constants. Kσ is kernel function with a local mean that Kσ (a-b) and the f1,f2 are the two regions in the image domain f, the local point x with a curvature of r. The kernel function is considered with the fixed σ. The two regions are considered as they are having mean and variance are spatially varying and defined as ui, σi^2 within the regions concern to local of a. As the smoothing functions are defined in the Vese and Chan model and C.Li

$$L(\phi)=v\int|\nabla H(\phi(x))|dx \quad (5)$$

Where Φ is zero level set function, the L (Φ) is penalizing the length and for smooth contour propagation. The regularized level set evolution is from a distance function which is for the accurate execution is given as

$$D(\phi)=\mu\int (|\nabla\phi(x)|-1)^2dx \quad (6)$$

The energy function is considered after including the both smoothing and distance functions is

$$F(\phi,f1,f_2)=E_f(\phi,f_1,f_2)+vL(\phi)+\beta D(\phi) \quad (7)$$

Where β and v are non-negative constants.

This is the energy functional we will minimize eq.(9) to find the object boundary. The method is most complimentary with the iterative process done in various steps shown in the flow chart as follows fig 3.

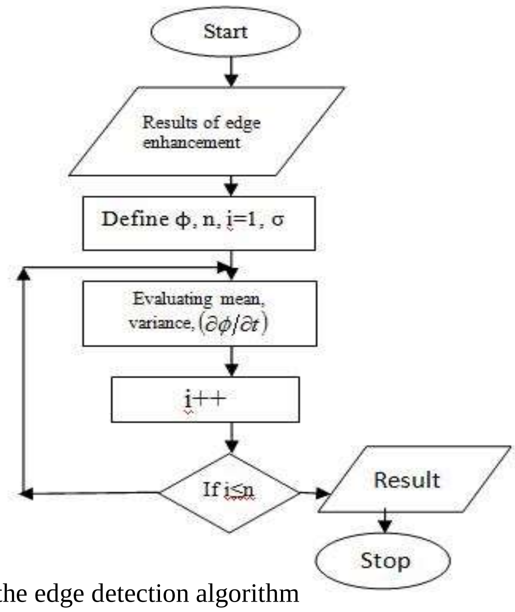


Fig.3 Flowchart of the edge detection algorithm

IV. SIMULATION RESULTS AND DISCUSSIONS

The application of algorithms absolutely gives the expected results for the costal line detection constituted by the edge enhancement algorithm before the application of region based method. The method proposed a edge enhance directly in daubechies wavelet transform domain and detected with active contour method.

Table: the Parameter values of edge enhancement for SAR image

WAVELETS	MSE	PSNR(db)	MAE
Haar	20.2708	35.0961	2.2886
Db-2	16.3583	36.0274	1.9380
Db-4	16.4266	36.0093	1.9380

MSE-Mean Square Error
PSNR- Peak Signal to Noise Ratio
MAE-Mean Absolute Error

By simulation the result obtained confirms a good enhancement with db-2 wavelet than the Haar wavelet transform without using any filter techniques shown in figure

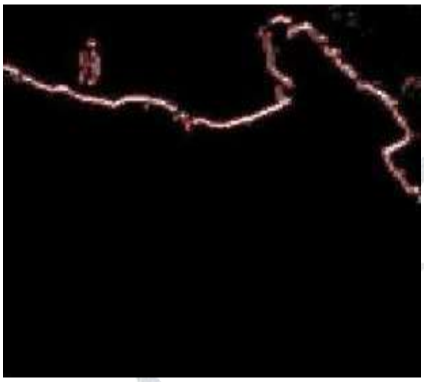


Fig.5 simulated image of detected edges by the application of algorithm for SAR image.

2(e).The observation of edge enhancement results a good match of edge coastline to the shore line that is visually inferred. The red line has been indicates for representation purpose shown in fig.5.

V. CONCLUSIONS & FUTURE SCOPE

The method proposes a robust edge enhancement directly in the wavelet transformed domain, the edge enhancement phase has been proven to be difficult in heterogeneous SAR images, and the original method proposed in this project constitutes a good solution that is used to deal with this data type particularly. It does not require any type of pre-filtering of data, and it is independent of the statistics of the input image. The proposed work focuses mainly on one of the fault generally occurs in the SAR data to reduce the speckle noise by using db2 wavelet transform and the results are also satisfactorily compared with Haar and db4 methods.

It is also found that the region based active contour gives best results for edge detection when compared to geodesic active contour. And the number of iterations is less in region based active contour method to detect an edge than Geodesic Active Contour method. So, the region based approach is most eligible method for the detection of edges in multiplicative noised images.

FUTURE SCOPE: The work can be further extended on 3D images and also for target and remote sensing applications with more reliability.

REFERENCES

[1] Caner Özdemi˙R, PhD Mersin University "Invers- Synthetic-Aperture-Radar-Imaging-MATLAB-Algorithms". Mersin, Turkey, A John Wiley & Sons, Inc., Publication -2012

[2] Amandeep Kaur, Karamjeet Singh "Speckle Noise Reduction By Using Wavelets" INDIA, 19-20 March 2010.

[3] S. Mallat, "A Wavelet Tour of Signal Processing", New York: Academic, 1999.

[4] Mohamedi. Moawad I. M.Dessouky,"Comparison between Haar and Daubechies Wavelet Transformions on FPGA Technology" Volume 20 April 2007

[5] K.V.Ramanaiah , P. Rajesh Kumar "Wavelet Transform Techniques for Image Compression – An Evaluation" I.J. Image, Graphics and Signal Processing, 2014

[6] K.P.Sorman, K.L.Ramachandrana, N.K.Resmi "Insight into Wavelets-from theory and practice,3rd edition" NewDelhi-2010

[7] C. Li, C. Kao, J. Gore, Z. Ding, "Implicit active contours driven by local binary fitting energy", IEEE Conference on Computer Vision and Pattern Recognition (CVPR), USA, 2007, pp. 1–7.

[8] M. Tello Alonso, C. Lopez-Martinez and J.J. Mallorqui, P. Salembier, “edge enhancement algorithm based on the wavelet transform for automatic edge detection in SAR Images”, IEEE transaction on geodesic and remote sensing , vol. 49, no.1, Jan 2011.
[9] C. Li, “Active contours with local binary fitting energy”, IMA Workshop on New Mathematics and Algorithms for 3-D Image Analysis, 2006.