Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 03, March-2021

Implementation of Oil Spill Detection from SAR Image through Improved Canny Edge Detection

A. Brahma Tejaswini
M. Tech, ECE (CESP)
Dr. Y. S Rajasekhara Reddy ANU College
of Engineering & Technology
Acharya Nagarjuna University
Guntur, AP

Dr. P. Siddaiah
Professor and Dean Department of ECE
Dr. Y. S Rajasekhara Reddy ANU College
of Engineering & Technology
Acharya Nagarjuna University
Guntur, AP

***Abstract*— An Oil spill frequently results in large-scale marine pollution and endangers the marine ecosystems as well as human life very badly. Major threat of oceanic and costal environments is caused by the oil spills. The satellite especially the synthetic aperture radar is an effective tool in checking the oil spills over a wide area. The images of an SAR contain large speckle noise, due to which the edges of the oil spill cannot be detected exactly. The proposed method is an alternative of edge detection, in the first step a preprocessing is done and then acquires the threshold values. After thresholding, region splitting and merging is applied for the segmented image and then edge detection is done by using canny edge detection to extract the oil spill information with accuracy.**

***Keywords*— SAR, Speckle noise.**

I. INTRODUCTION

Oil spill mainly occur due to two primary reasons, they are due to natural oil seepage and accidental spills during extraction, transportation and consumption of petroleum. The major accidents of oil spills occur in complex environmental conditions of maritime ecosystem. So, it is hard time to enter the polluted area and start the cleanup process at very early stages. Therefore the spill last for days, weeks and also for months. So, we need to continuously monitor the marine ecosystems in order maintain the safety of ecosystems which in turn can reduce the spill impact on environment as well.

In order control the marine pollution caused by the oil spills we need to detect the oil spills as early as possible and find the main reason for the pollution sources in time and calculates the quantity and area of the oil spill with accuracy.SAR is an effective tool which helps in continuous monitoring of marine environment. The high resolution of remote sensing can be obtained by using SAR.

SAR covers a wide area and day/night capabilities. SAR also has multi-look, multi-data acquisition, multi-resolution capabilities. Oil spills are nothing but hydrocarbon components this modifies the roughness of the ocean surface which results in short waves. The image of SAR is return of backscatter waves. The information of the image is determined by its pixels. The dark regions in the image contains low backscattering coefficient, where as bright regions contains high backscattering coefficient values. The oil slicks formed on the surface of the ocean smoothens the ocean surface, which reduces the radar backscatter coefficient. Edge mainly used for identification and classification in an image. Boundary outline information is very important for recognizing an object via human visual system. As the SAR images contains the speckle noise in it. So, it is a bit difficult to apply the edge detection and obtain the accurate results. For the reduction of the speckle noise we need to pre-process the image. The pre-processing contains, filtering, thresholding by which we can separate water and oil slicks. After segmentation the region splitting and merging method is applied for the segmented image by thresholding and then edges are extracted by using the canny edge detection.

II. PROPOSED METHOD

According to the characteristics of SAR image processing the image is a result of backscatter return. The image resulted is corrupted due the geometric distortion and the multiplicative noise known as speckle noise. The oil smoothens the ocean surface and effect in resulting the backscatter coefficients. The edge detection operators such as Roberts and Log operator use the additive Gaussian noise which is not much suitable for SAR images for detection.

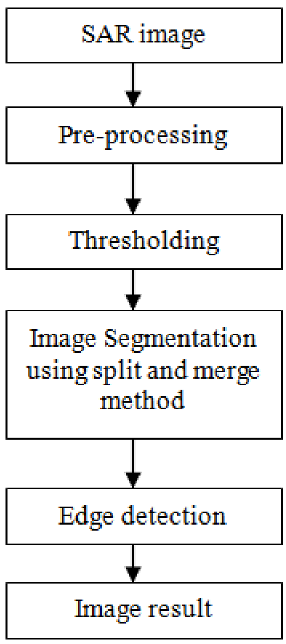


Figure 1: flowchart of proposed method.

A. *Image Pre-processing*

The normal resolution of the sensor is not sufficient for the

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 03, March-2021

resolving the individual oil spot within the in the required resolution pixel, the speckle appears in the SAR image. The problem with SAR images is the presence of speckle. The pre-processing phase was used for preparing the next work. There are two main reasons for pre-processing the original SAR image. The first reason is to overcome the speckle noise. The second reason is to smoothen the pixel values. If we attempt edge detection without pre-processing we might fail to reach our required result.

B. *Thresholding and segmentation*

After filtering we perform threshoding to split the SAR image into two classes, one is pixel having above desired value and the other pixel having below the desired value. Which further results in dark and bright region extraction which leads to extraction of dark regions. The pixels with the intensity values lower than the desired value are dark regions. The pixels with the intensity values above the threshold are said to bright regions. Thresholding is described by the following expression:

$$f(i,j) = \begin{cases} 0, & if\ f(i,j) \le T \\ 1, & if\ f(i,j) > T \end{cases} \qquad (1)$$

'T' in the above expression represents threshold. Generally the threshold values can be obtained gray value statistical histogram. In gray value statistical histogram the minimum value between two peaks is defined as threshold value.

C. *The split and merge method*

The split and merge (SM) algorithm is one of the most popular image segmentation algorithm based on the idea of divide and concur to segment homogenous region of interest. It is a top-down approach and it starts with assumption that entire image is homogenous. Let R be the entire image region with several objects which will be subdivided into n regions,R1,R2,R3,…..Rn, such that

a) $\bigcup_{i=1}^{n} R_i = R;$

b) R_i is a connected region, $\forall i;$

c) $R_i \cap R_j = \phi; \forall i, j; i \neq j;$

d) $P(R_i) = TRUE; \forall i;$

e) $P(R_i \cup R_j) = FALSE; \forall i, j, i \neq j;$

Where $P(R_i)$ is a logical predicate over the pixels of the region R_i and φ is an empty set. The predictions indicate that the image would be segmented into set of connected, different cluster of pixels which may call region R_i and the predicate of segmentation P (R_i) is true for single region at a time but not more than one region at a time.

The split and merge algorithm can be briefly described as
(a) split any region R_i into almost four equal regions where
(b) continue splitting until there is no region to split ,
(c) merge any two regions R_i and R_j for which $P(R_i \cup R_j)$ = TRUE and then
(d) continue merging until there is no region left for merging.

The major pitfalls of split and merge algorithm include no proper instruction about the selection of features and high dependency on threshold values used for both splitting and merging. The algorithm stops, where no splitting and merging is possible. The SM algorithm produces more compact regions than pure splitting algorithm.

The disadvantage of the SM algorithm, they may create regions that may be adjacent and homogenous but not merged.

D. *Canny Edge Detection*

The canny edge detection operator is one the best edge detector than other like sobel and log operator which are poor at localization. Each and every single pixel which forms an edge is very vital in edge extraction. For this the canny edge detector works in a very robust manner. The canny edge detector locates each edge in defined manner. In canny edge detector the width of the Gaussian filter, the high and low values of threshold can be adjusted according to the requirement.

The canny edge detection operator has some phases in order to obtain the accurate results. They are described below

1) *Noise reduction:*

As the raw unprocessed images contain noise the canny edge detector might be affected by it. So by using Gaussian filtering we remove the noise. The noise is removed from the raw image by convolving it with Gaussian filter. The obtain image after the filtering is a slightly blurred version of the original image.

$$g(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{\frac{-x^2}{2\sigma^2}} \qquad (2)$$

Where σ is standard deviation.

2) *Compute gradient magnitude and angle:*

.While performing the edge detection, the edge might obtain in any point irrespective of particular direction, it from vertical, horizontal or from the diagonal vertices. The edge gradient and direction can be obtained from the first derivative return values of edge detector, the horizontal direction G_x and G_Y.

$$G_x = \frac{\partial f}{\partial x}$$

$$G_y = \frac{\partial f}{\partial y} \qquad (3)$$

$$g(x,y) = [G_x{}^2 + G_y{}^2]^{1/2}$$

$$\alpha(x,y) = \arctan(G_x/G_y)$$

3) *Non –maximum suppression:*

The Non-maximum suppression traces the edge in all direction and if any edge is found out the local maximum it suppress it and sets the value as zero. This helps in the reduction of false edges. This has an effect suppressing the image information if it is not a local maxima.

4) *Hysteresis thresholding:*

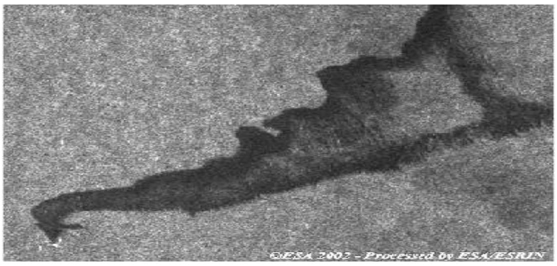
Hysteresis thresholding is also very useful in eliminating the false edges. By tracking the edges it eliminates the weak edges and holds the strong edges. If the gradient magnitude

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 03, March-2021

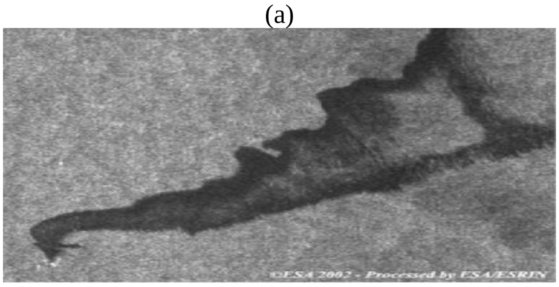
of a pixel is high then it is defined as a edge pixel and if the gradient magnitude of the pixel is low then it is considered as a non-edge pixel. If the gradient magnitude of the pixel is in between the low and high it is compared with the neighboring pixel respectively.

III. EXPERIMENTAL RESULTS

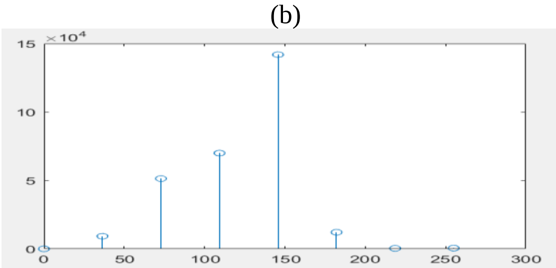
The proposed method is focused on extraction of oil spills more accurately. The first input image of oil spill is captured by ENVISAT-1 ASR in the year 2002, of the Galicia, Spain. The second input image of oil spill is captured by ENVISAT ASAR. Figure 2(b) and 3(b) are the filtered images after using mean filter. Figure 2(c) and 3(c) is used for calculating the threshold value. The SM algorithm split the image into small parts where there is no other chance to split. In the same way the merging is also done until no chance to merge after splitting. Use of canny edge detection directly to the original images of SAR leads to obtaining much noise. The use of thresholding and SM algorithm gives much accurate results as shown figure 2(e) and 3(e).



(a)

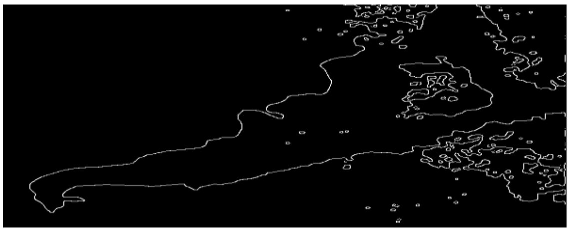


(b)

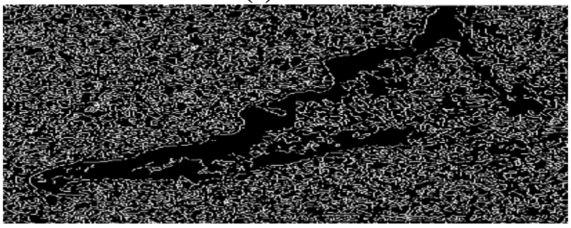


(c)

(d)



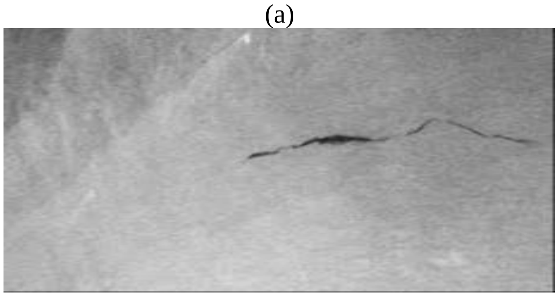
(e)



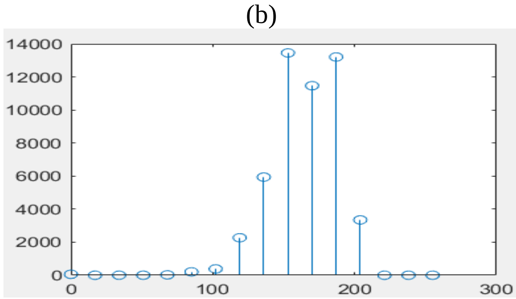
(f)

Figure 2: (a) input SAR image, (b) image after applying filter to SAR image,(c) hysteresis thresholding, (d) image obtained by SM alogrithm after thresholding, (e) canny edge detected image after applying thresholding and SM algorithm, (f) canny edge detection applied to original image.

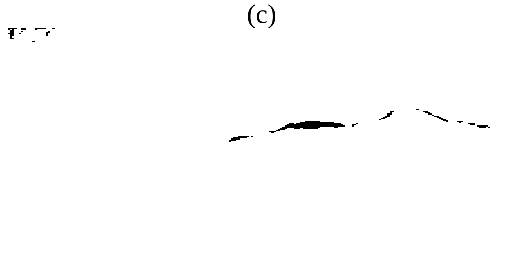
(a)



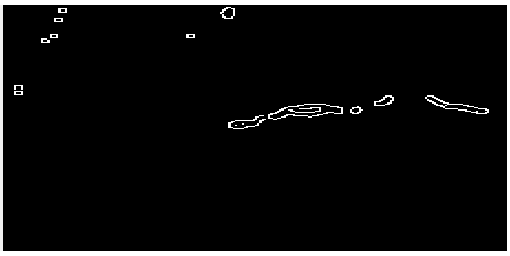
(b)



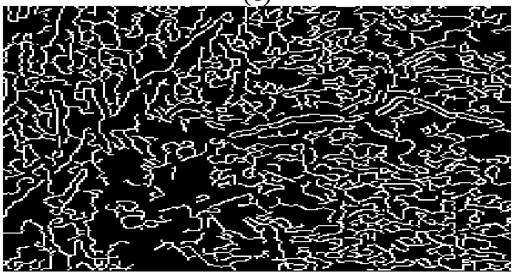
(c)



(d)



(e)



(f)

Figure 3: (a) second input image , (b) image after applying mean filter, (c)hysteresis thresholding for gray scale image, (d) image after applying split and merge, (e) canny edge detected image after applying thresholding and split and merge algorithm, (f) canny edge detection applied to original image.

IV. CONCLUSION

The proposed method is used for the extracting edges of oil spills by using canny edge detection with the help of thresholding and SM algorithm. Due to the presence of noise in the original image the canny edge detection cannot be applied directly to the original image, the noise makes the surface of original image rough and there are more chances for false edges detection. In this paper the use of SM algorithm is very efficient and made easy to obtain the accurate results.

REFERENCES

[1] Z. Zhang, C. Chen, J. Sun and K.L. Chan, EM algorithms for Gaussian mixtures with split-and-merge operation, Pattern recognition, Vol. 36, pp. 1973-1983, 2003

[2] A. B. M. Faruquzzaman, N. R. Paiker, J. Arafat, M. A. Ali, and G. Sorwar, Literature on Image Segmentations Based on Split-andMerge Techniques, The 5th Internatioal Conference on Information Technology and Applications, Australia., 2008..

[3] F. Yu, W. Sun, J. Li, Y. Zhao, Y. Zhang, G. Chen," An improved Otsu method for oil spill detection from SAR images", Oceanologia, Vol. 59, Issue.3, pp.311-317, 2017.

[4] C. Deng, G. Wang, X. Yang, "Image Edge Detection Algorithm Based on Improved Canny Operator ", Proceedings of the 2013 International Conference on Wavelet Analysis and Pattern Recognition, China, pp. 168-172, 2013.

[5] B.D. Setiawan, A.N. Rusydi, K. Pradityo, "Lake edge detection using Canny algorithm and Otsu thresholding", IEEE, 2017 International Symposium on Geoinformatics (Icy), Indonesia, pp.72-76, 2017.

[6] Bovik A C, "On detecting edges in speckle imagery, " IEEE Trans,on Acoustic Speech, and Signal Processing , 36(10), pp.16I8-1627, 1988.

[7] Canny, J., 1986. "A Computation Approach to Edge Detection". IEEE Transactions on Pattern Analysis and Machine Intelligence 8(6):679-

[8] Dhrisya Krishna, Keerthi Krishnan K, Oil Spill Detection from Synthetic Aperture Radar Image through Improved Edge Detection Method, Vol.-6,Issue-6, June 2019. Z. Zhang, C. Chen,

[9] F. Galland: Synthetic Aperture Radar oil spill segmentation by stochastic complexity minimization. IEEE Geoscience and Remote Sensing Letters, vol. I, issue 4, 2004.

[10] Guo Huadong, 'Theory and application of earth observation by radar", Science Publishers, Beijing,

[11]]C.Brekke, A.H.S.Solberg, "Oil spill detection by satellite remote sensing", Remote Sensing of Environment 95 (2005) pp. 1-13.

[12] Fingas, M. F., & Brown, C. E.. "Review of oil spill remote sensing". Spill Science and Technology Bulletin, 1997,4, 199-208.

[13] Assilzadeh, H., & Mansor, S. B. (2001). "Early warning system for oil spill using SAR images". Proc. ACRS 2001-22nd Asian Conference on Remote Sensing, 5-9 November 2001, Singapore, vol. I (pp. 460-465).

[14] Girard-Ardhuin, F., Mercier, G. and R. Garello, 2003. "Oil slick detection by SAR imagery: potential and limitation". IEEE/MTS Proc. Of the Marine Technology and Ocean Science Conference OCEANS2003, San Diego, CA, USA, vol.l, 22-26, pp. 164-169.