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# OIL SPILL MONITORING AND RESPONSE TECHNIQUES USING ASAR RADAR IMAGES

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**ABSTRACT:-** *This research aim find out oil spill in ocean using satellite image which helps in regular monitoring of sea. Here comparing of Markov random fields and fuzzy c mean techniques are used to find out results in less time consuming, oil spill tracking, oil spill area, dark patches and spill patterns. This approach helps to find out which algorithm is best suited for detection of oil spill with low time complexity. This work is carried out using ASAR RADARSAT-2 image, which is capture from Gulf of Mexico region. After analysing both algorithm it results that Markov random field is more suitable for detection of oil spill with less time duration using radar images than Fuzzy c mean algorithm .*

***KEY WORDS**: pattern, tracking, RADARSAT-2, Markov random field, fuzzy c mean.*

## I. INTRODUCTION

Oil spill is one of the most important problem occurs in the world which become one of the biggest issue in marine life. So regular monitoring is important, which helps to solve problems based on oil spill. Extraction of oil from ocean is a fundamental work done for agencies to regular monitoring the sea. In this scenario satellite image play an important role for data acquisition. In ever year oil spill accident take place in history it was on the Gulf of Mexico in Deepwater Horizon on April, 20, 2010, with explosion in July 15, 2010. It effected on wildlife habitats and maritime spices. To overcome this problem radar image was used for regular monitoring which improves over all oil spill problems by various approaches. To survey oil spill SAR image provide various advantage for detection and tracking of oil spills. Several satellite SAR sensors are involved in the oil spill detection and survey. These data are from ERS-1/2, (Brekke and Solberg 2005) ENVISAT (Marghany 2013), ALOS, (Zhang et al. 2011, 2012), RADARSAT-1/2, (Zhang et al. 2012) and TerraSAR-X (Velotto et al. 2011) which have been globally used to identify and monitor the oil-spill. Recently, the multi polarimetric SAR high-resolution data have become a vital research area for oil spill detection (Skrunes et al. 2012; Shirvany et al. 2012). Oil spill detection and monitoring using SAR technology, data are scarce job, because of barely discrimination between oil spill and other features of look-alike ,shadows, wind speed that appear patches in SAR data as Dark patches (Topouzelis 2008). The problems faced in oil spill automatic using SAR data, is achievements in past decades. Simultaneously, Frate et al. (2000) proposed semi-automatic oil spill detection by using neural network, in which a vector defining features of an oil-spill is used. Topouzelis et al. (2007, 2009) and Marghany, Hashim (2011) confirmed that neural network technique could give precise difference among look-alike and oil- spill in SAR data. Topouzelis et al. (2007) has used neural networks in finding both oil-spill and dark patches detection. Experimental results shows, 89 % accuracy and 94 % dark patches segmentation but certain disadvantages like they cannot efficiently detect small and fresh spills. Skrunes et al. (2012), reports that there are several disadvantages associated with SAR sensors based oil spill detection. So they suggested using multi-polarization acquisition data, such as Terra SAR-X satellites and RADARSAT-2.

## II. DATA ACQUIRED

In this study, RADARSAT-2 SAR data acquired by RADARSAT-2 operating with Scan SAR Narrow single mode beam on 27$^{th}$ April, 2010; 1$^{st}$ May 2010; and 3$^{rd}$May, 2010 are investigated for detection of oil spill in the Gulf of Mexico. The satellite armed with Synthetic Aperture Radar (SAR) with multiple modes of polarization, which includes fully polar metric mode of operation in which HH, VV and VH polarized data's were acquired (Maurizio et al. 2012). It has got highest resolution of 1 m in Spotlight beam mode (Ultra Fine mode of 3 m) with 100 m of positional accuracy. In the Scan SAR Wide Beam mode (WBM), the SAR has nominal width of 500 km and 100 m imaging resolution. The ground data obtained are based on study of Garcia-Pineda et al. (2013) where majority of oil types are emulsion and silver sheen.

| Sl. No | Beam mode | Place | Date | Nominal pixel spacing( m) | Resolution (m) | Incident angle | Polarization |
|---|---|---|---|---|---|---|---|
| 1. | ENVISAT ASAR | Gulf Of Mexico | 27 April 2010 | 25 x 25 | 79.9-37.7 x 60 | 20-55 | HH |
| 2. | ENVISAT ASAR | Gulf Of Mexico | 1 May 2010 | 25 x 25 | 79.9-37.7 x 60 | 20-46 | HH |
| 3. | ENVISAT ASAR | Gulf Of Mexico | 3 May 2010 | 25 x 25 | 79.9-37.7 x 60 | 25-50 | HH |

**Table1. ENVISAT ASAR IMAGE**

**Figure1. Input images**

## III. MATERIAL AND METHODOLOGY

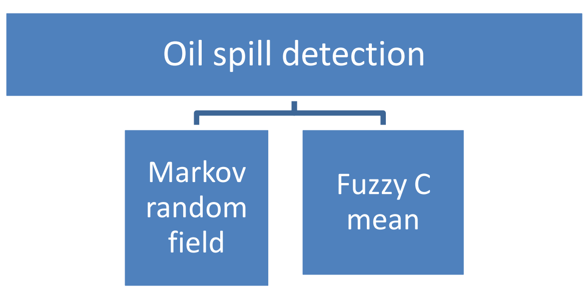



**Figure2. Methodology**

### A. Markov random field

Markov random field technique provides mutual influences in given data, which helps to provide more clear detection on oil spills in images with objective function modification. With the help of modification process it helps in reducing speckle noise effect in radar images. It works together with membership function using neighborhood pixels. Steps are as follows- (1) initially two satellite image has to be taken, consider as $P_1 = \{P_1(I,h), 1 \leq I \leq M, 1 \leq h \leq N\}$ and $\{P_2(I,h), 1 \leq I \leq M, 1 \leq h \leq N\}$, where M x N. (2) in second step generate logarithmic and mean operator to cover over all area taken for monitoring it is denoted with $l = \frac{k_1}{f_1}$, $mean = 1 - \min(\frac{k_1}{f_1}, \frac{k_2}{f_2})$, Where as, , $f_1$ & $f_2$, $k_1$ & $k_2$ are logarithmic and mean values. Here Mean produces difference images using information of pixels. Log value used to find out intensity for images and it covers larger area. Let us considered iteration x =1 with standard deviation $\sigma_r^1$ *and* mean $\mu_r^1$ values. Now find out energy function $E_{pq}^x$ with iteration 'x'. Now apply Gibbs expression, to find out prior probability ($\pi_{pq}^c$)

$$\pi_{pq}^c = \frac{\exp(-E_{pq}^x)}{\exp(-E_{pq}^x) + \exp(-E_{pq}^x)}$$

Now ($p_r^c$) determine conditional probability then generate the distance matrix ($d_{pq}^c$) for the given input image.

$$p_r^c\left(\frac{y_j}{\mu_r^c, \sigma_r^c}\right) = \frac{1}{\sigma_r^c\sqrt{2\pi}} exp\left[-\frac{y_{j-}\pi_r^{c\,2}}{2(\sigma_r^c)^2}\right]$$

$$d_{pq}^c = -1n\left[p_r^c\left(\frac{y_j}{\mu_r^c, \sigma_r^c}\right)\right]$$

Now compute objective function- $d_{pq}^c = -1n\left[p_r^c\left(\frac{y_j}{\mu_r^c,\sigma_r^c}\right)\right]$,

$$\left|J_{pq}^c - J_{pq}^{c-1}\right| \le \delta$$

Now determine Membership matrix $\{\mu_{pq}^{c+1}\}$

$$\mu_{pq}^{c+1} = \frac{\pi_{pq}^c \exp(-d_{pq}^c)}{\pi_{pq}^c \exp(-d_{pq}^c) + \pi_{pq}^c \exp(-d_{pq}^c)}$$

Update deviation and mean values $\sigma_r^{c+1}$ and $\mu_r^{c+1}$respectively, *c*=*c*+1

$$\mu_r^{c+1} = \frac{\sum_x(\mu_{pq}^c\, y_j)}{\sum_x(\mu_{pq}^c)}$$

$$\sigma_r^{c+1} = \sqrt{\frac{\sum_x[u_{pq}^c\ (y_j - \mu_r^{c+1})^2]}{\sum_x(u_{pq}^c)}}$$

**B. Fuzzy c-Mean:**

It is a clustering technique, which allows one object belongs to two or more object in clusters form. Similarly object or data will be placed in one place and other place. This method improves frequently using pattern recognition.

Minimization object function

$$J_x=\sum_{p=1}^{M}\sum_{q=1}^{b} u_{pq}^n \,||\, x_p - c_q \,||^2 \quad, 1 \le n < \infty$$

Whereas m, belongs to real number which is greater than 1, $u_{pq}$ is a degree of membership, p is a dimensional measured data, $C_q$ is a cluster center. || * || it denotes similarity between center and measured data.

In fuzzy c- mean clustering, with the help of iterative optimization objective function, fuzzy partitioning can be done, using update membership $u_{pq}$ and center of cluster $c_p$.

$$u_{pq} = \frac{1}{\sum_{i=1}^{b}\left(\frac{||x_p - c_q||}{||x_p - c_i||}\right)^{\frac{2}{n-1}}} \qquad , c_{pq}=\frac{\sum_{p=1}^{M} u_{pq}^n\, x_p}{\sum_{q=1}^{M} u_{pq}^n}$$

Iteration stops when $max_{pq}\left[\!\left[u_{pq}^{(i+1)} - u_{pq}^{(i)}\right]\!\right]$< Es

E denotes terminal point between 0 and 1 for $k^{th}$ iteration; it also covers local minimum point$J_x$.

Following steps are

1. First initialize process U so it denoted as $[u_{pq}]$matrix, $u^{[0]}$
2. Now calculate center of vectors $c^{(i)}=[c_q]$ with $u^{(i)}$ , $c_{pq}=\frac{\sum_{p=1}^{M} u_{pq}^n\, x_p}{\sum_{q=1}^{M} u_{pq}^n}$
3. Update the process by using $u^{(i)}$, $u^{(i+1)}$

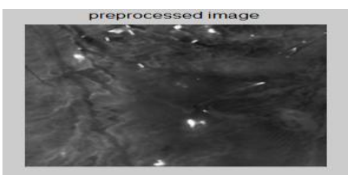
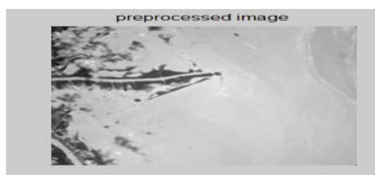
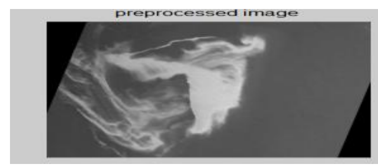
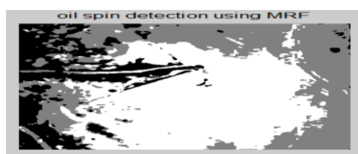
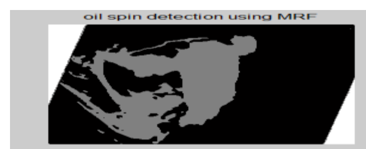
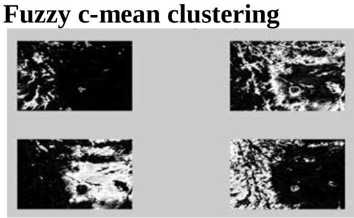
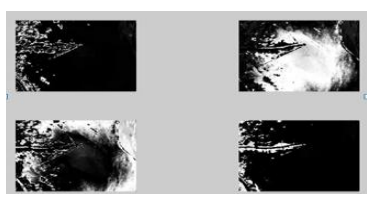
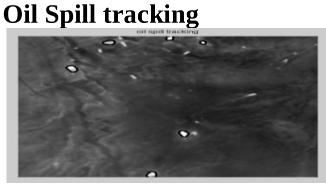
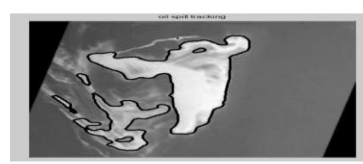
Therefore $U_{pq}=\frac{1}{\sum_{i=1}^{b}\left(\frac{||x_p - c_q||}{||x_p - c_i||}\right)^{\frac{2}{n-1}}}$

If $\left[\!\left[u_{pq}^{(i+1)} - u_{pq}^{(i)}\right]\!\right]$< E then stop the process for further operation otherwise return to step 2.

## IV. RESULTS AND DISCUSSION

In this approach, two different techniques were used which helps to regular monitoring and detection of oil spills in the ocean. This research work is carried out using SAR RADARSAT-2 image. This technique examined SAR image to find structure of the oil spill with levels of gray corresponding to less damp / most damped area of sea surface roughness. Radar images confirmed grey level mask containing structure of the slick in Gulf of Mexico. Oil spill happened on 27 April 2010 where crude oil spread in 49,500 km2 across 19,112 square miles in Gulf of Mexico. As we know oil spill is one of the biggest issue in marine environment. Here two algorithms are applied to find out pattern, dark patches and tracking of oil spill with low time complexity in the given ENVISAT ASAR images. In this research different days images has been taken for regular monitor and observe occurrence of oil spill in ocean. For detection of oil spill incidence angle with HH polarization is suitable for research. According to HH polarization and incidence angles it helps to reduce noise which is created during bad weather conditions. For detection of spill ASAR width increase to 300km- 350km. Advance synthetic aperture radar provide high level of sensor images. Figure-3 indicates spills with patterns, dark patches, oil spill tracking and surrounding area of the images. To determine positive and negative pattern it compared with neighborhood pixels. In this paper after comparing two algorithms, it define Markov random field is more convenient and good for oil spill detection because in ASAR images it slowly varies gray level point based on image location and positions which help to monitor and detect oil spill region in fast way with low time complexity based on different weather condition.
Here Table2. represents experimental results for oil spill detection with coverage area.

Figure3. Oil spill Detection Results

| | | |
|---|---|---|
|  |  |  |
| **Markov random field**  Time taken for MRF 1.932765e+00 secs |  Time taken for MRF 1.764280e+00 secs |  Time taken for MRF 1.710396e+00 secs |
| **Fuzzy c-mean clustering**  Time taken for fuzzy c means 5.373666e+01 secs |  Time taken for fuzzy c means 5.373666e+01 secs |  Time taken for fuzzy c means 5.529804e+01 secs |
| **Oil Spill tracking**  |  |  |
| **Oil spill Pattern** | | |

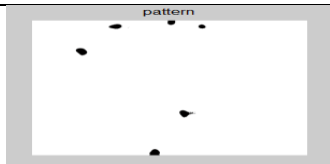
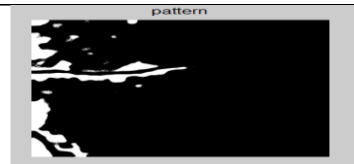
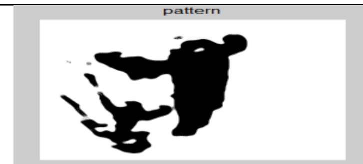
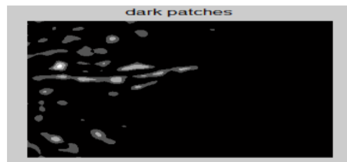
| | | |
|---|---|---|
|   |   |   |
| **Dark patches**   **Area 3.561250e+02** |   **Area 6.009575e+04** |   **Area 1.209288e+04** |

Table2. Experimental Results for oil spill Detection Time

| **Techniques used** | **Image 1** | **Image 2** | **Image 3** |
|---|---|---|---|
| Markov Random Field | 1.932765e+00secs | 1.764280e+00secs | 1.710396e+00secs |
| Fuzzy c means | 5.373666e+01secs | 5.390935e+01secs | 5.529804e+01secs |
| **Coverage Area ($m^2$)** | 3.561250e+02 | 6.009575e+04 | 1.209288e+04 |

## V. CONCLUSION

This research aim find out oil spill in ocean using satellite image which helps in regular monitoring of sea. Here comparing of Markov random fields and fuzzy c mean techniques are used to find out results in less time consuming, oil spill tracking, oil spill area, dark patches and spill patterns. This approach helps to find out which algorithm is best suited for detection of oil spill with low time complexity. This work is carried out using ASAR RADARSAT-2 image, which is capture from Gulf of Mexico region. After analysing both algorithm it results that Markov random field is more suitable for detection of oil spill with less time duration using radar images than Fuzzy c mean algorithm .

## REFERENCES

(1) T.Nishidaid, H.Harahsheh, T.Onumad, monitoring and detection oil spill, Environmental Modeling and Software, Science Direct, March 2007.
(2) Albert Osei, Edmund C Merem, Data to detect environmental degradation, Remote Sens., Applied plant and soil science 21, March 2010.
(3) Turgay Celik, unsupervised change detection for satellite image using Dual tree wavelet transform, IEEE transactions on geo science and remote sens. Vol-48, 3 March 2010.
(4) Istein Johansen, Mark Reed Oil spill modeling, science and technology Bulletin, vol. 5, pp 16, 1999.
(5) M. Marghany, Multi-Objective Evolutionary Algorithm for Oil Spill Detection, ICCSA,355-371, Springer 2014,
(6) M. Marghany , Automatic detecting oil Gulf of Mexico, Environment and Earth Science, June 2015, Springer.
(7) Maged Marghany, Detecting of oil spills in Gulf of Mexico using SAR Data, ISRS June 2016.
(8) K.Karantzalos and D.Argialas, level set segmentation oil spill tracking." International Journal of remote sensing (IJRS), Volume 29, November 2008.
(9) H.S. Solberg, Detection of oil spill, Elsevier, Science Direct, Remote Sensing of Environment, November 2004.
(10) M. Marghany, automatic reduction of oil spill from Satellite data. International symposium of the digital Earth IOP, July 2009.
(11) D. Camassa, Adalsteinsson, R. Harenberg, Z. McLaughlin, S. Lin, Subsurface trapping of oil plumes in stratification, Oil Spill Monitoring and Modeling the Deepwater Horizon, Geophysical Monograph Series, 2011. Camilla Brekke, Anne H.S. Solberg. November 2004,"Oil spill Detection by satellite remote sensing." Science Direct, Elsevier. Remote Sensing of Environment.
(12) Van Genderen J and Marghany M, July 2009 Entropy automatic reduction of oil spill from RADARSAT-2 SAR Satellite data. International symposium of the digital Earth IOP conference10.1088/1755-1315/18/10/01 2051.
(13) Zhao J, Ghedira and Temini M, September 2014, Exploring the potential of optical remote sensing for oil spill detection in shallow coastal waters a case study in the Arabian Gulf, express 22:13755-13772.