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K-MEAN CLUSTERING ALGORITHM FOR OIL SPILL MONITORING AND DETECTION

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ABSTRACT- *Here k-mean clustering algorithm is used for oil spill monitoring and detection. As we know oil spill is a biggest issue in marine environment which effect marine life cycle. In this research K- mean clustering algorithm take place which results in less time consuming, oil spill tracking, oil spill area, dark patches and oil spill patterns. This work is carried out using ASAR RADARSAT-2 image, which is capture from Gulf of Mexico region. The work illustrates detection of oil spill in the ocean using satellite with less time consuming. Here k- mean clustering techniques can be used as a good tool for monitoring and identifying the occurrence of oil spill.*

KEY WORDS *- Oil spill, Gulf of Mexico, pattern, tracking, ASAR RADARSAT-2.*

1. 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 Terra SAR-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.

2. DATA ACQUIRED

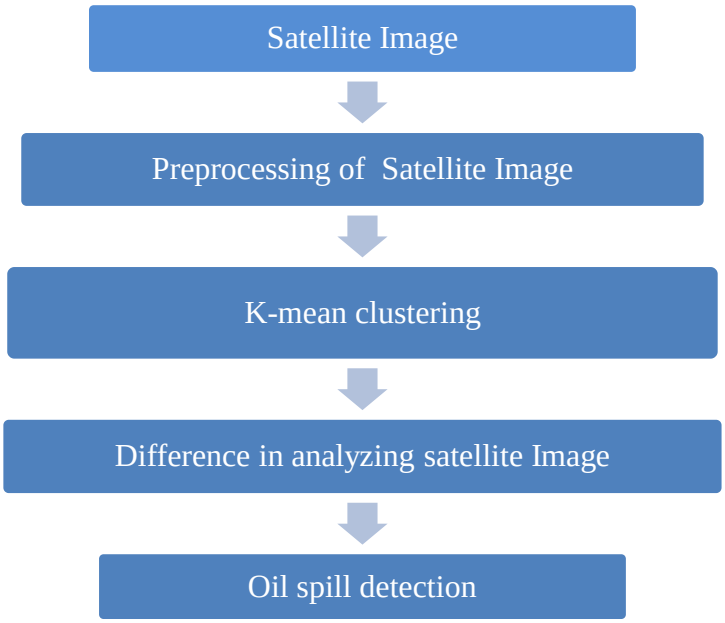
In this study, RADARSAT-2 SAR data acquired by RADARSAT-2 operating with Scan SAR Narrow single mode beam on 27th April, 2010; 1st May 2010; and 3rdMay, 2010 are investigated for detection of oil spill in the Gulf of Mexico. The satellite armed with Synthetic Aperture Radar (SAR) with multiple modes 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.

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

3. METHODOLOGY



K-mean clustering:

K mean clustering is a vector quantization method used for oil spill detection. Here each element is partition into k clusters which belongs to nearest mean, act as prototypes for the cluster. It works on dividing data cell into voronoi cells. K mean cluster determine comparable spatial extent clusters. It classifies data which is new into existing clusters which called as centroid nearest classifier.

Let as consider set observations $(a_1, a_2, a_3, \ldots . a_n)$ with D real vector dimensional. Here 'c' means clustering partition number of observation into c $\leq n$ sets which is denoted as S = $\{set_1, set_2, set_3 \ldots . set_k\}$, it will minimize sum of squares with cluster.

$\arg_S minimum \sum_{set=1}^{c} \sum_{a \in set_i} ||a - \mu_p||^2 = arg_{set} minimum \sum_{p=1}^{c} |set_p| vars_p$, μ_i is points mean of set_p which is similar to squared pairwise deviations in same cluster.

$arg_{set} \min imum \sum_{p=1}^{c} \frac{1}{2|set_p|} \sum_{a,y \in set_p} ||x - y||^2$

similar features can be deleted by using formula $\sum_{a \in set_i} ||a - \mu_p \Big||^2 = \sum_{a \neq y \in set_p} (a - \mu_p \Big) (\mu_p - y)$, which shows number of total variance is constant between points in cluster.

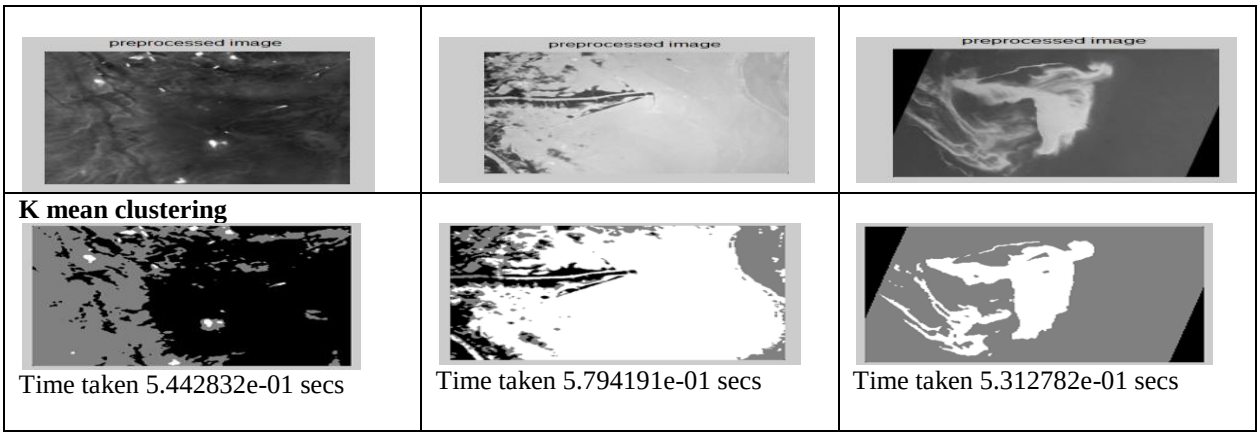
Let as consider k mean initial set $n_1^{(1)}, \ldots \ldots \ldots n_k^{(1)}$, with assign observation in cluster, where mean has Euclidean distance

$set_p^{(i)} = \{a_p || a_p - n_p^{(t)}||^2 \leq ||a_p - n_j^{(t)}||^2 \forall_j, 1 \leq j \leq c\}$, where a_p assigned one's and $s^{(t)}$ can be assigned to three or more cluster. In update step it calculates and observed new mean to be centroid in the new cluster.

4. RESULTS AND DISCUSSION

In this approach, k-mean clustering 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. Algorithm 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. It define k-mean clustering techniques 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.

Figure3. Oil spill Detection Results



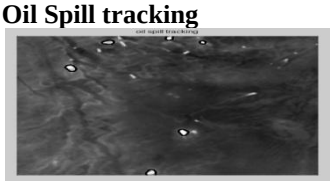
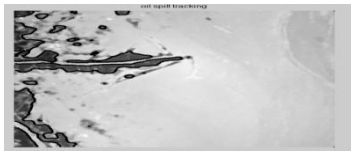
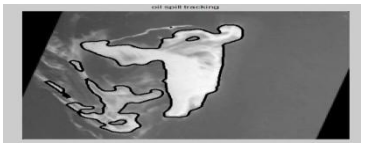
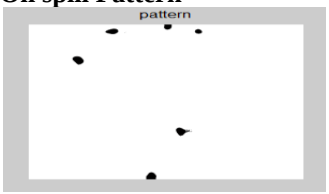
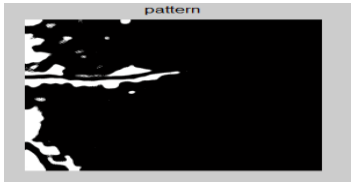
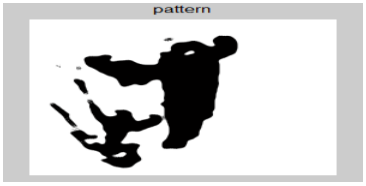
Oil Spill tracking 		
Oil spill Pattern 		
Dark patches  **Area 3.561250e+02**	 **Area 6.009575e+04**	 **Area 1.209288e+04**

Table2. Experimental Results for oil spill Detection Time

Sl. No	Beam mode	Place	Date	Resolution (m)	Time Taken	Area Covered (m)	Polarization
1.	ENVISAT	Gulf Of	27 April 2010	79.9-37.7 x	5.442832e-01 secs	3.561250e+0	HH
2.	ASAR	Mexico	1 May 2010	60	5.794191e-01 secs	2	HH
3.	ENVISAT	Gulf Of	3 May 2010	79.9-37.7 x	5.312782e-01 secs	6.009575e+0	HH
	ASAR	Mexico		60		4	
	ENVISAT	Gulf Of		79.9-37.7 x		1.209288e+0	
	ASAR	Mexico		60		4	

CONCLUSION

As we know oil spill is a biggest issue in marine environment which effect marine life cycle. In this research, comparing of algorithms take place which results in less time consuming, oil spill tracking, oil spill area, dark patches and spill patterns. This work helps to regular day to day monitoring and detection of oil spill in the ocean. 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. The work illustrate detection of oil spill in the ocean using satellite data with gray level masking, prepared with slick-relevant structure extracted by the algorithm with less time consuming. Here morphological closing techniques can be used as a good tool for monitoring and identifying the occurrence of oil spill and Synthetic aperture radar image serves as a good sensor for surveying of oil spill. In conclusion, after comparing eight algorithms, morphological technique serves as excellent method for detection of oil spill with low time complexity.

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