VOL. 13, NO. 5, MARCH 2018 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

MONITORING AND IDENTIFYING THE OCCURRENCE OF OIL SPILL IN THE OCEAN USING SATELLITE IMAGE FOR DISASTER MITIGATION

Mukta Jagdish[1] and Jerritta S.[2]
[1]Department of Computer Science and Engineering, School of Engineering, Vels Institute of Science Technology & Advanced Studies (VISTAS), Vels University, Chennai, TN, India
[2]Department of Electronics and Communication Engineering, School of Engineering, Vels Institute of Science Technology & Advanced Studies (VISTAS), Vels University, Chennai, TN, India
E-Mail: mukta.jagdish13@gmail.com

ABSTRACT

In this approach a morphological closing techniques is used which solve the problem of oil spills detection in the ocean. As we know marine species face biggest issue of oil spill to solve this issue a morphological closing method is applied for Monitoring and identifying the occurrence of oil spill in the ocean using satellite image for disaster mitigation. This research work is carried out using SAR RADARSAT-2 image, which is capture from Gulf of Mexico. 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. In conclusion, morphological closing techniques can be used as a tool for monitoring and identifying the occurrence of oil spill and Synthetic aperture radar image serves as a good sensor for detection and surveying of oil spill. The performance shows the resulting grey level mask containing structure of the slick with levels of gray corresponding to less damp / most damped sea surface roughness.

Key words: coastline extraction, oil spill monitoring, satellite image, sensors, histogram, remote sensing.

1. INTRODUCTION

Oil spill monitoring for coastal zone is an important task. For oil spill monitoring, extraction of oil from ocean is a fundamental work. For oil spill monitoring remote sensing plays an important role for spatial data acquisition. The biggest accident offshore oil spill in history was the (DWH) Deepwater Horizon MC-252 in the Gulf of Mexico. The Deepwater Horizon started on 20, 2010, April, with the sinking and explosion of the Deepwater Horizon platform 15 July. The DWH oil spill has had critical influences on wildlife habitats, feeble, the coastal ecology, maritime spices and the tourism industry (McNutt *et al*. 2011; Minchew *et al*. 2012). Consistent with the work of Topouzelis *et al*. (2007, 2009a) and Marghany and Hashim (2011), synthetic aperture radar (SAR) improves oil spill detection by using various precious approaches. SAR has various tools to detect and survey oil spills which are vessels, airplanes for instance, Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR, by JPL, L-band) (Zhang *et al*. 2012) and E-SAR, (by DLR, multi-land) (Skrunes *et al.* 2012). 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 a*l. 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,ecause 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, and stated that the SAR sensors cannot detect oil–water emulsion ratio, volume, thickness distribution, and chemical properties of oil spills. So they suggested using multi-polarization acquisition data, such as TerraSAR-X satellites and RADARSAT-2. Later, Garcia- Pineda *et al.* (2013a) modified and developed the Textural Classifier Neural Network Algorithm (TCNNA) to map and detect oil-spill by fusing wind model outputs and ENVISAT ASAR data .They stated TCNNA are used as a semi-automates tool for detecting oil spill as a function of Wind Condition.

VOL. 13, NO. 5, MARCH 2018 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

Table-1. Current and future SAR satellite.

Sensor	Band	Polarizations	Spatial Resolution [m]	Swath Width [km]	Revisit Frequency	Status
RADARSAT-2	C	HH, VV, HV, VH	1 to 100	50 to 500	2 to 3 days	Operational
COSMO-SKYMED	X	HH, VV, HV, VH	1 to 100	10 to 200	2 days	Operational
TERRASAR-X	X	HH, VV, HH/VV, HH, HV, VV, VH	1 to 18	10 to 150	3- 4 days	Operational
SENTINEL-1	C	HH, VV, HH/VV, HH, HV, VV, VH	20	250	1 to 3 days	Launch in 2013
RCM	C	HH, VV, HV, VH	1 to 100	50 to 500	Daily	Launch in 2018

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. 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.

2. MATERIAL AND METHODOLOGY

Here Different methodology is applied during each phases they are Processes of dark spot detection, oil spill/slick/look-alike and feature extraction classification.

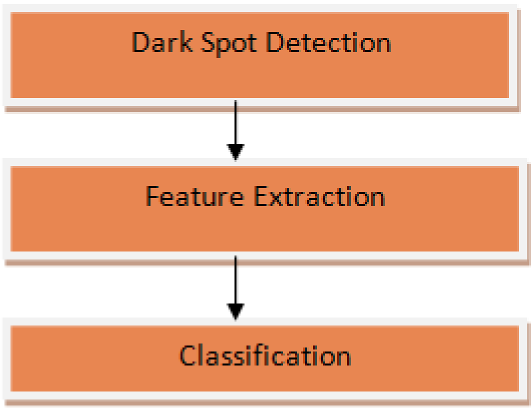


Figure-1. Methodology

2.1 Dark spot detection

In Dark spot detection initial step is grey level mask is created with multi hysteresis thresholding technique. With the help of histogram analysis the hysteresis thresholding values are obtained. The histogram grouped and divided in 10 bins. The locations of bins are used as pairs of hysteresis threshold. Here each threshold response was observed and recorded as grey level mask. It shows bin number which is correspond to the values of hypothesis threshold and grey level mask of the dark spot. In slick mask the closer gray level 4 can be thought darker levels in synthetic aperture radar image level close to 1 are mid level range in SAR image. The second step is grey level mask cleaning to suppress the artifacts that appear in the mask due to speckle noise. Cleaning step leaves pixels that are adjacent towards the direction of the maximal edge gradient of the values on the previous levels. Third step is morphological closing technique in which it allows to close level of pixel which is caused by speckle noise (after the thresholding the higher value is left out).

VOL. 13, NO. 5, MARCH 2018 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

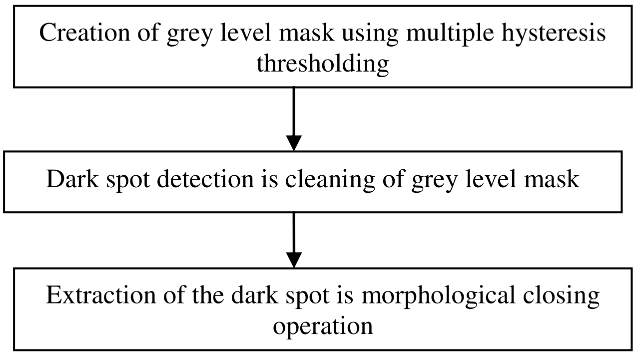


Figure-2. Creation of gray level mask, cleaning and morphological closing.

2.2. Feature extraction

The feature extraction gray level is treated as binary masking using detection/classification algorithms with connected component analysis. Here in this step finds pixels that are connected in one class or component if they match with each other, then for each class or component a number of features is computed such as area, centroid eccentricity, length of major axis and length of minor axis, orientation.

2.3. Classification

Classification is based on the structure analysis, in which some components are selected among all, which satisfy Gestalt principles such as (1) Proximity state that two objects are easier regard as a single object by a human being if those objects are close to each other. (2) Good continuation states that objects are easier regard as a single object if they can be continued from one to other. According to these principles criteria have been developed. If both analysed components are lines then first group of criteria is applied. Based on this criteria proximity is state as minimum of Euclidean distances between starting and ending points of these lines and the excellent continuation is determined by checking orientation difference. If both objects are not lines then second group of criteria is applied. Relation of lines to non-lines then third group of criteria is applied. The analysis is done by two routines: In-level routine and inter level routine.

In-level routine: It Analyses level N = {3, 2, 1} component to gain oil slick structure. Structure is consist element that satisfy proximity criteria and good continuation criteria. The oil slick structure is selected from each component of level N that calls the inter-level routine to group or cluster it with the structures levels from lower.

In Inter-level routine the component is given from a level N > 1, all component are search from level N-1 and component are find that satisfies criteria of Gestalt-based. Set current component, set level as N = N-1, then call Inter-level routine again, then stop the analysis when current level show N = 1or no components present to analyse. Analysis start for gray level mask from level 4. This level represents lowest backscatter area in radar images. If level 4 gray contain few pixel then merge level 4 and level 3 that represent dark areas of the Synthetic aperture radar fragments with slick correspond look-alikes areas. The levels N= {3, 2, 1} routine is run to find oil silk structure which correspond to less-dark areas of SAR image. Then this structure passed to subsequent analysis for inter-level routine analysis. Components are selected in stages of analysis are retained in the image and other considered as noise.

RESULTS AND DISCUSSION

In this approach a morphological closing techniques is used which solve the problem of oil spills in the ocean. This research work is carried out using SAR RADARSAT-2 image, which is capture from Gulf of Mexico. This technique examined SAR image to find grey level mask containing structure of the slick 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. In Dark spot detection initial step is grey level mask is created with multi hysteresis thresholding technique. With the help of histogram analysis the hysteresis thresholding values are obtained. The histogram grouped and divided in 10 bins. The locations of bins are used as pairs of hysteresis threshold. Here each threshold response was observed and recorded as grey level mask. The feature extraction gray level is treated as binary masking using detection/classification algorithms with connected component analysis. Classification is based on the structure analysis, in which some components are selected among all, which satisfy Gestalt principles such as (1) Proximity state that two objects are easier regard as a single object by a human being if those objects are close to each other. (2) Good continuation states that objects are easier regard as a single object if they can be continued from one to other. According to these principles criteria have been developed. If both analysed components are lines then first group of criteria is applied. Based on this criteria proximity is state as minimum of Euclidean

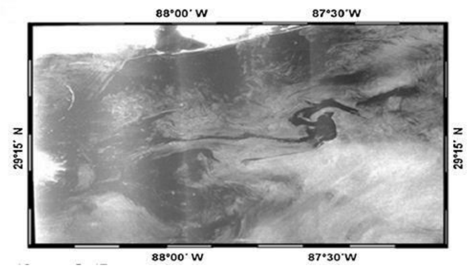
ARPN Journal of Engineering and Applied Sciences

distances between starting and ending points of these lines and the excellent continuation is determined by checking orientation difference. If both objects are not lines then second group of criteria is applied. Relation of lines to non-lines then third group of criteria is applied. The analysis is done by two routines: In-level routine and inter level routine. This experimental result shows significant difference with critical value, statistics value, time per seconds and standard error, Polarization (p). The statistics value 0.78 is smaller than the critical value 1.11 with standard error 0.12 in 78 seconds which result grey level mask containing structure of the slick with levels of gray corresponding to less damp / most damped area of sea surface roughness in the image with low time capacity.

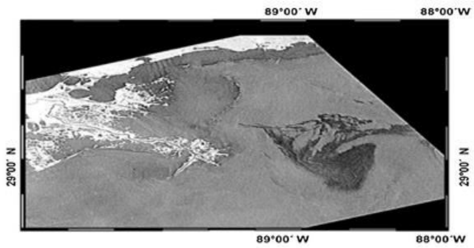
Table-2. Synthetic aperture radar characteristics.

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	20-46	HH
2	ENVISAT ASAR	Gulf of Mexico	1st May 2010	25 x 25	79.9-37.7 x 60	25-46	HH

(a) Gulf of Mexico oil spill satellite image ENVISAT ASAR, dated 26 April 2010.



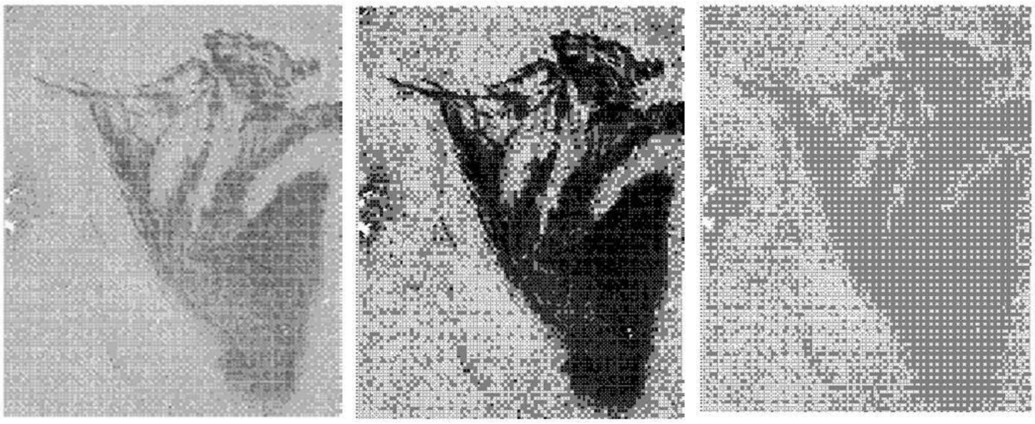
(b)



(c)

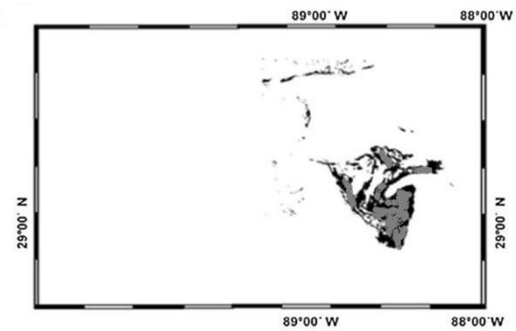
(b) Gulf of Mexico oil spill satellite image ENVISAT ASAR, dated 27 April 2010 with incidence angle 20-46 (c) Gulf of Mexico oil spill satellite image ENVISAT ASAR, dated 1st May 2010 with incidence angle 25-50.

ARPN Journal of Engineering and Applied Sciences



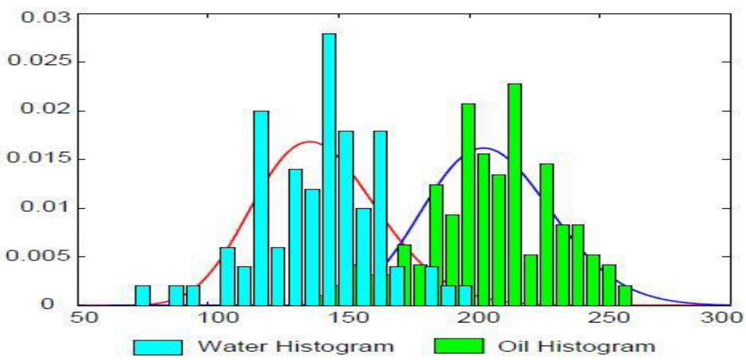
(d) **(e)** **(f)**

(d) Low backscatter areas are coded in the grey level mask of 4 levels, Lower areas of backscatter score higher values of gray in the mask. (e) Speckle-related values on level 1 of grey level mask are cleaned. (f) Morphological closing fills pixel level holes in the gray level mask.



(g)

(g) It represent Final grey level mask prepared with slick-relevant structure extracted by the algorithm.



(h) Histogram represent oil spill and look alike features.

Figure-3.

VOL. 13, NO. 5, MARCH 2018 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

Table-3. Significant differences for oil spill performance matrix.

Sl. no.	Data	Statistics value	Critical value	Standard error	Difference in percentage (%)		P < 0.05	Time/ second
					Oil spills	Look alike		
1	ENVISAT ASAR	0.78	1.11	0.12	92	8	0.00007	78
2	ENVISAT ASAR	0.76	1.15	0.15	90	10	0.00009	80

3. CONCLUSION

It represent morphological closing techniques is used which solve the problem of oil spills detection in the ocean. A morphological closing method is applied for Monitoring and identifying the occurrence of oil spill in the ocean using satellite image for disaster mitigation. This research work is carried out using SAR RADARSAT-2 image, which is capture from Gulf of Mexico. 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. In conclusion, morphological closing techniques can be used as a tool for monitoring and identifying the occurrence of oil spill and Synthetic aperture radar image serves as a good sensor for detection and surveying of oil spill. The performance shows the resulting grey level mask containing structure of the slick with levels of gray corresponding to less damp / most damped sea surface roughness. Advantage of doing this work is less time complexity and faster monitoring process for oil spill detection.

REFERENCES

[1] T. Nishidaid, H. Harahsheh, T. Onumad. 2007. Monitoring and detection oil spill, Environmental Modeling and Software, Science Direct, March.

[2] Istein Johansen, Mark Reed. 1999. Oil spill modeling, science and technology Bulletin. 5(16).

[3] M. Marghany. 2014. Multi-Objective Evolutionary Algorithm for Oil Spill Detection, ICCSA, pp. 355-371, Springer.

[4] M. Marghany. 2015. Automatic detecting oil Gulf of Mexico, Environment and Earth Science, Springer.

[5] M. Marghany. 2015. Automatic detecting oil Gulf of Mexico, Environment and Earth Science, Springer.

[6] Maged Marghany. 2016. Detecting of oil spills in Gulf of Mexico using SAR Data, ISRS June.

[7] K.Karantzalos and D. Argialas. 2008. Level set segmentation oil spill tracking." International Journal of remote sensing (IJRS), Volume 29, November.

[8] H.S. Solberg. 2004. Detection of oil spill, Elsevier, Science Direct, Remote Sensing of Environment, November.

[9] M. Marghany. 2009. Automatic reduction of oil spill from Satellite data. International symposium of the digital Earth IOP, July.

[10] 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.

[11] 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 conference 10.1088/1755-1315/18/10/01 2051.

[12] 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.