Journal of Basic and Applied Engineering Research
Print ISSN: 2350-0077; Online ISSN: 2350-0255; Volume 2, Number 14; April-June, 2015 pp. 1192-1200

http://www.krishisanskriti.org/jbaer.html

Fuzzy Classification of Oil Spill Detection on SAR Images

S. Vijaya Kumar

School of Computing Science and Engineering VIT-University
E-mail: vijayakumar.chinna@vit.ac.in

Abstract—*Synthetic Aperture Radar (SAR) satellite images are mostly used for identifying the oil spills on the ocean surfaces. The identification of oil spills are extracted from the dark spots in marine surroundings. The SAR satellite system analysis is developed a framework for detecting the dark spots on the SAR images. And this type of identification of oil spills; I used a classification of dark spots on SAR images. The fuzzy logic in that the classification is conceded on show to acquire major partition of the pixels on the basis of grey scale moderations. This mechanism is based on the threshold values is clear for detection of dark spot, which is acquired from histogram analysis. In this, the dark spots obtained from different SAR scenes, which are classified as oil spills in SAR images. The result of the system is receiving from different SAR images processed with fuzzy classification technique.*

Keywords: *Oil Spills, SAR, Ocean Monitoring, Fuzzy Classification*

1. INTRODUCTION

Now a day's, ocean environmental protection is very important subject for increasing public concern. The specific result of responsiveness is being paid to the environmental damage caused by the oil spills on sea surface. A successful operation is performed on marine oil spill depends on rapid response from the detecting of oil spills. In detail, the oil spill model is referring to many types of activities are developed for the immediate response of oil spill detection is most important. In previously also reported on oil spill contingency planning [1, 2, 3, and 4].

The SAR system is already proved useful and efficient in ascertaining and measuring oil spills [5, 6]. But this type of operational use is sufficient by the time resetting, cost expenditures, wind force, and fabricated objectives. Mostly, the oil spills are appears as dark areas on the SAR images. Because of oil dampens the capillary waves of the ocean surfaces. Generally, oil slicks property reduces backscattering waves on the ocean surface in arrears to both overpowering of tendency progress and increase of flood indulgence. Hence, the oil spills to reduce the radar backscatter from the SAR images on dark spots. Moreover, the other natural occurrences also creates dark spots in SAR images, such as low wind speed surface areas, organic film, ocean fronts, surface lands, current fronts, coastal upwelling conditions and etc. So many common possessions in SAR images for specific look-alike, such type of deal is mostly with the false identification problem in oil spill detection using SAR images. But the oil spill discrimination is as usually carried out with classification procedure based on the different characteristics monitoring. These characteristics are including geometrical constrains, image physical intensities, texture and more contextual information's describing slicks in relation to its surroundings [7].

SAR imagery processing is a corporate medium for recognizing the oil spills. Especially, some of the cases is a large number of SAR projections has to be observing, the task (Gade and Alpers, 1999) of image processing techniques are used to detecting between oil spills and look-alikes. Most of the techniques are already used to the detection of oil spills through a SAR images without interference of the practiced. Those SAR image systems are referring to retrieving the under ocean region surface considerations on radar sensor projections. In previous reporting to detecting oil spills in SAR images is very complicated task. Because of the rarely occurring of object close to oil spills in SAR images based on the low wind conditions.

In present, many types of classification techniques have been used to identifying the oil spills from the look-alikes. These types of techniques are used statistical design with prior rule-based modification of probability [8], Mahalanobis classifier [9], perceptron multi-layer classifier [10], and the basic function of neural network classifier [11]. The statistical classifier is using a guassian model with possible rule-based change to seen from the different conditions of ocean monitoring. Keramitsoglou et al. [12], operation is a fuzzy logic structure to assessment the possibility of oil spills by using different image for training and testing. The some sample system parameters are to be analysed by the fuzzy ways and assign the possible of dark spot to be a describing the oil spill. The fuzzy logic is a technique to improve the accurate detection and at the equivalent time to reduce the floor area ratio compare with other techniques.

In our paper, a same fuzzy logic classification was established in other country ocean based on surface landscapes of oil spills and with different SAR images for preparation of information. Basically, fuzzy system having the four types of the fuzzy sets is created based on the statistics of the ocean surface features and with appropriate rules made by the four fuzzy sets. The different classification techniques have been applied to classify a slick as oil or look-alike. These different oil spill identification approaches classification accuracy is difficulty to comparing. In this we are using the different data sets and different classifiers, so the result of classification truthfulness cannot be unswervingly associated with an ocean wind conditions. This is including the low wind where an in elevation number of look-alikes can be expected from the SAR images. In this paper, we are testing the performance analysis of classification on test set of different views of look-alikes on SAR images.

Classification is to be ready to categorize the dark regions into oil spills and look alike established on the ocean surface monitoring features should be extracted. In this, commonly used are statistical classifiers, which are the based on possible decisions of classifications. This classification results variation is inspected by the trained operator and the consequent contribution of different standard SAR images, which is to be variation of the oil spill detections done about the satellite services. Mainly, in this paper we present a fuzzy based classification for identifying the oil spills in SAR images. This classification to be trained on hundreds of images from the each satellite sensor and they are detecting results on the basis of aircraft verifications.

2. SAR IMAGE OF OIL SPILLS

Most of the SAR satellite sensors are efficient performance for identifying the oil spills. In [7] the other sensors used for detection of oil spills in SAR images. The oil spill may also include entire oil-allied coastal surface areas caused by oil spills from oil attires, pipeline leakages, passing containers as well as the ocean ground level conditions, whereas natural films/slicks, surface areas of wind speed of threshold, landscapes, sea shore areas, waves flow, etc. A coastal department are trained to possible distinguishing between the oil spills and SAR system projections of look-alikes. It is based on the knowledge and earlier details with reference to position, transformations in natures and dissimilarity, and whether conditions. This knowledge is about the vessel tracks and oil outfit locations can be identified from SAR imagery data sets. But vessel and oil outfit locations container correspondingly be there resulting from the SAR images (i.e., a specific vessel smallest possible size). Considering the information about wind level is frequently used for classification of the oil spills. This type of influences is based on the wave backscatter altitudes and the brightness of oil spills and look-alikes. The brightness of slicks in SAR images is discussed in [13] and [14]. In the ocean surface wind speed less than 0.003-0.005 KM/s, the observing possible projecting of views is high. The local low-wind surface areas are about the smaller number of dark spots generating based on the wind speeds from 0.005 to 0.01 KM/s. in between the oil and the sea surface decrease then automatically wind is increases. Sometimes only dark oil slicks will be identified, because of the rare look-alikes with high wind speed.

2.1 An approach of oil spill detection

The structure of the oil spill detection approach is as shown in following Fig.1. Image processing consist of several pre-processing methods are available, which one of the land-masking method is converting the land mask to SAR image grid to avoid the recognized pattern, that is followed by the radar scaling and conversion values. It is obtained from a sea shore data base. The coastal department is depends on the radar backscatter projection angles, which I contains the low level projection angles. This type of incidence depends

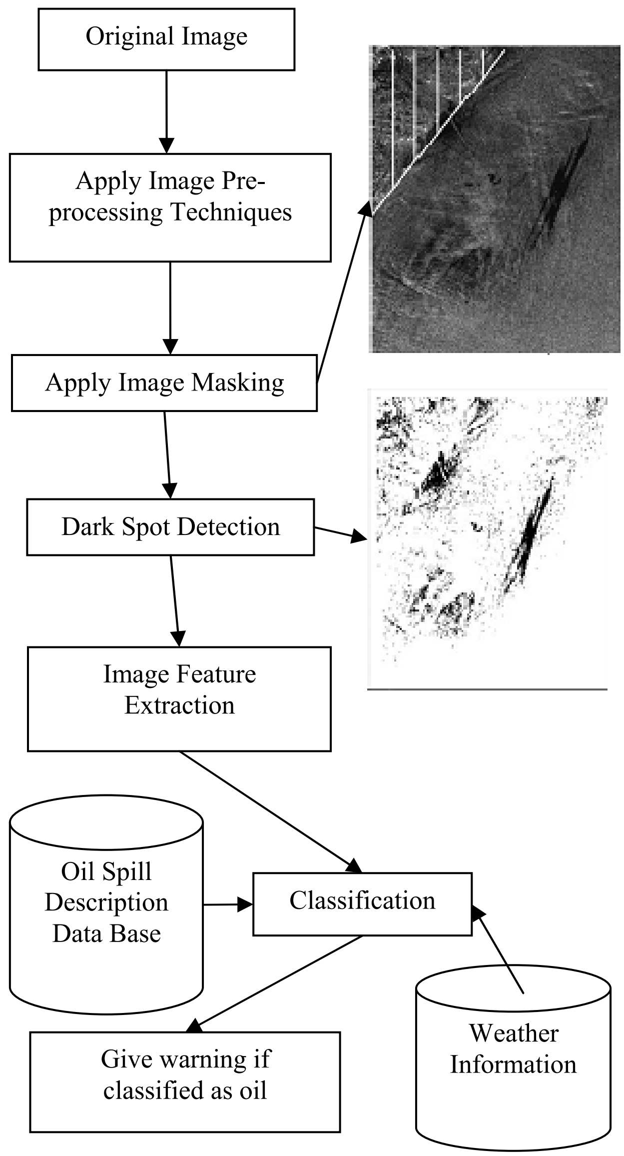


Fig. 1: The structure of oil spill detection approach

on the wavelengths, polarization, and sea surface monitoring conditions. Instead of these effects based on to estimate and compensate for weather conditions. We have determined the simple solution of using the compensation of incidence angles for all weather conditions.

2.2 SAR image dark spot detection and Segmentation

The starting phase in the oil recognition algorithm is to segment on show the oil spill applicants in SAR images. To segment on show all dark regions in the SAR images and future distinguish between oil spills and look-alikes founded on features work out for each ocean region surfaces. This resultant approach is applicable only for the large number of dark areas being segmented, specifically for the low-wind conditions where continuously observing the sea look-alikes. In SAR images specific modules are identified for detecting the dark spots has been developed. Starting segmentation test with an algorithm developed specifically for ERS SAR images [15], which show a single-scalar approach. But it is not perform well in segmenting both small and large sea surface regions. At present a multi-scale approach was developed. From the original image, the next level of averaging image pixels for creating the image pyramid and with half the pixel size of the original image. For this we can apply the adaptive thresholding to each level of the image pyramid. The following steps are to be used to segment the each level in image pyramid with the threshold.

- To calculate the each pixel (i) of the mean value μ and the power-to-mean (PM) value σ/μ in a local size of window W, where σ is the standard deviation.
- Calculate the homogeneity category h from PM as described the image interval values i.e., [0.015, 0.15]
- About to get threshold value Δd_k, given the homogeneity category from the image intervals
- Then set the $P_i = \mu - \Delta d_k$.
- Threshold pixel i with the computed value of the P_i.

Thus the threshold value is adaptively set based on roughness of the sea surface areas. Suppose, if the low wind with several look-alikes, the PM value will be high. As the wind speed is increase then the PM value will also be decrease.

2.3 Dark Spot Feature Extraction

It is after segmentation of all image objects are from the segmented images. In further no little objects are processed and the subsequent process is considering only for region objects. In each region a set of region are calculated and later cases, these features are classified to using the each slick as oil or look-alike. Specifically, the maximum features are consists of a max of features developed for oil spill recognition and testing to identifying from the literature of image analysis. More features can be grouped into descriptors for shape, contrast, slick ambiances and slick consistency. In earlier performed a study on the subject of oil spill features in the SAR images and mainly these features are used from [15], but some researchers have been modified. Thus the feature extraction is overlapped based on the SAR image threshold values.

2.4 Shape Features

i. Complexity of slick is defined by $S_c = P^2/R$, where B is the boundary and R is ocean surface of the region.
ii. The ratio of the slick width between the ocean surface of the region and the width of the branches of the essential region.
iii. Compute slick area is the number of pixels of the region.

2.5 Contrast Features

i. Local slick contrast is the difference between the slick mean and area slick mean.
ii. To compute the Sobel operator is used to gradient of area border values.
iii. Smoothness is defined as the ratio between the number of region pixels R_p and the sum of the region pixel gradient values G_p and the ratio of the number background pixels B_p and the sum of the background gradient values G_b, i.e., $(R_p/ G_p) / (B_p/ G_b)$.

2.6 Slick Ambiances

i. Compute the PM as the PM ratio σ/μ in a huge window containing slick surroundings.
ii. Slick PM is computed based on the slick PM ratio.
iii. Slick Consistency :
iv. SAR scenes the number of detected dark spots.
v. In a larger window number of nearest spots from the centred of the region.
vi. In a small window number of nearest spots from the centred of the region.

2.7 Dark Spot Classification

Consider the many important factors for to be discriminate between oil spills and look-alikes. In this one of the factor is the probable number of oil spills comparing to probable number of look-alikes. These look-alikes are liable on the wind speed and location with the segmentation approach. Revising the spatial distribution and temporal trends for oil spills is further [16], than the scope of this paper.

3. DATASET AND METHODOLOGY

3.1 Dataset Description

In this paper SAR data is received by the different satellites, such as ERS-1/2, ENVISAT, and RADARSAT. The entire SAR data were used in background active the fuzzy logic system. All SAR image data owns a pixel of 12.5m X 12.5m.

Each SAR data contains a certain number of dark areas corresponding to the oil spills or look-alikes on the sea surface. But the SAR images with verified oil spills come from three data sources:

1. Some of the publications provide the SAR images with well-known oil spill fortunes,

2. Shows the projection of the tropical and subtropical ocean surface regions, which provides some SAR images with known oil spills, and

3. The other images with oil spills are classified by the experience of researchers.

The SAR satellite data is passing in two ways of images. The first is Terra local time (i.e., in the time limits between 9 A.M. to 11 A.M.) and Aqua local time (i.e., in the time limits between 12 P.M. to 5.30 P.M.). The oil slicks are clearly visible in both Terra and Aqua images.

3.2 Methodology

In SAR images automatic oil spill detection is implemented by the series of computational procedures to including correction, geo-reference and segmentation. Mostly the image processing includes the application of lee filter to the original image is followed by the mean and median filter. The image processing is over then applies the threshold method for segmentation. The histogram of SAR images encompasses the oil spills continuously give the impression to be bimodal. Texture feature is providing the details of pixels structure arrangement and their spatial correlation among adjacent pixels. These are contributed the statistics approximately relative position of a number of stages within the image. And this is based on the grey level co-occurrence matrix with early warning radar system for oil-spill credentials. The assessed grey-scale image pixel is number of pair of adjacent pixels with a translation of radar direction angle. For example, the number of adjacent pixels $P_a(x, y, R_d, \theta)$ are at pixel (x, x) with a displacement of radar direction angle θ. To calculate the image entropy in different directions corresponds to angle θ of 0^0, 45^0, 90^0, and 135^0 respectively. The entropy value for each pixel in an image was calculated in a N X N window size based on average grey-level matrix with displacement of $R_d = 1$.

The final entropy was an average of all the four direction angles. The fuzzy logic system is based on the grey level matrix of four variables of the text features.

The fuzzy classification probability computing of the dark object to be an oil spill, which shows a framework of fuzzy logic system including the cluster validity analysis, fuzzification, inference and defuzzification. Basically, the fuzzy enhancement is grey level mapping of fuzzy system plane. It is using a membership transformation function.

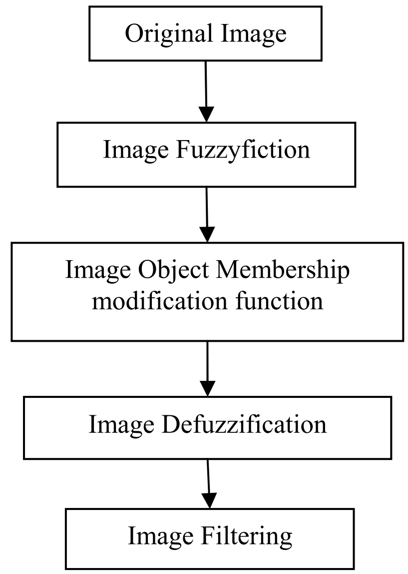


Fig. 2: Structure of fuzzy enhancement classification modules

The Main aim of this function is producing an image of sophisticated feature than the original image by providing a more weight to the grey levels with appropriate image mean. For this type of representation, I can use the fuzzy classification control characteristics about the human knowledge or fuzzy rules. The fuzzy system enhancement modules scheme is illustrated in the following Fig. 2. The Fig. 2 structure is used for computing the enhancement of fuzzy classification about the original image of possibility distribution algorithm with help of the grey level characteristics.

4. RESULT AND DISCUSSION

In this paper, I was discussing the two methods for detecting dark region and feature extraction of the each dark region. Fuzzy classification method is applied for classify dark regions into oil spills and look-alikes.

4.1 Detection of Dark Region

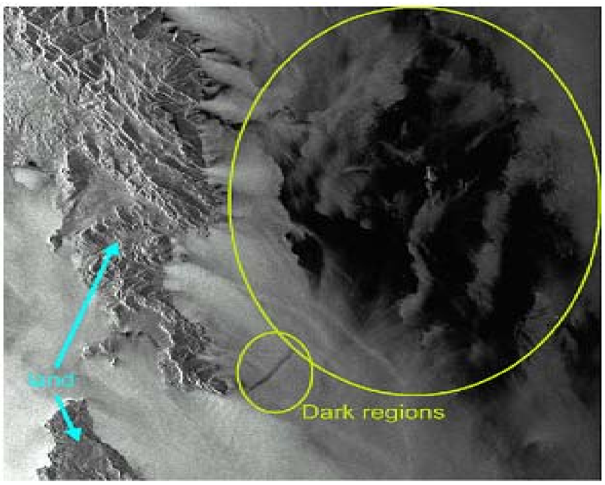
A specific method called histogram analysis is applied for identifying the dark region. This is basically used a statistical method as explained. For example, Fig. 3 representing one of the satellites is given by the six SAR images (i.e., a small dataset) with including dark regions of the image subsets. Clusters of the dark regions are obtained from the single larger area. This entire SAR dataset is applied a statistical method and classify the dark region from the background.

4.2 Feature extraction

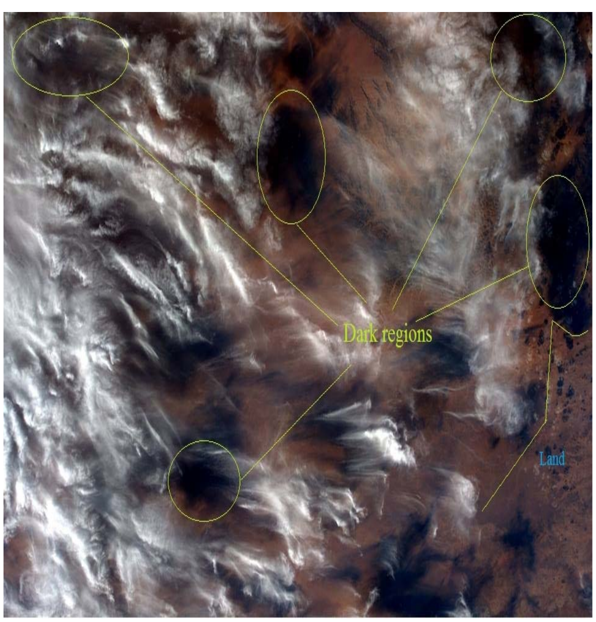
It is made very sensible using the centreline extracted for each dark area. In the previous cases, the width has been computed based on the minor axis of the slicks. These are perpendicular to the centreline given an accurate estimation of the width.

4.3 Classification

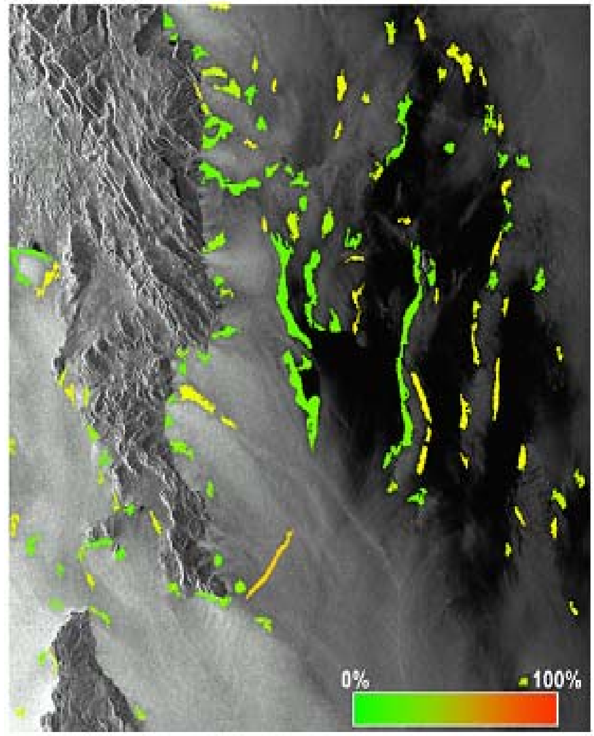
Fuzzy rationality was set up to be useful in classification for areas where there is a lack of training data sets available. This classification method is an unsupervised method and it can be used to organize the data into groups based on similarities among the individual data items. The sum of geometric features such as width, projection, textual features like mean and standard deviation of gradient along the sea shore, local area contrast. The feature dark region areas are representing to determine the fuzzy set Gaussian membership values. Usually many oil spills are do not cover extremely large areas. But many small areas are having been to possibility of look-alike and dark spots. It is considering due to local disturbances and backscatter errors. The final fuzzy system probability of an object to be an oil spill and it should be a crisp number.



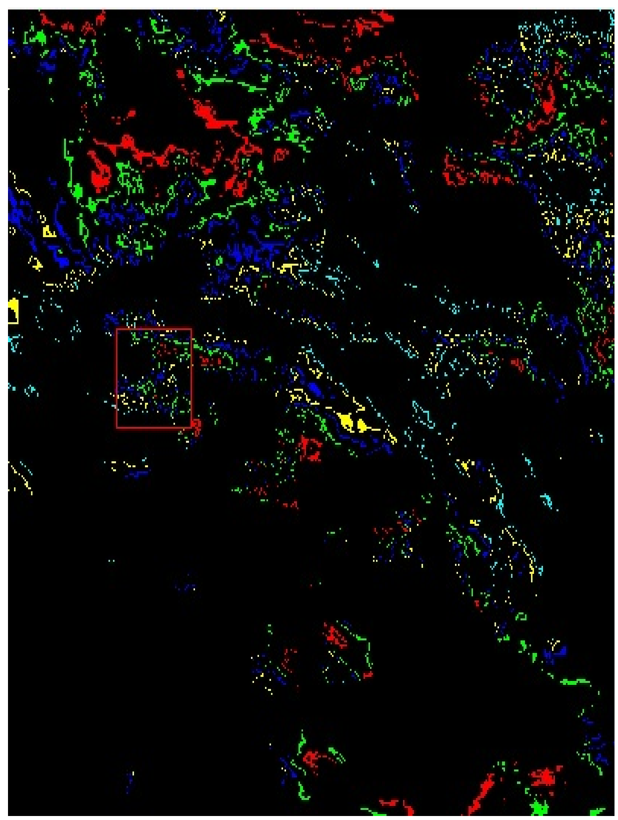
(a)



(b)



(c)



(d)

Fig. 3 – (a) and (b) are the SAR scene of original images; (c) and (d) are the outputs of the respective images (a) and (b) with dark objects coloured according to their possibility to be oil spills (green is low, red is high, blue or yellow is medium)The fuzzy classification analysis is using the possible of the membership functions for enhancement of fuzzy structure without loss of information is implemented for the results of SAR images. To reducing the noise and image structure is illustrious by using the fuzzy membership functions. In addition, the fuzzy membership function structure is adapted according to the image noise level to preserve the image information. The proposed fuzzy classification approach is validated by using oil spill images degraded by speckle noise of various levels. But the results are assessed by both of the subjective and numerical analysis. The numerical analysis shows the better performance of fuzzy control approach. The performance of results is using the fuzzy membership function over the speckle noise reduction in first iteration.

The fuzzy classification algorithm is to be detecting the oil spills in SAR images. The various classification features were expected and used as the input constraints in the fuzzy logic system. In future, fuzzy logic verifies the large number of SAR images. In some cases, a simple approach can be classified incorrectly as oil for the reason that certain typical types have a comparable effect to oil spills in the radar backscatter signal. And also consider to be including oil spill information in terms of a dataset with previously reported oil slick and their appropriate locations.

REFERENCES

[1] Monk, D.C., Cormack, D., 1992. The management of acute risks. Oil spill contingency planning and response. In: Cairns, W.J. (Ed.), North Sea Oil and the Environment: Developing Oil and Gas Resources, Environmental Impacts and Responses. Applied Science, Elsevier, pp. 619–642.

[2] Uthe, E.E., 1992. Application of airborne lidar to oil-spill emergency response decision-support systems. In: Proceedings of the First Thematic Conference on Remote Sensing for Marine and Coastal Environments, New Orleans, USA, pp. 159–169.

[3] Assilzadeh, H., Maged, M., M anson, S.B., Mohamed, M.I., 1999. Application of trajectory model, remote sensing and geographic information systems (GIS) for oil spill emergency response in straits of Malacca. In: Proceedings of the 20th Asian Conference on Remote Sensing, Hong Kong, pp. 331–339.

[4] Theophilopoulos, N.A., Efstathiadis, S.G., Petropoulos, Y., 1996. ENVISYS, Environmental Monitoring, Warning and Management System. Spill Science and Technology Bulletin 3, 19–24.

[5] H. A. Espedal, 0. M. Johannessen, J. A. Johannessen, E. Dano, D. R. Lyzenga and J. C. Knulst, "COASTWATCH'95: ERS-1/2 SAR detection of natural film on the ocean surface," J Geophys. Res., vol. 103, no. C 11, pp. 24969-24982, 1998.

[6] M. Gade, W. Alpers, H. Huhnerfuss, H. Masuko and T. Kobayashi,"Imaging of biogenic and anthropogenic ocean surface films by the multifrequency or multipolar- rization SIR-C/X-SAR," J. Geophys. Res., vol. 103, no. C9, pp. 18851-18866, 1998.

[7] C. Brekke and A. Solberg, “Oil spill detection by satellite remote sensing,” Remote Sens. Environ., vol. 95, no. 1, pp. 1–13, 2005.

[8] A. Solberg, C. Brekke, and P.Husøy, ”Oil spill detection in Radarsat and Envisat SAR images,” IEEE Transactions on Geoscience and Remote Sensing., vol.45, no.3, pp.746-755, Mar.2007.

[9] B.Fiscella, A.Giancaspro, F.Nirchio, P.Pavese, and P.Trivero, “Oil spill detection using marine SAR images,” International Journal of Remote Sensing, 21(18), pp.3561–3566, 2000.

[10] F.Del Frate, A.Petrocchi, J.Lichtenegger, and G. Calabresi, “Neural networks for oil spill detection using ERS-SAR data,” IEEE Transactions on Geoscience and Remote Sensing, 38(5), pp.2282– 2287, Sep.2000.

[11] Topouzelis, K., K., Karathanassi, V., Pavlakis, P., Rokos, D., 2008. Dark formation detection using neural networks. International Journal of Remote Sensing, 29(15-16), pp.4705-4720.

[12] I.Keramitsoglou, C. Cartalis, and C.Kiranoudis, “Automatic identification of oil spills on satellite images,” Environmental Modelling & Software 21 (5), pp.640-652, 2006.

[13] T.-I. Bern, S. Moen, T. Wahl, T. Anderssen, R. Olsen, and J. A. Johannessen, “Oil spill detection using satellite based SAR. Completion report for phases 0 and 1,” Trondheim, Norway, OCEANOR Tech. Rep. OCN-R92071, 1992.

[14] M. Perez-Marrodan, “ENVISYS-Environmental monitoring warning and emergency management system,” in *Proc. AFCEA Kiev Semin.*, May 28–29, 1998, pp. 122–132.

[15] A. H. S. Solberg, G. Storvik, R. Solberg, and E. Volden, “Automatic detection of oil spills in ERS SAR images,” *IEEE Trans. Geosci. Remote Sens.*, vol. 37, no. 4, pp. 1916–1924, Jul. 1999.

[16] L. Tufte, “D6(a)-report on oil spill data standardisation, oil spill pattern analysis and hot spots, as well as pollution conditions in test sites including oil spill maps and time series,” 2004, Oceanides project, Eur. Commiss., Archive No. 04-10225-A-Doc, Contract No: EVK2-CT-2003- 00177, Tech. Rep. [Online]. Available: http://oceanides.jrc.cec.eu.int