ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 4, April 2015

Automated System for Oil Spill Dark Spot Detection in Ocean

R.Srinivasan[1], P.Sangamithira[2]

Associate Professor, Dept. of EEE, Krishnasamy College of Engineering and Technology, Cuddalore, Tamilnadu, India[1]

PG Student [EST], Dept. of EEE, Krishnasamy College of Engineering and Technology, Cuddalore, Tamilnadu, India [2]

ABSTRACT: A major aspect of marine pollution, oil release into the sea has become a common phenomenon, and it can have serious biological and economic impacts. Cargo ships and pipelines are submerged in the marine environment carry huge amounts of petroleum across the open ocean. Large-scale release of oil into sea are called "spills". Accurate detection and forecast of oil spill in a timely manner is one of the most important applications for operational Oceanography.The main objective of the proposed system is to detect the oil spill dark spot in large pixels with smaller duration. In this case SAR imagery is used to detect the automated dark spot. The WMM and ANN techniques are used to differentiate between the dark spots and the background in large pixel. First, the filter created based on WMM is applied to each subimage. Second, the subimage is segmented by ANN techniques. As a last step, Median filter is used to eliminate the false targets. In existing method IDL software is used to detect the 512*512 pixels dark spot in half an hour. In proposed method MATLAB software is used to detect the 1024*1024 pixels dark spot in 5s.

KEYWORDS: Dark spot detection, oil spill detection, artificialneural networks, SAR image processing, synthetic aperture radar (SAR),Weibull multiplicative model.

I. INTRODUCTION

Digital image processing is the use of computer algorithms to perform image processing on digital images. As a subcategory or field of digital signal processing, digital image processing has many advantages over analog image processing.

Tasks : Digital image processing allows the use of much more complex algorithms, and hence, can offer both more sophisticated performance at simple tasks, and the implementation of methods which would be impossible by analog means.In particular, digital image processing is the only practical technology for:

- Classification
- Feature extraction
- Pattern recognition

A major aspect of marine pollution, oil release into the sea has become a common phenomenon, and it can have serious biological and economic impacts. Cargo ships and pipelines submerged in the marine environment carry huge amounts of petroleum across the open ocean and in coastal areas. Normally, small-scale release of oil into the sea is ascribed as "slicks," while large-scale ones are called "spills".

Accurate detection and forecast of oil spill in a timelymannerwould be beneficial to resource management for monitoring and conservation of the marine environment. It is one of the most important applications for operational oceanography. In recent years, remote sensing instruments have become one of the most effective methods in marine oil-spill detection. Moreover, it has been demonstrated to be a tool that offers a non destructive investigation method and has a significant added value to traditional methods.

A number of remote sensing systems are available for detecting oil slicks, namely, passive (i.e., optical sensors,) and active (i.e., laser fluoro sensors and radar systems). Among them, synthetic aperture radar (SAR) can provide valuable

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 4, April 2015

synoptic information about the position and size of the oil spill due to its wide area coverage and day/night and all-weather capabilities .

Detection of oil spills from SAR imagery can be divided into three steps:
1) dark feature detection;
2) computation and extraction of physical and geometrical features characterizing the dark feature; and
3) accurate discrimination between oil spills and look-alikes such as ice and rain cells. These procedures can be done manually or automatically.

In the present paper, an attempt has been made to develop fast, robust, and effective automated approach that is adequate for practical oil-spill monitoring. A new approach from the combination of (WMM) and (ANN) techniques is proposed for achieving this goal.

II. GENERAL TERMINOLOGY

DIP :Digital image processing is the use of computer algorithms to perform image processing on digital images.
MATLAB : Stands for MATrixLABoratory. It is a high-performance language for technical computing. It integrates computation, visualization, and programming environment. Furthermore, MATLAB is a modern programming language environment: it has sophisticated data structures, contains built-in editing and debugging tools, and supports object-oriented programming.
SYNTHETIC APERTURE RADAR(SAR) : Environmental monitoring, earth-resource mapping, and military systems require broad-area imaging and also acquired in all weather or during night as well as day.
WEIBULL MULTIPLICATIVE MODEL(WMM) : The WMM is applied to each sub image which contains dark spots.
ARTIFICIAL NEURAL NETWORKS(ANN) : The ANN is used to segment the sub image.
MEDIAN FILTER : This Process is used to eliminate the false target.Median Filter is a simple and powerful non-linear filter which is based order statistics. It is easy to implement method of smoothing images. Median filter is used for reducing the amount of intensity variation between one pixel and the other pixel.

III. RELATED WORK

In existing system WMM, PCNN, KNN, MLP, Spatial density features, area thresholding and contrast thresholding were used. It has some disadvantages based on time duration, image pixel size, software and accuracy.The proposed system adds the features of quality of the SAR image with WMM and ANN algorithm.The oil spill surrounded by the ship can be detected and measured.It uses high quality SAR image to improve speed of calculation and its accuracy. Image - **1024*1024,** Time Duration - **6s**, Hardware – Rasperry Pi, Camera, Fast & accurate Detection.

IV. PROPOSED SYSTEM

The flow diagram of the proposed system is shown in Fig1.

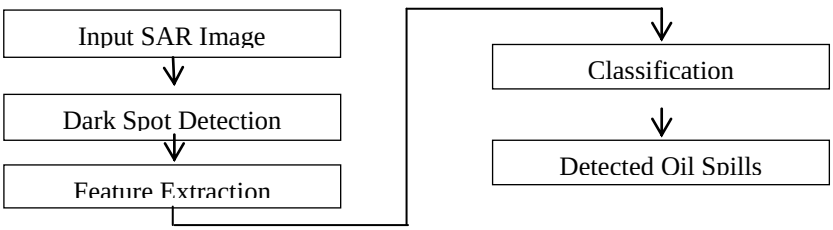

Fig1. Oil Spill Designing Process

Fig 1 shows the oil spill designing process to detect the dark spot in ocean. It has used two types of methods for the detection that is WMM and ANN. SAR is used to capture the image from ocean in all weather conditions.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 4, April 2015

A. SAR

Two main difficulties occur when using the automatic model for dark-spot detection: 1) the speckles in SAR imagery due to the constructive and destructive interferences of the reflections from surfaces of objects and 2) the contrast between the dark spots and the background can vary, depending on the type of dark spot, the local sea state, and the resolution and incidence angle of the SAR imagery.

B. DARK SPOT DETECTION

Dark formation detection is considered the fundamental step in oil spill detection systems and constitutes the first step in oil spill detection approaches. Several techniques have been presented in bibliography for detecting dark formations in SAR images. An overview of them is given in the following paragraphs. Once dark formations are detected, classification methods are applied to characterise them as oil spills or look-alike objects. If dark formations are not detected in this step they will never be classified.

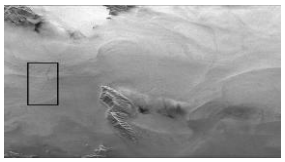

Fig2. Original image

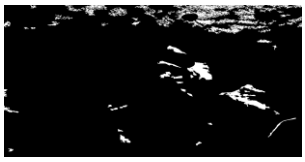

Fig3. Dark spots selected with threshold

Dark Spot Types	Description
Massive Well-Defined Dark Spot	A massive Dark Spot located within a homogeneous background where the boundry between the dark spot and the surrounding water is very clear
Linear Well-Defined Dark Spot	A Linear dark spot located within a homogeneous background where the boundry between the dark spot and the surrounding water is very clear(eg. Oil sills discharged by ships)
Massive Not Well-Defined Dark Spot	A massive dark spot within a homogeneous background where the boundry between the dark features and the surrounding water is not well defined.
Linear Not Well-Defined Dark Spot	A Linear dark spot within a homogeneous background where the boundry between the dark feature and the surrounding water is not well defined

Table 1.Comparison between different types of dark spot in oil sill area.

C. FEATURE EXTRACTION

Features are very important for the classification because they are used as inputs to the classifier. Therefore, the combination of features which discriminate better the oil spill from the look-alikes is of very high importance for the classifier and for the method's accuracy. In general oil spill detection methodologies traditionally use arbitrary selected quantitative and qualitative statistical features for classifying dark objects on SAR images into oil spills or look-alike phenomena. Features referring to the geometrical characteristics of oil spills (e.g. area, perimeter, complexity), features capturing the physical behaviour of oil spills (e.g. mean or max backscatter value, standard deviation of the dark formation or a bigger surrounding area) and features referring to the oil spill context in the image (e.g. number of other dark formations in the image, presence of ships).

D. CLASSIFICATION

1. ARTIFICIAL NEURAL NETWORK

Artificial neural networks (ANN) have been developed as generalizations of mathematical models of biological nervous systems. The basic processing elements of neural networks are called artificial neurons, or simply neurons or nodes. In a simplified mathematical model of the neuron, the effects of the synapses are represented by connection weights that modulate the effect of the associated input signals and the nonlinear characteristic exhibited by neurons is

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 4, April 2015

represented by a transfer function. The neuron impulse is then computed as the weighted sum of the input signals, transformed by the transfer function.

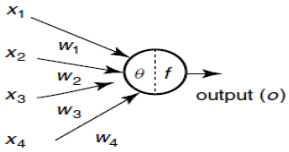

Fig4. Architecture of ANN

2. WMM

WMM (with the assumption that the amplitude or the intensity image has the Weibull distribution) in order to remove speckle and to enhance the contrast between the dark spot and the background. In SAR images, the texture is embedded in the speckle, which is originated by the coherent reflection of waves in a rough surface. WMM applies a nonlinear transformation to generate the texture image from the original speckled image. The extraction of the texture image from the Weibull-distributed SAR image employs the local estimation of the scale and form parameters of the Weibull distribution.

Segmentation

The analysis of the objects in images it is essential that we can distinguish between the objects of interest and "the rest." This latter group is also referred to as the background. The techniques that are used to find the objects of interest are usually referred to as segmentationtechniques - segmenting the foreground from background. In this section we will two of the most common techniques thresholding and edge finding and we will present techniques for improving the quality of the segmentation result.

- Thresholding
- Edge finding

Thresholding :This technique is based upon a simple concept. A parameter θcalled the brightness threshold is chosen and applied to the image a[m,n] as follows:

If a[m,n]$_{\geq\theta}$ **a[m,n] = background = 1**
Else **a[m,n] = background = 0**

This version of the algorithm assumes that we are interested in light objects on a dark background. For dark objects on a light background we would use:

If a[m,n]$_{<\theta}$ **a[m,n] = background = 1**
Else **a[m,n] = background = 0**

The output is the label "object" or "background" which, due to its dichotomous nature, can be represented as a Boolean variable "1" or "0". In principle, the test condition could be based upon some other property than simple brightness.Eg :(If (Redness{a[m,n]} >= θ_{red}), but the concept is clear.

3. SALT AND PEPPER NOISE

The salt-and-pepper noise are also called shot noise, impulse noise or spike noise that is usually caused by faulty memory locations, malfunctioning pixel elements in the camera sensors, or there can be timing errors in the process of digitization.

Reasons for Salt and Pepper Noise

a. By memory cell failure.
b. By malfunctioning of camera's sensor cells.
c. By synchronization errors in image digitizing or transmission.

4.FILTERS

Filtering in an image processing is a basis function that is used to achieve many tasks such as noise reduction, interpolation, and re-sampling.

g(x,y) → Filter → f(x,y)

Where, **g(x, y)**=Corrupted image,**f(x ,y)**=Filtered image

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 4, April 2015

Median Filter
Median Filter is a simple and powerful non-linear filter which is based order statistics. It is easy to implement method of smoothing images. Median filter is used for reducing the amount of intensity variation between one pixel and the other pixel.

Algorithm of Median Filter

Step 1. Select a two dimensional window W of size 3*3. Assume that the pixel being processed is Cx,y.
Step 2. Compute Wmed the median of the pixel values in window W.
Step 3. Replace Cx,y by Wmed.
Step 4. Repeat steps 1 to 3 until all the pixels in the entire image are processed.

D. OIL SPILL DETECTION
The first step towards oil spill detection is to detect dark spots in the image. The dark spots can than be extracted and analysed for features that can tell apart oil spills from low wind areas, rain, or other causes of low radar reactivity.

Fig 5. Original Oil spill image

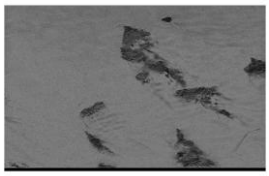

Fig 6.Divided by closed oil spill images

Two main approaches exist for the oil spill detection on SAR images
1. Manual approach
2. Semiautomatic or Fully Automatic approach

1. MANUAL INSPECTION
Manual inspection is the most popular technique for oil spill detection as is it not very complex and under certain circumstances can be easily reproduced. Nevertheless, it is not very reliable as it depends on the experience of the interpreter. In this approach operators are trained to detect oil spills through photo-interpretation. In general it can be assumed that dark formations are usually classified by photo-interpreters as potential oil spills according to the following criteria:

- Dark homogeneous spots in a uniform windy area Linear dark areas, not extremely large, with abrupt turns i.e. most likely abrupt turns due to wind directions changeor surface current. Natural slicks in these conditions tend to disappear. Man made slicks have higher viscosity and tend to change their shape.

Dark formations are usually classified by photo-interpreters as look-alikes according to the following criteria:

- Low wind areas
- Coastal zones due to wind sheltering
- Elongated dark areas with smooth turnings in spiral shape.

2. SEMI-AUTOMATIC AND FULLY AUTOMATIC METHODOLOGIES
Semiautomatic and fully automatic methodologies are not very popular for oil spill detection as they are complex, they cannot be easily reproduced and require specific knowledge on image understanding, pattern recognition and classifications theories into four steps:

- Detection and isolation of all dark formations presented in the image. Mainly this step is a result of thresholding and segmentation processing.
- Extraction of statistical parameters of the dark formations, so called “features” for each oil spill candidate. These features are related with the geometry of the formation (e.g. area, perimeter) their physical behaviour (e.g. mean backscatter value) and their context in the image (e.g. distance to ships).

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 4, April 2015

- Test of the extracted values against predefined values, which characterize man-made oil spills and look-alike phenomena. These values are usually determined through phenomenological considerations and statistical assessments.

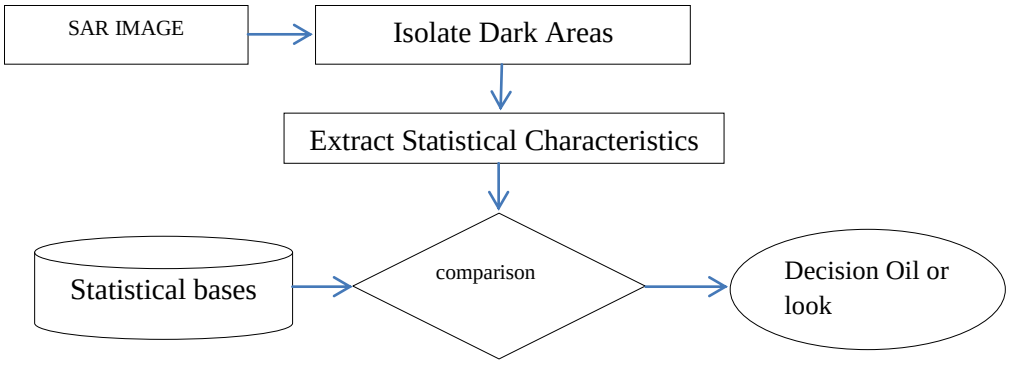

Fig 7.The basic functions of oil spill detection methodologies.

VI. RESULTS AND DISCUSSION

The dark spot images were obtained from the best visual (SAR) detection. After applying ANN, some regions were incorrectly detected as dark spots. A very simple filtering process is used to eliminate these false targets as the post processing step.
Fig 8 shows a SAR original RGB image. It is a **Pre-processing**step and fig 9 shows the **WMM** process which can be dividing the full image into subimage for easy identification of oil spill in each subimage.

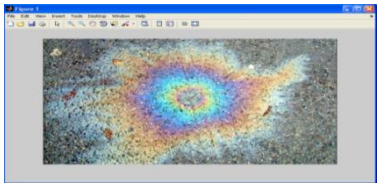

Fig 8. SAR image

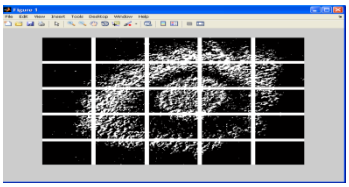

Fig 9. WMM divided sub image

Fig 10 shows a segmented oil spill image by using Artificial Neural Network Algorithm. Fig 11 is a detected dark spot oil spill image.

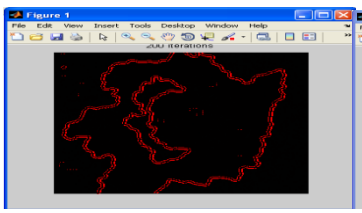

Fig 10. ANN image

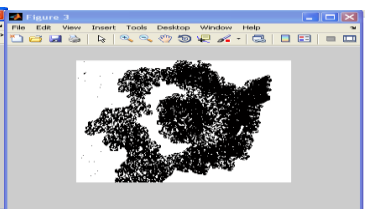

Fig 11. Dark spot image

Fig 12 is the Post processing step for removing the unwanted noise by applying filter (For removing false target)

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 4, April 2015

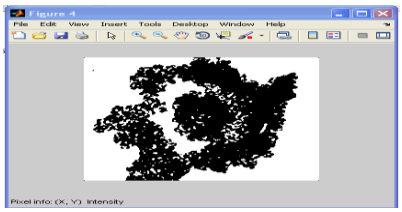

Fig 12. Filtered image

VII. CONCLUSION AND FUTURE WORK

In this project simulation is carried out for the detection of oil spill dark spot in large pixels with less computational time, also the salt and pepper noise from images are removed during image acquisition and transmission. The WMM and ANN methods are new and efficient techniques that can be very helpful for extracting the oil spill affected area from the background, by making use of the SAR images. Hardware implementation of the proposed project will be carried out by using ship with oil tank, camerarasberry pi etc.

REFERENCES

[1] C. Brekke and A. H. S. Solberg, "Oil spill detection by satellite remote sensing," *Remote Sens. Environ.*, vol. 95, no. 1, pp. 1–13, Mar. 15, 2005.
[2] K. Topouzelis, V. Karathanassi, P. Pavlakis, and D. Rokos, "Detection and discrimination between oil spills and look-alike phenomena through neural networks," *ISPRS J. Photogramm. Remote Sens.*, vol. 62, no. 4,
pp. 264–270, Sep. 2007.
[3] K. N. Topouzelis, "Oil spill detection by SAR images: Dark formation detection, feature extraction and classification algorithms," *Sensors*, vol. 8, no. 10, pp. 6642–6659, Oct. 2008.
[4] Y. M. Shu, J. Li, H. Yousif, and G. Gomes, "Dark-spot detection from SAR intensity imagery with spatial density thresholding for oil-spill monitoring," *Remote Sens. Environ.*, vol. 114, no. 9, pp. 2026–2035,
Feb. 2010.
[5] Y. Ma, L. Liu, K. Zhan, and Y. Wu, "Pulse-coupled neural networksand one-class support vector machines for geometry invariant texture retrieval," *Image Vis. Comput.*, vol. 28, no. 11, pp. 1524–1529, Nov. 2010.
[6] F. Palazzo, D. Latini, V. Baiocchi, F. Del Frate, F. Giannone, D. Dominici, and S. Remondiere, "An application of COSMO-SkyMed to coastal erosion studies," *Eur. J. Remote Sens.*, vol. 45, pp. 361–370, 2012.
[7] F. Del Frate, D. Latini, C. Pratola, and F. Palazzo, "PCNN for automatic segmentation and information extraction from X-band SAR imagery," *Int.J. Image Data Fusion*, vol. 4, no. 1, pp. 75–88, Mar. 2013.