A Review of Oil-Spill Detection Techniques using Marine SAR images

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Abstract— Oil spills have been a major cause of Marine Pollution and a risk to Marine Life. Due to its hazardous outcomes, Oil spill detection has become prominent job of marine inspectors. Also, many industries discharge waste oil in Oceans to get rid of it without coming in notice of pollution control board. Such cases are known as illegal oil spills and such oil spills need to be detected as accurately and immediately as possible. To do so, many technologies are advent. SAR images have been employed in many cases to detect such spills mostly by human operators. To automate such thing, machine learning and classification based approaches are used. This paper reviews such techniques in order to evaluate the overall advancement in accuracy of detection of such techniques.

Keywords—Remote Sensing, SAR, Oilspill Detection, Classification, Review

I. INTRODUCTION

Oil spills are outstanding in ocean areas as lots of the enormous Ships carry massive quantity of Oil as gas for his or her travel and some raise Crude Oil in form of exchange cargo from one country to a different. The unintended spill of oil in such instances is outstanding. [1][2][3]. In contrast, many corporate firms like refineries deposit the waste oil in form of leak whilst transporting cargos illegally to be able to eliminate waste oil without getting in discover of pollution manipulate Board. [2][3] Such unlawful oil spills put the marine lifestyles into chance. A survey suggests that unintended oil spills because of tanker/ship accidents make a contribution handiest to five% of all pollution coming into the sea. [1][4] This shows that deliberate Oil Spill deposition is better. Such illegal oil spills need detection. An extra be trained means that such managed oil spills are a a lot greater danger to marine life than typical oil spill accident circumstances. [1]

A Microwave based sensor procedure like synthetic Aperture Radar (SAR) is used for monitoring marine. These SAR gadgets are most often in-constructed into Satellites and are known as satellite tv for pc SAR. In different instances, the device is mounted on an aircraft and the airplane flies over the sky of ocean shooting the data and is often called Air borne SAR. SAR captures a 2-dimensional photograph of the area in phrases of reflection of the microwave. The brightness or depth worth defines the microwave backscattering houses of the skin.

II. LITERATURE REVIEW

Brekke et al. [1] presented the state of the art for oil spill detection in the world oceans. The papered discussed different satellite sensors and oil spill detectability under varying conditions. It summarized manual and automatic approaches to discriminate between oil slicks and look-alikes based on pattern recognition. It concluded with a discussion of suggestions for further research with respect to oil-spill detection systems.

Fiscella et al. [2] developed a probabilistic approach to distinguish oil spills from other similar oceanic features in marine Synthetic Aperture Radar (SAR) images. The method used statistical information obtained from previous measurements of physical and geometrical characteristics for both oil spill and natural features.

Farte et al. [5] presented a neural network approach for semi-automatic detection of oil spills in European remote sensing satellite-synthetic aperture radar (ERS-SAR) imagery. The network input is a vector containing the values of a set of features characterizing an oil spill candidate. The classification performance of the algorithm on a data set containing verified examples of oil spill and look-alike showed promising results. A direct analysis of the information content of the calculated features has been also carried out through an extended pruning procedure of the net.

Solberg et al. [6] presented some algorithms for automatic detection of oil spills in synthetic aperture radar (SAR) images. The algorithms consist of three main parts, namely: 1) detection of dark spots; 2) feature extraction from the dark spot candidates; and 3) classification of dark spots as oil spills or look-alikes. The algorithms have been trained on a large number of Radarsat and Envisat Advanced Synthetic Aperture Radar (ASAR) images. The performance of the algorithm is compared to manual and semiautomatic approaches in a benchmark study using 59 Radarsat and Envisat images.

Topouzelis et al. [7] provided a comprehensive review of the use of Synthetic Aperture Radar images (SAR) for
detection of illegal discharges from ships. The paper summarized the current state of the art, covering operational and research aspects of the application. The paper discussed the most common techniques to detect dark formations on the SAR images, the features which are extracted from the detected dark formations and the most used classifiers.

Fingas et al. [8] reviewed the existing technologies in remote sensing of for Oil Spill detection. Many different active and passive sensors both on ground, air borne and satellite based sensors are discussed. The paper summarized their benefits and disadvantages of each also.

Marghany et al. [9] developed an automatic model for oil spill detection. This model includes texture analysis and two types of algorithms (Lee and Gamma). Texture analysis, such as contrast analysis, was used to discriminate between oil and water. The Lee algorithm was used to determine the linearity of oil movements, while the Gamma algorithm was used to determine oil spill spreading. The results showed that texture analysis and Lee and Gamma algorithms can be good modules for automatic detection of oil spills by using SAR data.

Singha et al. [10] proposed a new approach to SAR oil spill detection by employing two different Artificial Neural Networks (ANN) modules used in sequence. The first ANN segments a SAR image to identify pixels belonging to candidate oil spill features. A set of statistical feature parameters are then extracted and used to drive a second ANN which classifies objects into oil spills or look-alikes. The proposed algorithm was trained using 97 ERS-2 SAR and ENVISAT ASAR images of individual verified oil spills or/and look-alikes. The algorithm was validated using a large dataset comprising full-swath images and correctly identified 91.6% of reported oil spills and 98.3% of look-alike phenomena. The segmentation stage of the new technique outperformed the established edge detection and adaptive thresholding approaches. An analysis of feature descriptors highlighted the importance of image gradient information in the classification stage.

III. REMOTE SENSING FOR OIL SPILL DETECTION

The discussion of the sensors is split into two fundamental classes, particularly active and passive. Active sensors are those that furnish their possess source of illumination or excitation, whereas passive sensors rely on illumination from a secondary source. A normal passive sensor is an infrared digicam or an IR/UV (infrared/ultraviolet) procedure. The inherent weaknesses comprise the incapability to discriminate oil on beaches, among seaweeds or debris. Amongst energetic sensors, the laser fluorosensor is a most useful instrument for the reason that of its specific ability to identify oil on backgrounds that incorporate water, soil, ice and snow. It is the only sensor that may positively discriminate oil on most backgrounds. Risks include the significant dimension, weight and excessive fee. Radar offers the one expertise for giant subject searches and foul weather far flung sensing. Radar is high-priced, requires a committed plane, and is prone to a lot interference. Equipment that measures relative slick thickness continues to be beneath progress. Passive microwave has been studied for a number of years, however many industrial instruments lack adequate spatial decision to be functional, operational instruments. A laser-acoustic instrument, which supplies the one technology to measure absolute oil thickness, is below development. Gear running in the visible region of the spectrum, reminiscent of cameras and scanners, is priceless for documentation or supplying a basis for the overlay of different data. It's not useful past this on the grounds that oil shows no spectral traits within the noticeable area which can be used to discriminate oil.segmentation of Dark Formation in SAR Images

Radar backscatter values from oil spills are very similar to backscatter values from very calm sea areas and different ocean phenomena named “appear-alikes” (e.g. Currents, eddies). [7]

Figure 1: Difference between a True Oil Spill and Look-alike [11]

A few house-borne SAR programs have been used for oil spill monitoring. They traditionally are characterized by means of their frequency (or band). The NASA’s SEASAT satellite, which was launched in 1978, was once the primary satellite tv for pc designed to become aware of the sea surface with an L-band SAR approach. Later, SAR methods had been launched by using the Russian area agency (RSA), the eu area agency (ESA) and the Canadian area agency (CSA).

Darkish formations will also be placed manually by using cropping a broader area containing the darkish formation, or an photograph window with constant measurement can be utilized, wherein threshold algorithms -adapted or no longer-can be utilized. Simple thresholds have one value for the entire photo e.G. The half of of the natural Normalized Radar pass part (NRCS) of the image [2], or NRSC minus the common deviation [14]. In adaptive algorithms threshold is calculated in the community, most commonly on areas blanketed with the aid of a moving window. Solberg et al. [6, 13] the brink is about k dB beneath the imply value of the moving window and it is calculated using a multi-scale pyramid procedure and a clustering step. Karathanassi et al. [12], the threshold is totally adaptive to local contrast and brightness of colossal photograph segments, thus the picture window does not have a fixed size but it varies according to brightness and contrast values of significant areas in the image. Frate et al. [5] used an facet detection technique based on photo histograms that have been derived from areas with suspicious darkish formations. Kannaa et al. [15] utilized a hysteresis thresholding [16] the place linear dark formations have been successfully detected. Huang et al. [17] utilized a partial differential equation (PDE) - founded
level set manner, which represents the slick floor as in implicit propagation interface.

IV. CONCLUSION

In this paper, we have reviewed the existing technologies for classification of Oil Spill in Ocean by use of SAR images. The different techniques used are related to machine learning based classification. The backscattering based features of region based on the isolated spill shows highest accuracy of classification of oil spills from other non-oil spill regions known as look-alikes. The different system performances are reviewed. The considerations of the different systems show that use of advanced classification systems like Artificial Neural Networks is getting prominent in these scenarios while some are also using these algorithms for advanced Segmentation with high segmentation accuracies. The use of adaptive thresholding with Partial Differential Equations (PDEs) is also showcased by many researchers. The overall evaluation is that SAR image segmentation is the first step to detection of Oil-Spill. Work is going on to classify the natural Oil-Spill with that of Illegal discharge that can in future be of help to marine inspection systems.

References