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A Novel Approach for Oil Spill Detection in SAR Imagery

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ABSTRACT--Oil spills are one of the most dangerous catastrophes that threaten the oceans. Therefore, detecting and monitoring oil spills by means of remote sensing techniques that provide large scale assessments is of critical importance to predict,prevent,and clean oil contamination. The detection of an oil spill using synthetic aperture radar(SAR) imagery is considered. A recently offered change detection method that depends on finding changes in the boundaries if oil spill, Ocean and Land Area is used. The changes in the image itself are classified based on subtraction of them. The common change areas are excluded and uncommon change areas are included. Thus the total oil spill affected area is detected.

Index Terms-Change Detection(CD), Correlation Coefficient, Intensity Ratio value,Oil Spill,Remote Sensing of Oceans, Synthetic Aperture Radar (SAR) Imaging.

1 INTRODUCTION

Synthetic aperture radar (SAR) imaging is extensively used for monitoring various types of natural hazards and disasters. These include but are not limited to earthquakes, landslides, volcanic activity, flooding, fires, hurricanes, tsunamis, and oil spill [1]. Satellite systems became invaluable tools for early warning and post disasters assessment studies since they provide a large-scale view of the disaster area. This is critically important for identifying the areas affected by the disaster. Compared to some small-scale monitoring systems, they can also provide information about the extent of the disaster in inhabited areas[11]. SAR imagery is also used to detect oil spills and surfactants. The detection of ocean oil spills by processing of captured oil spill SAR image using the Change Detection methods is evaluated and improved with novel processing methods and obtaining the different levels of processed output image with correlation coefficient, intensity ratio and affected area values.

2 METHODOLOGY

A novel approach for oil spill by using the Change Detection (CD), mapping and analysis can be applied to various types of imagery obtained by different sensing systems such as radar, optical, multispectral. They are used to extract information about the changes occurring in a scene [1]. These changes can be in the magnitude, location, and the direction of the scene [10]. The Change Detection algorithm is an accurate technique specifically used to detect the boundary value changes in the single ocean oil spill image [1]. From that image, the changed pixel values of the oil spill boundary and the ocean boundary are taken and then colour based clustering and segmentation are done. The following descriptions are related to oil spill block diagrams shown in Fig 2.1 and briefly explained.

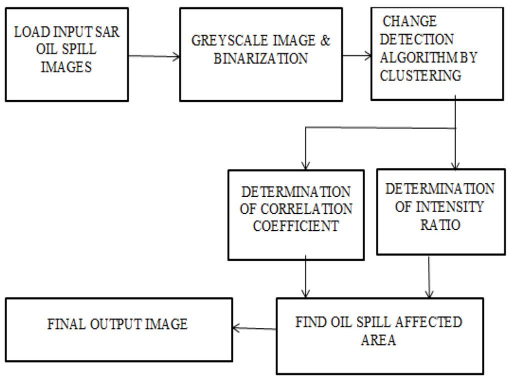


Fig 2.1 Block diagram of oil spill detection in sar imagery

2.1 OIL SPILL IMAGE ACQUISITION

The first stage of any vision system is the image acquisition stage. After the image has been obtained, various methods of processing can be applied to the image to perform the many different tasks required today. However, if the image has not been acquired satisfactorily then the intended tasks may not be achievable, even with the aid of some form of image enhancement. Firstly, the Mexico Oil spill image is read and its width and height are resized and reshaped to our desired dimensions as 256x256. After that process, the contrast and brightness of the input oil spill image is adjusted with higher brightness. It is done because to identify the different regions of the image distinctively and easier for the conversion of grey scale image and also binary images.The following input SAR oil spill image is processed using the Change Detection algorithm by means of K-means clustering as shown in Fig 4.1.

2.2 GREY SCALE IMAGE &BINARIZATION

The second step of this image processing technique involves the conversion of colour image into grey scale image. The luminance of a pixel value of a grey scale image ranges from 0 to 255. The conversion of a colour image into a greyscale image is converting the RGB values (24 bit) into grey scale value (8 bit).

It converts the grey scale image to a binary image. The output image replaces all pixels in the input image with luminance greater than level with the value 1 (white) and replaces all other pixels with the value 0 (black). The Specified level will be in the range [0,1]. This range is relative to the signal levels possible for the image's class. Therefore, a level value of 0.5 is midway between black and white, regardless of class [5]. This process is very much useful for differentiating the land areas, ocean and oil spills in the loaded input oil spill images [1]. The pixel values of each of these regions are different. So, the changes are found in a much easier way.

The RGB image is converted into grey scale image because of these reasons:

1. The black and white image can be easily differentiated by the system than that of the colour images. But for the human eye, colour images can be easily differentiated.
2. The execution time of the image processing will be less.
3. The size of the grey scale image is smaller than the RGB image (ie.Averaging the RGB values) and also binary image is smaller than the grey scale image (ie.0s and 1s).

2.3 CHANGE DETECTION ALGORITHM BY K MEANS CLUSTERING

Clustering is a way to separate groups of objects. K-means clustering treats each object as having a location in space. It finds partitions such that objects within each cluster are as close to each other as possible, and as far from objects in other clusters as possible. K-means clustering requires that specifies the number of clusters to be partitioned and a distance metric to quantify how close two objects are to each other. By default, K means uses the squared Euclidean distance measure and the K-means++algorithm for cluster centre initialization. K means is used to cluster the objects into three clusters using the Euclidean distance metric. These are threecolours are used namely White, Green and Blue. The L*a*b* space consists of a luminosity layer 'L*' which indicates white colour, chromaticity-layer 'a*' indicating where colour falls along the red-green axis, and chromaticity-layer 'b*' indicating where the colour falls along the blue-yellow axis. All of the colour information is in the 'a*' and 'b*' layer. The difference between two colours is measured using the Euclidian distance metric. Since the colour information exists in the 'a*b*'space, the blue and green colours are pixels with 'a*' and 'b*' values.Thecolours of the processed image have been set to n=3 and columns are adjusted to reshape the image again by changing the distance metric of the various colours of the processed oil spill image.In the clustering process, the oil spill image has 'Lab layers' which is classified as

1. L=The luminosity Layer indicating Oil Spill area
2. a= The red-green axis indicating the Coastal land region
3. b= The blue-yellow axis indicating the Ocean region

Then the pixel values of the height and width of the processed image are labelled by using the instruction from the toolbox by converting the number to string values.

2.4DETERMINATION OF CORRELATION COEFFICIENT AND INTENSITY RATIO

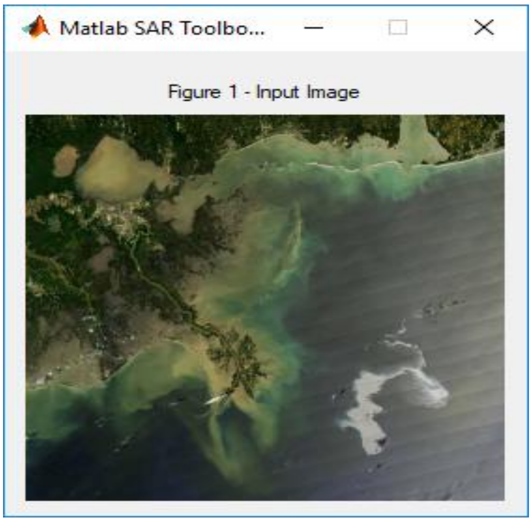
The correlation coefficient means the difference between oil spill image pixel values and the ocean image pixel values. These values are different for different SAR images. The values are in the range of point values. For finding intensity ratio value, the colour contrast of the image must be enhanced. For that enhanced image, intensity ratio value will be calculated. These steps will be done after the change detection by colour based clustering. By this process, three major regions are clustered and their phase values are taken [4]. The correlation and intensity values are used for accurate and appropriate visualization of oil spill cluster by converting the white colour to green colour and pointing out the oil spill area by blocking them respectively. The correlation coefficient values of the image regions are lesser than intensity values as they are sensitive to images with oil spill area (dark pixels) closer to land region which has the brighter pixels [1].

TABLE 1

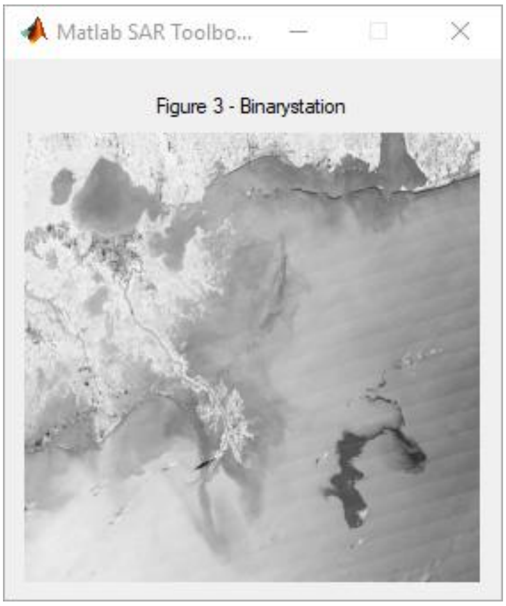
OILSPILL AFFECTED SAR IMAGERY	CORRELATION COEFFICIENT	INTENSITY RATIO
IMAGE 1	0.189	0.634
IMAGE 2	0.22	0.53
IMAGE 3	0.27	0.71

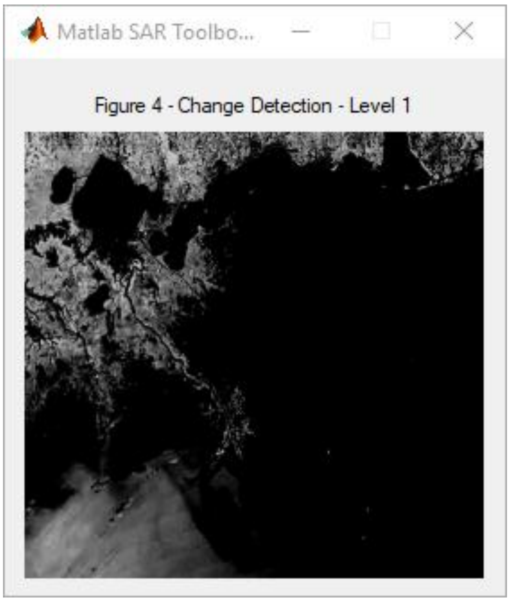
The image1 shown in the table below indicates the input image taken for Change Detection Algorithm. The images 2 and 3 are also processed and got the tabulated values but are not displayed inthe paper.

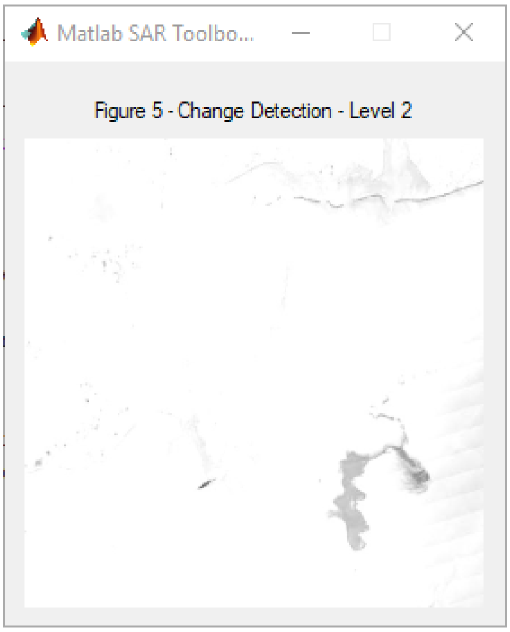
3 RESULTS

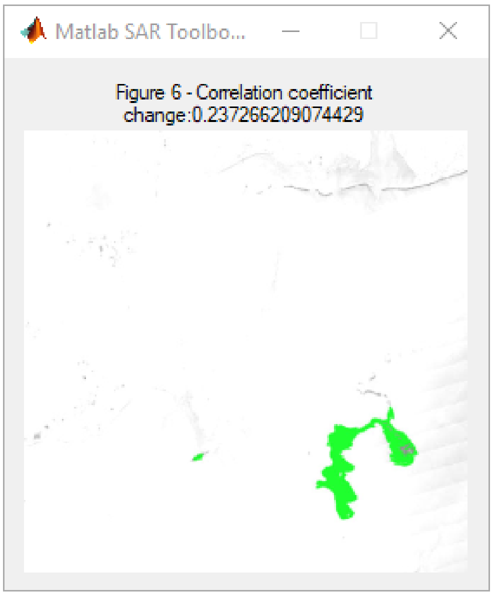



Matlab SAR Toolbo...
Figure 2 - Greyscale Image

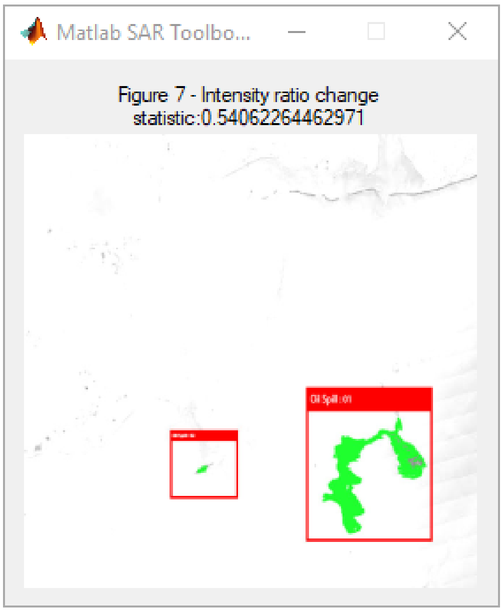

Matlab SAR Toolbo...
Figure 3 - Binarystation


Matlab SAR Toolbo...
Figure 4 - Change Detection - Level 1


Matlab SAR Toolbo...
Figure 5 - Change Detection - Level 2


Matlab SAR Toolbo...
Figure 6 - Correlation coefficient
change:0.237266209074429


Matlab SAR Toolbo...
Figure 8



4. CONCLUSION

Thus the SAR images of oil spills will be detected by applying change detection algorithm by means of colour based clustering. Thus algorithm used for detecting the oil spill affected area effectively. At present the identification of oil spill areas are done by radar images. The main advantage of this oil slick detection is that reducing the dangerous pollution in the environment and saving the Bio-diversity. The tracking of oil spill affected area is also done effectively with better accuracy.

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