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Oil Spill and Debris Detection using Image Processing

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Abstract: ***Marine life is a huge ecosystem that faces many threats, the biggest one being pollution. And one of the major contamination sources are oil spills. Oil spills can be devastating, especially when a large area of the ocean/sea is covered with it. Oil that gets leaked into the ocean pollutes the water and prevents algae from getting sunlight and fish from getting the oxygen trapped in water. The oil also gets trapped in the wings of birds that prey on the fish, making it difficult for them to fly. In short, oil can pose a great threat to ocean life if not taken care of. Here, a quick detection software can help in alerting about the spread of a potentially harmful oil spill and hence reduce its effect on the ocean. Image processing is a rapidly growing technology, which has applications in computer vision as well as remote sensing. We aim to broaden its range of application in controlling global pollution by industrial wastes.***

Index Terms: ***SAR image, image segmentation, Sobel edge detection, Canny edge detection, Dilation, Erosion.***

I. INTRODUCTION

The ocean covers more than 73% of the Earth's surface, teeming with life-forms that are extremely crucial to the existence of ecosystems - ecosystems that humans thrive on. Often as a mistake or deliberately, humans have polluted the water bodies - oceans, seas, rivers and lakes with oil and industrial wastes. Factories and cargo carrying oil leave massive spills of oil in the water, which is extremely hard to clean up too. On the coastal side and river banks, many factories dump their wastes, without measuring their toxicity before release. Oceans and seas are a source of food and home for a million species. Fishes, whales and other aquatic beings including birds who feed on the fishes. Human dependency on the ocean life cannot be ignored, since fisheries constitute more than 10% of the world's economy. And all face threats from oil spills. Oil that is spilled can affect the bio sphere as well as the aquatic life as its harmful and poisonous for living thing.Due to oil spill entire marine life gets disturbed. Oil covers and smoothens the surface of ocean due to that small fishes and different species dies, this is a major loss of food sources and covers the feathers of birds, reducing their ability to maintain their body temperatures. Entities that are mostly affected by the oil spills are seabirds & Enhydra lutris. Due to this, mostly marine birds fall in grave danger. Other smaller organisms like Gastropoda and hard clams along with various other terrestrial animals are affected if the oil spilled over the ocean surface continues to be suspended. Pollution not only by oil, but industrial wastes is also very high. Plastics and harmful chemicals released in the water may cause immediate death of animals, and have disastrous effects on humans. Hence immediate detection of these pollutants can enable quick cleaning actions and prevent further repercussions of the disaster.

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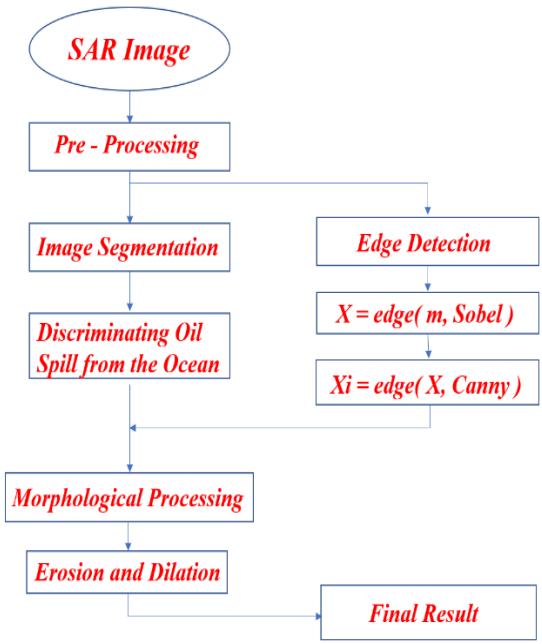
II. METHODOLOGY

The process follows:
1) SAR Image.
2) Pre-processing.
3) Sobel Edge Detection.
4) Canny Edge Detection.
5) Morphology
6) Dilation.
7) Erosion.
8) Opening and Closing.



Flow Diagram

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1. Using SAR image

SAR image stands for Synthetic-aperture radar which is a form of image that is able to form two-dimensional and 3D reconstructions.The radar antenna is moved over the target area to produce a fine 3d reconstruction. UAVs are often used on which the SAR is fixed which has an advanced surrounding sensing radar. The amount of distance these microwaves cover in the time taken for the radar pulses to return to the receiver generates the entire synthetic aperture. Basically, the larger the aperture, the higher the resolution of the image will be.Generating a SAR image involves propagation of continuous beams of microwaves that are transmitted to "irradiate" the target area, the echo of each and every pulse is recorded and processed. The pulses are transmitted and the echoes are received using a single beam-forming antenna. As a SAR device loaded space-craft moves, the SAR antenna's relative position with respect to the target area also changes with time.Processing of these continuous received pulse echoes allows the merging of the received data. This process leads to the formation of the SAR aperture.These images can be generated using various satellites like RADARSAT-2, RISAT-1, where the latest used technology is Sentinel-1A.

2. Pre-processing

The obtained image is pre-processed to reduce noise in the image. The noise in an image generally leads to formation of various unnecessary edges and contrasts that are not actually present in the original image but forms due to the noise in the image when applied for edge detection algorithms. Gaussian filter masking is the most commonly used mechanism to reduce noise in an image and make it smoother by applying various filters. Conversion of the original image into its Gray scale form is the conversion of a colour image into gray image which reduces noise in the image and prevents sharper gradients from producing unnecessary edges in the image during further processing. Pre-processing techniques ensures accurate, efficient and meaningful analysis of the obtained image.

Figure 1: Processed Image

3. Sobel Edge Detection

Sobel operator is a Kernel Convolution Process which returns a high response where there's a sharp change in gradient image and a low response where there isn't. It's generally well on grayscale images that we first blurred just to make sure image is smooth. Sobel operator is run in both the x and y directions. Sobel edge detector is not pixel independent as if we have a high-resolution image, the gradient is going to be spread over many pixels but in a low-resolution image we will have a very sharpish gradient as that's the best we can do with those pixels. Canny edge detector gets rid of all that stuff and just identifies where the edge is. It also produces an orientation at every point which tells us north in image, upwards to downwards, left to right and what direction is our edge facing.

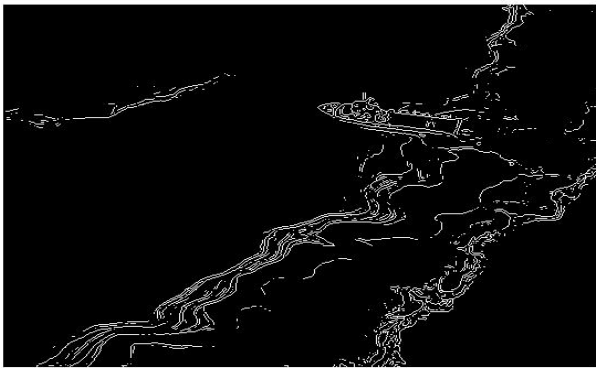

Figure 2: Sobel Edge Detection

4. Canny Edge Detection

Canny edge detector works by taking the image from the Sobel output and makes it just a step better. Thinning all the edges so they are 1 pixel wide because thick edges doesn't really help us as we really care about where are the edges not how thick they are. Canny works by first finding the edges and then use a process called hysteresis thresholding. The hysteresis thresholding is essentially a two-level thresholding which determines and preserves only the dominant edges. Canny identifies the orientation of our edge based on the output of Sobel operator which is figured out by using inverse Tan and the identifies if a particular pixel is bigger than its neighbors, and doing that over the whole image produces a lot of very thin edges right at the peaks of the centre of our response.

Figure 3: Canny Edge Detection

5. Morphology

The motive of morphology is study of objects. Morphology is a rich set of image processing operations that processes various images based on their shape, size, contrast & orientation. In this operation creating an output image of the same size as that of the input image includes the inclusion of a structuring element to an input image. By selecting the shape and size of the neighbourhood, we can formulate a morphological operation that is sensitive to specific shapes in the input image. In this paper we are going to perform morphological operations dilation and erosion.

6. Dilation

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Dilation adds pixel to the edges of the objects. So the gray scale image can be utilized to produce an edge detection image by performing dilation operation on it and then removing the parts of the original image from it. *Grayscale* dilation with an Oil spill and Garbage area detection shapes structural elements by generally brightening the image. Bright regions surrounded by dark regions enlarges in size and dark regions surrounded by bright regions shrink in size.

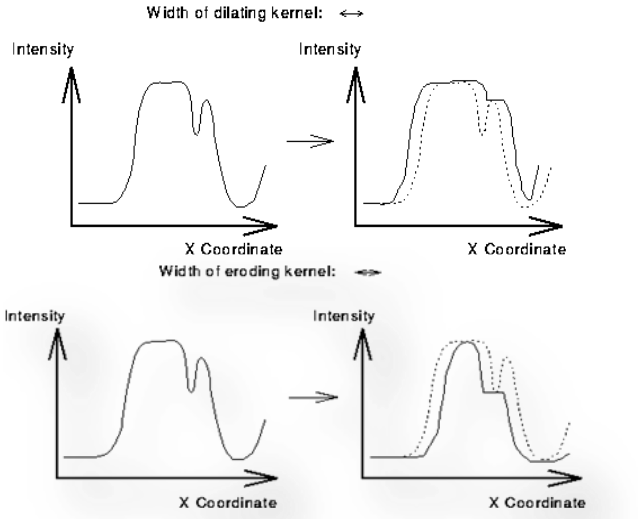

Figure 4: Graphs of Dilating kernels

7. *Erosion*

Erosion removes pixel from the edges of the objects. The value of the output pixel is the minimum value of all the pixels. In a binary image, the output pixel is set to 0 if any of the pixels is set to the value 0. *Grayscale* erosion with an Oil spill and Garbage area detection where the idea of erosion is to make the image smaller by reducing the pixels of the outer edges.

Figure 5: Graphs of Eroding kernels

8. Opening and Closing

Opening is a method that follows erosion and then dilation operation. It smoothens the edges, breaking the narrow joints which are present in the images. Closing is a method that follows dilation and then erosion operation.It has various properties like Dual transformation, Increasing transformation.

Figure 6: Obtained Image

Figure 7: Gray Scale Image

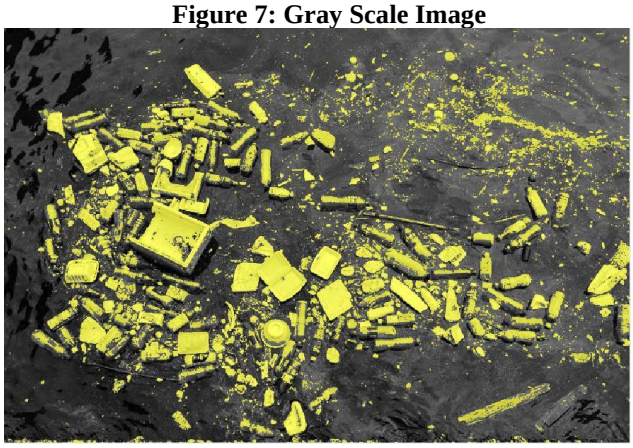

Figure 8: Processed Image

III. FUTURE WORKS

SAR images are the main type of imaging focused on in this paper, but there is a drawback. In the Arctic regions, the freezing temperatures hides the spilled oil in terms of ice. In case of an oil spill, ice collects on top of the oil and freezes, making the oil invisible to the SAR imaging device. This can prove to be very dangerous since it can spread for miles and block the oxygen from the atmosphere, yet go undetected. In scenarios like this, it is not impossible to find the oil.GPR uses tomographical images to view and locate objects in the ground. It's a process that utilises electromagnetic waves to produce image of the subsurface. It is comprising of three main elements namely control unit, the antenna and the survey encoder. The antenna has a transmitter and a receiver, when the signals are returned to the antenna the amplitude is calculated, this amplitude is the signal strength. This methodology may be used to locate the hidden oil spills in Arctic regions as a future extension. The existing SAR methodology can't detect oil spills or debris in an arctic environment, thus GPR imaging improves the implementation by overcoming this obstacle.Debris in the sea has become a global problem. Plastic floating in the sea and ocean is ingested by animals like whales, sharks and turtles and chokes most of them to death. Locating the depth of the pollution can help take immediate action for cleaning up the water body. Here also, using SAR and GPR images the depth of the debris in the water can be located, working as an added extension of the project.

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IV. CONCLUSION

Pollution has reached a dangerously high level, and its effect on marine life is high. Mistakes by humans can't be avoided completely, but all measures to prevent a small mistake from becoming a major disaster should always be taken. Methods used in this paper can help detect oil spills and debris pollution at an early stage and can contribute in minimizing damage to ocean ecosystems.

REFERENCES

1. West, Larry. (2019, January 16). 5 Environmental Consequences of Oil Spills. Retrieved from https://www.thoughtco.com/environmental-consequences-of-oil-spills-1204088
2. Hansman, H. (2015). Scientists Find a Natural Way to Clean Up Oil Spills, With a Plant-Based Molecule. [online] Smithsonian. Available at: https://www.smithsonianmag.com/innovation/scientists-find-natural-way-to-clean-up-oil-spills-with-plant-based-molecule-180955815
3. Business Insider. (2012). We Finally Have A Reliable Way To Detect Oil Spills Before They Get Disastrous. [online] Available at: https://www.businessinsider.com/detecting-oil-spills-2012-11?IR=T
4. Schubert, A. (2013). Synthetic Aperture Radar: Of Bats and Flying Pianos. [online] YouTube. Available at: https://youtu.be/g-YICKbcC-A
5. Wikipedia contributors. (2019, March 22). Oil spill. In Wikipedia, The Free Encyclopedia. Retrieved 18:37, March 28, 2019, from https://en.wikipedia.org/w/index.php?title=Oil_spill&oldid=888969416.
6. Smith, R. and Baker, K. (1978). The bio-optical state of ocean waters and remote sensing 1. Limnology and Oceanography, 23(2), pp.247-259.
7. Devi, N. and Sharma, S. (2016). Synthetic Aperture Radar (SAR) Images Processing: A Review. IRJET, 3(7), p.6.

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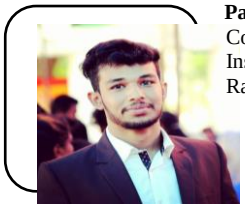

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