AUTOMATION OF MARINE POLLUTION MONITORING USING SAR IMAGES ON OPEN SOURCE PLATFORM

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Abstract— Ocean covers 80 % of surface of the earth. Some of the crude material and food originates from oceans. Oil slick makes enormous issues in ecosystem of the ocean. Oil slick endangers marine life and marine environment. It also influences the natural food cycle and water cycle. So it is imperative to recognize and remedy oil slicks. Oil Spill Detection is the application of physical oceanography. Oil spills are detected in three steps: Dark spot detection, Features extraction and classification. The paper explains experiments using Hysteresis method for Dark spot detection using imageJ platform with a proposal for enhancing the impact of the technique.

Index Terms—Oil Spill Detection, SAR images, Oceanography, ImageJ

I. INTRODUCTION

Oil Spill detection is an application of Oceanography. Oceanography is the general name given to the scientific study of ocean. Wide range of topics are included in oceanography like ocean circulation, marine life, plate tectonics and the geology of the sea floor, ecosystems, and the chemical and physical properties of the ocean.[7] All the domains are shown below : A Biological Oceanography is study of the underwater plants, and animals environment, changes in environment and the effects of changes on marine life.[6]

B Chemical Oceanography is study of composition of sweater, the changes in the same, its chemical process with other chemicals such as atmosphere pollutants and their impact on marine life, how ocean effects climate, which oceanic product can be used as medicine etc.[7]

C Geological oceanography is study of the oceanic floor and the process which makes mountains and valleys, the plates structures under the sea area, the climate change and the changes in ocean area, volcanic processes and effects, metal and under water oil detection etc.[9]

D Physical oceanography is study of the physical processes within the ocean such as eddies, wave, currents, wind directions, tides, coastal erosion, interaction of atmosphere and ocean, transmission of light sound and other rays through ocean, etc. Oil spill detection is a physical oceanographic application [8]

Oil Spill detection is very difficult task as oil spills may be on surface, under surface, sandwiched in ice, on sea shore or may be in the water column. There may be some lookalikes of oil spills which may have same reflection properties, smell, and look or behavior as oil. There are many methods for Oil spill detection, but as per the literature survey SAR (Synthetic

Aperture Radar)images are apt for satellite application based on image processing method.[2] SAR images are very effective for oil spill detection because they have good coverage and high resolution plus they are not affected by different wheather conditions.[5]

II. STATE OF ART

Despite the fact that there are numerous systems to locate oil slicks, remote sensing is widely utilized method. SAR Images are utilized for satellite surveillance. SAR is the most productive and predominant satellite sensor for oil slicks detection. SAR Images have the preference over optical sensors that they can procure images of ocean at day time or night time and regardless of any climate conditions and wind level. Oil Spill Detection can be divided into three steps as follows:

A Dark Spot Detection: Dark spot detection is the first step of oceanography. This step may be manual or semi automated. The dark spot can be detected by cropping the border area manually. In the semi automated and automated method a fixed or variable sized window is used. The size of window is decided using thresholding. The threshold value may be Normalized Radar Cross Section (NRCS). or NRCS minus Standard Deviation. Partial Differential Equation may also be used for the same purpose. Rather than statistical approach Wavelets also can be used. The research is going on for in the neural network area for thresholding method too. [11]

B Feature Extraction: Feature Extraction is very important task as it is input to classification, it helps the system to discriminate from the oil spills from look alikes. There are generally 25 features used for oil spill detection. All features are listed below:

1	Area
2	Perimeter (P)
3	Perimeter to area ratio (P/A)
4	Object complexity (C)
5	Shape factor I (SP1)
6	Shape factor II (SP2)
7	Object mean value (OMe)
8	Object standard deviation (OSd)
9	Object power to mean ratio (Opm)
10	Background meanvalue (BMe)
11	Background standard deviation (NSd)
12	Background power to mean ratio (Bpm)
13	Ratio of the powerto mean ratios (Opm/Bpm)
14	Mean contrast (ConMe)
15	Max contrast (ConMax)
16	Mean contrast ratio (ConRaMe)
17	Standard deviationcontrast ratio (ConRaSd)
18	Local area contrast ratio (ConLa)
19	Mean border gradient (Gme)
20	Standard deviation border gradient (GSd)
21	Max border gradient (GMax)
22	Mean difference toneighbours (NDm)
23	Spectral texture (TSp)
24	Shape texture (TSh)
25	Mean Haralick texture (THm)

Table I: List of Features

C Classification: Classification differentiates between oil spills and look alikes. As per conventional method first training data set is fed to classification algorithm and then test data sets are checked. Accuracy and efficiency of classification depends on the chosen algorithm. Some statistical methods are used like probability assigned to Gaussian density function and derived signature. The recent technology is based on machine learning used for classification like Neural Network [3][1], Fuzzy logic, genetic algorithm, swarm intelligence[4] etc.

III. METHODOLOGY ADOPTED

In this paper all the general steps are performed along with some other steps. The images captured with SAR sensors need some calibration and denoising. First of all contrast is enhanced [17] for the visibility. Median Filter is used to remove Spackle noise.[16]

The next step is dark spot detection. We have used hysteresis segmentation method as it is having Trinarisation stage which further decides whether the pixels with intermediate values indicate backgroud or object. The survey results says that it is a very effective segmentation method.[19]It uses multiple thresholds. The algorithm is as shown below:

A If pixel value is greater than first threshold, set the pixel value as 255.

B Else if pixel value is greater than second threshold and less than first threshold set the pixel value as 128.
C Else set the pixel value as 0.
D If the pixel value is 128 and all the 8 neighbor values are 128 than set the pixel value as 255.

After dark spot detection features are extracted from the image. According to survey mentioned in [10], only 10 features out of 25 mentioned in table I, are widely required to detect the oil spill. The list of features is shown below:

Sr no	Feature Name	Description
1	Perimeter to area ratio (P/A)	Perimeter to area ratio of all objects
2	Object complexity (C)	complexity is defined as ratio of all perimeter square and area
3	Shape factor II (SP2)	Symmetry of object
4	Object standard deviation (OSd)	Standard deviation of all intensity values of object
5	Object power to mean ratio (Opm)	The ratio of object standard deviation to object mean value
6	Background standard deviation (NSd)	Standard deviation of all intensity values of background
7	Background power to mean ratio (Bpm)	The ratio of background standard deviation to object mean value
8	Local area contrast ratio (ConLa)	contrast ratio of object to local window intensity
9	Mean border gradient (GMe)	Mean value of sobel output
10	Mean Haralick texture (THm)	Mean value of cooccurrence matrix

Table II: List of Important Features [20]

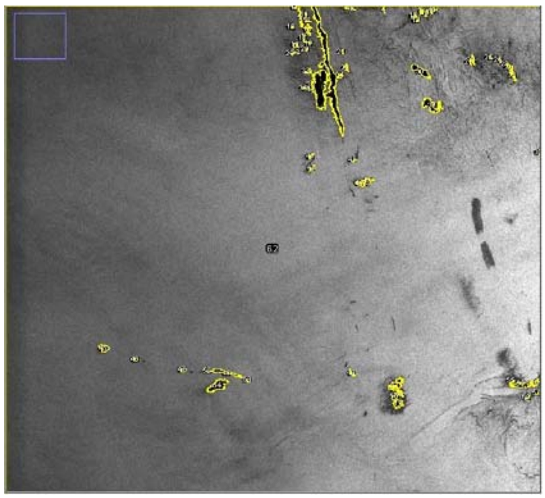
IV. Experimentation

We have implemented the above mentioned methodology and tested on 15 images taken from online resource. Because geoTiff images have geo referenced tags to get the location of the images, and all the information about the satellite and image specification, they are highly used for satellite image processing. The images specifications are as shown bellow:

Image Type	GeoTiff
Image Band	c- band
Spatial Resolution	50X50
Sattellite	RISAT-1
Tools	Netbeans, ImageJ

Table III: Image Specification

Because of unavailability of GeoTiff images we have taken 14 jpeg images for checking the working of the algorithm and the result of one of the image is as shown in the table IV and V. The threshold values are T1=60 and T2=50.



The area of the object is calculated

V. Proposal

In this experiment the existing algorithms like hysteresis, sobel, harlick texture etc. are used. There is need of some improvements in the algorithm as it is a supervised method to find out the dark spot in the image using image processing. The threshold values can be optimized using otsu[13], adaptive thresholding[14] or any other method. Neural network can be used for classification.

VI. Conclusion

According to literature survey we ended up using hysteresis method. For dark spot detection the results indicates that there is room for improvement if manual selection of threshold values is replaced by some other method.This manual selection of threshold can be replaced by threshold estimation. Current experiments are being carried out for estimating threshold values using various existing methods.

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Sr No.	Object Area	Object Mean	Object StdDev	Object Min	Object Max	Object Perim.	Object Median	Object P/A	Object Complexity	Object Pow To Mean	Mean Border Gradient
1	18	36.38889	12.6869	11	53	18.72792	43	1.04044	19.485281	0.348648	
2	2591	12.83366	16.40401	0	133	903.259	7	0.348614	314.88879	1.278203	
3	17	35.35294	15.87034	4	68	25.79899	35	1.517588	39.152228	0.448911	
4	18	34.22222	10.63599	7	44	24.14214	39	1.34123	32.380151	0.310792	
5	63	20.95238	15.74128	0	47	78.76955	21	1.25031	98.486388	0.751289	
6	18	31.94444	17.30852	0	49	21.79899	40	1.211055	26.399776	0.541832	
7	27	30.92593	14.50975	0	49	40.28427	32	1.49201	60.104537	0.469177	
8	11	24.90909	10.70004	12	40	21.31371	23	1.93761	41.297652	0.429564	
9	12	36.75	15.49853	1	47	19.79899	43	1.649916	32.666667	0.421729	
10	23	36.04348	8.583696	11	47	28.97056	37	1.25959	36.491022	0.238148	
11	17	32.58824	9.185987	15	49	22.72792	30	1.336937	30.385791	0.28188	
12	26	28.57692	13.73513	0	49	34.87006	33	1.341156	46.766189	0.480637	
13	21	30	14.57738	0	49	25.55635	32	1.216969	31.101285	0.485913	
14	11	36.09091	6.774283	23	47	18.14214	36	1.649285	29.921553	0.187701	
15	59	25.45763	15.65614	0	49	68.66905	26	1.163882	79.92268	0.614988	
16	11	39.72727	8.580104	19	47	13.31371	42	1.210337	16.114076	0.215975	
17	25	26	11.6476	1	47	34.14214	28	1.365685	46.627417	0.447985	
18	11	32.81818	13.69539	1	49	16.14214	35	1.467467	23.688049	0.417311	
19	26	37.5	21.82705	7	117	30.38478	36	1.168645	35.509024	0.582055	
20	13	24.92308	18.43214	0	49	17.31371	23	1.331824	23.058808	0.739561	
21	21	23.09524	13.8885	0	49	19.31371	23	0.9197	17.762826	0.601358	
22	11	27.81818	7.040145	14	42	19.8995	28	1.809045	35.999082	0.253077	134.8463
23	13	39.92308	8.712649	26	49	25.55635	43	1.965873	50.240537	0.218236	
24	35	28.2	14.77438	0	47	51.45584	32	1.470167	75.648683	0.523914	
25	11	33.72727	12.4747	11	46	16.72792	35	1.52072	25.438489	0.36987	
26	12	26.41667	17.81959	0	49	21.31371	35	1.776142	37.856181	0.674559	
27	14	25.14286	13.49562	0	49	24.14214	29	1.724438	41.631622	0.536758	
28	11	28.09091	16.72396	2	47	14.72792	35	1.338902	19.719244	0.595351	
29	30	34.7	13.88661	2	49	45.1127	40	1.503757	67.838518	0.40019	
30	237	7.953586	13.45024	0	51	84.56854	0	0.356829	30.176533	1.691091	
31	34	28.38235	11.42834	7	49	40.28427	30	1.184832	47.730074	0.402657	
32	29	32.24138	14.20175	1	49	44.87006	37	1.547243	69.424899	0.440482	
33	43	27.62791	15.12019	0	49	61.59798	29	1.432511	88.239793	0.54728	
34	30	36.06667	10.19443	8	49	36.87006	37	1.229002	45.313372	0.282655	
35	15	26.4	14.7251	0	46	25.31371	30	1.687581	42.718923	0.557769	
36	16	38.0625	7.103696	28	49	28.14214	37	1.758883	49.498737	0.186632	
37	10	34.5	12.40296	5	46	12.48528	40	1.248528	15.588225	0.359506	
38	301	17.31229	15.53219	0	81	152.4092	14	0.506343	77.171272	0.897177	
39	15	22.73333	16.04221	0	46	16.48528	25	1.099019	18.117633	0.705669	
40	19	37.68421	9.273934	15	49	26.04163	40	1.370612	35.692975	0.246096	
41	24	37.54167	6.007091	28	47	26.38478	37	1.099366	29.006518	0.160011	
42	30	36.26667	11.02953	14	49	27.2132	42	0.907107	24.685281	0.304123	
43	80	40.1375	8.360158	16	70	50.76955	40	0.634619	32.219343	0.208288	
44	68	39.69118	6.265893	23	51	58.42641	40	0.859212	50.200662	0.157866	

45	115	17.93913	14.61511	0	49	51.59798	14	0.448678	23.150883	0.814706	
46	24	17.33333	16.24183	0	47	16.72792	18	0.696997	11.659307	0.937029	
47	35	22.02857	15.87911	0	47	22.72792	19	0.649369	14.758813	0.720842	
48	179	23.72626	12.19771	0	49	107.4975	23	0.600545	64.557023	0.514102	
49	29	37.48276	7.688678	14	49	38.28427	37	1.320147	50.540877	0.205126	
50	13	27.53846	12.35324	4	44	15.65685	30	1.204373	18.856699	0.448581	
51	213	42.53991	7.647577	25	67	171.6224	43	0.805739	138.282801	0.179774	
52	45	41.42222	12.03685	18	81	45.1127	40	1.002504	45.225679	0.290589	
53	27	23.7037	14.84229	1	49	20.72792	22	0.767701	15.912843	0.626159	
54	348	22.41667	12.95465	0	53	98.2254	19	0.282257	27.724795	0.577903	
55	13	43.15385	5.785703	36	56	15.8995	42	1.223038	19.445688	0.134072	
56	181	35.66851	12.29004	0	56	134.267	39	0.741807	99.600191	0.344563	
57	22	39.81818	13.06262	22	79	28.97056	43	1.316844	38.149705	0.328057	
58	54	43.87037	5.576387	32	56	34.62742	46	0.641248	22.204778	0.127111	
59	10	47	2.054805	42	49	18.14214	47	1.814214	32.913708	0.043719	
60	11	39.36364	5.679309	32	49	21.79899	37	1.981726	43.199633	0.144278	
61	128	44.67188	7.110057	21	65	70.91169	46	0.553998	39.284903	0.159162	

Table IV Result SetI

Sr No.	BG Area	BG Mean	BG StdDev	BG Min	BG Max	BG Perim.	BG Median	BG P/A	BG Complexity	BG Pow To Mean
1	665626	124.2033	41.74439	0	255	5511.11	114	0.00828	45.629724	0.336097

Table V Result SetII