UTLIZIATION OF RADARSAT FOR FORECASTING OIL SLICKT RAJECTORY MOVEMENT

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Abstract

This study presents work to utilize RADARSAT SAR image for forecast oil slick trajectory movement. The fractal dimension algorithm used to detect oil slick. The Doppler frequency shift and quasi-linear model was used to simulate a current pattern from RADARSAT image. The Fay's algorithm of oil slick spreading was developed based on a Doppler frequency shift model. Thus, the study shows that fractal dimension algorithm discriminated the oil slick from the surrounding water features. The quasi-linear model shows that the current pattern can be simulated from single RADARSAT image. The oil slick trajectory model shows that after 48 hrs, the oil slick parcels deposited along the coastal waters.

Introduction

Spaceborne RADARSAT SAR image may be employed as monitoring and controlling tool. The oil slick detection mechanisms by SAR images have been reported in several literatures (Maged and Genedern, 2001). They agreed that the presence of surface films reduces roughness of surface water. The oil slick resulted in the detection algorithms have been received a lot of attention between scientists. For instance, classification algorithms, based on pattern recognition and frequency spectrum attention (Fukunaga 1990). Anne et al., (1999) employed the probability density spectra model as automatic detection of oil slicks. The main objective of this study is to utilize SAR image for oil slick spreading forecast. This study will not investigate the effect of wind on oil slick parcels spreading.

Fractal Dimension Algorithm

Oil slick detection tool was consisted of fractal algorithm. The fractal algorithm which used to detect the self-similar characteristics of RADARSAT SAR image intensity variation. A box-counting algorithm was used in this study. The box counting estimator of fractal dimension divided a convoluted line of slick, which was embedded in the image plane in smaller and smaller boxes. This processes could be done by dividing the initial length of convoluted line at backscatering $\boldsymbol{b}_s$ by recurrence level of the iteration (Li, 2000). Define a decreasing sequence of backscatering $\boldsymbol{b}_s$ tending from $\boldsymbol{b}_0$ the biggest value to less than or equal zero. The fractal dimension D($\boldsymbol{b}_s$) as a function of RADARSAT SAR image intensity $\boldsymbol{b}_s$ can be given by

$$D(\boldsymbol{b}_s) = D_B = \lim_{s\to\infty} \frac{\log M(\boldsymbol{b}_s)}{-\log(\boldsymbol{b}_s)} \qquad (1.0)$$

where $M(\boldsymbol{b}_s)$ is denoted the number of boxes which needed to cover the RADARSAT SAR contour backscatters $(\boldsymbol{b}_s)$. The number of boxes were produced by fractal dimension algorithm having side length l_s needed to cover a fractal profile varies as $\boldsymbol{b}_s^{-D}$ where D is the fractal dimension that is to be estimated.

Oil Slick Spreading and Trajectory Models

Once the tidal current velocities and the rate of spreading are modeled from RADARSAT image, it is easy to establish the trajectory model of oil slick. The oil slick trajectory movements can be derived from equation 2.0 by using Lagrangian model. The parcel of oil slicks are divided into a large number of Lagrangian parcels of equal size. At each time step, each parcel is given a diffusive and a convective displacement as follows. We assumed that the initial position (x_i, y_i) of spreading $S(t)_i$ in position of the 1^{th} parcel and the first guess position of oil slick spreading is $S'[(t+\Delta t)_i]_{i+1}$. The velocity vectors are linearly interpolated in both space and time. The first guess position can be given by

$$S'(t+\Delta t)_{i+1} = S(t)_i + [V(S(t+\Delta t)_i]_{i+1,j} \qquad (2.0)$$

and final position can given by

$$S(t+\Delta t)_{i+1,j} = S(t)_{i,j+1} + 0.5\left[V(S,t) + V(S',t+\Delta t)\right]_{i+1,j}\Delta t \qquad (3.0)$$

Trajectories are terminated if they exit the model down to the water depth, but the advection continues along the surface. The integration time step Δt can vary during the simulation

Results and Discussion

Figure 1 shows the result of fractal dimension output. Fractal dimension map shows a good discrimination between different textures on the RADARSAT SAR image. It is obvious that the oil slick area has a sharp peak at narrow range of RADARSAT SAR backscatter. It is obvious that the sea surface is dominated by wide peak of fractal dimension which ranged between 2.59 and 2.63 while the oil spills have different value of fractal dimension ranged between 2.03 and 2.43 (Figure 1). In an statistical fractal set, the interference looks statistically similar if the scale is reduced. This finding is similar to study of Benelli and Garzelli, (1999). It can be suggested that fractal analysis can be used as good method to discriminate oil slick from surrounding water features.

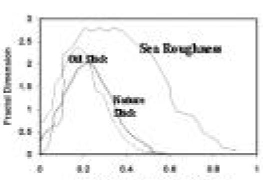

Figure 1. Fractal Dimensional Profile.

Figure 2 shown that the parcels started to move along the range direction with 24 hrs. It might be the effect of easterly tidal current components value of 0.2 m/s will assist to move the oil slick parcels towards the west coastline of Peninsular Malaysia. From the above results, it is not difficult to find out the characteristics of the oil slick ' s drift and spreading. The oil slick ' s spreading exists mainly in the initial several hours; afterwards, only the surface shape changes; and the area change is significant. In this model, the initial oil slick is assumed as irregular distribution. Under the effects of tidal current components variation which makes oil slick spread rapidly in the initial several hours.

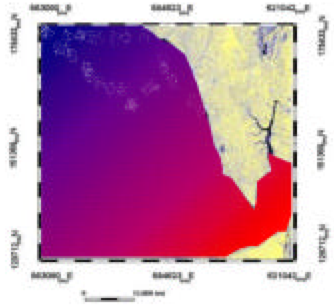

Figure 2 Simulated Trajectory Movement from RADARSAT SAR image after 24 hrs.

The trajectory model of this study does not agree with the previous study done by Assilzadah and Mansor (2001). The oil slick spreading pattern simulated from Assilzadah and Mansor (2001) does not show an elliptical pattern but rectilinear pattern. This does not agree with Fay s' theory of oil slick spreading. According to Fay s' algorithm, the oil slick might be spread in elliptical pattern. This is because of the fact that Assilzadah and Mansor (2001) did not show attention to the tidal current effect on the oil slicks spreading. Assilzadah and Mansor (2001) have failed to establish any relation between surface current movement imagined from RADARSAT image and oil slick areas appear in RADRASAT image.

Conclusion

The utilization of RADARSAT for oil slick detection has been implemented by fractal dimension algorithm. The fractal dimension algorithm can be used as automatic tool to discriminate between oil slick and the other surface features such as look-alikes and surface roughness. The oil slick in fractal map has a lower backscatter ranged from 0 to 0.27 with sharp peak of fractal dimension D(i) which is 2.43

References

Assilzadah, H. and S.B. Mansor, " Early warning System for Oil Spill Using SAR Images". *Proceeding of 22 th Asian Conference* 5- 9 November 2001, Singapore, Vol II, pp: 1143-1149, 2001

Anne, H., S., Solberg, S.Geir, S. Rune and E. Volden, 1999. " Automativ Detection of Oil Spills in ERS SAR Images. IEEE Transactions on Geo. & Remote Sen. 37 (4): 1916-1924.

Benelli, G. and A. Garzelli, 1999. "Oil-spills Detection in SAR Images By Fractal Dimension Estimation". Proceedings of IGARSS'99, 28 June - 2 July, Homburg, Germany. Vol II, pp: 1123-1126.

Fiscella, B. A. Giancaspro, F.Nirchio,P.Pavese and P.Trivero, 2000. Oil Spill Detecting Using Marine SAR Images. Int.J.Remote Sensing. (12)(18), 3561-3566.

Fukunaga,K., 1990. Introduction to Statistical pattern Recognition, 2nd edition (New York: Academic Press.

Maged, M. and J. Genderen, 2001. Texture algorithms for oil Pollution Detection and Tidal Current Effects on Oil Spill Spreading. Asian J. Geoinformatics, 1, 33-44.