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Inversion of the scattering model to estimate oil slick parameters based on ANN

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1. Introduction

The oil thickness distribution is as important as the spatial distribution of oil slicks, which is beneficial for proper choice of response methods and spatial allocation of response resources, as well as for legal purposes for prosecution. Although SAR sea oil slick surveillance is a mature enough application to monitor sea environment, the estimation of ancillary information related, e.g., to oil's thickness and fraction water content is still a challenging task.

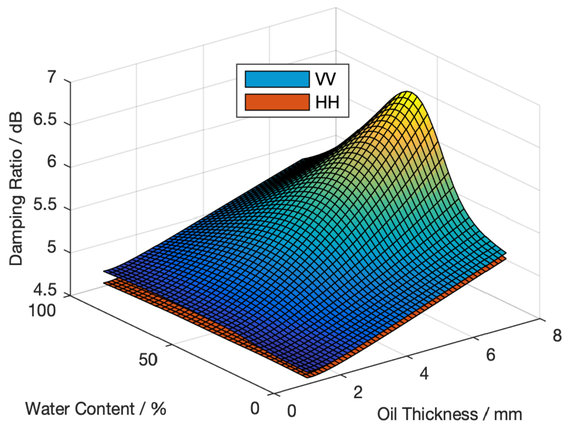
Recently, artificial neural network (ANN) has been developed rapidly and applied extensively in the field of quantitative remote sensing. The inversion of oil parameters is carried out by the multi-layer perceptron of ANN technique, which is trained and validated by the data simulated using the forward model. And the trained NN is applied to the UAVSAR data acquired during the DWH oil accident to estimate the oil thickness as well as the volumetric water-in-oil fraction.

2. Methodology

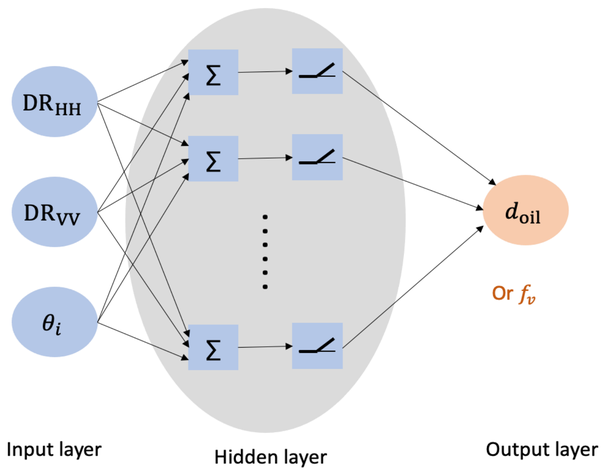
- To generate training dataset for the neural network by forward electromagnetic scattering model
- To train the neural network and adjust the structure and parameters of the network
- To test the NN using the other different simulated dataset
- To retrieve the parameters of oil slicks by applying the adequately trained NN to actual SAR measurements.

(1) Forward Scattering Model

$$DR_{pq}(\theta_i, d, f_v) = \frac{\sigma^0_{pq}}{\sigma^{0,s}_{pq}}$$

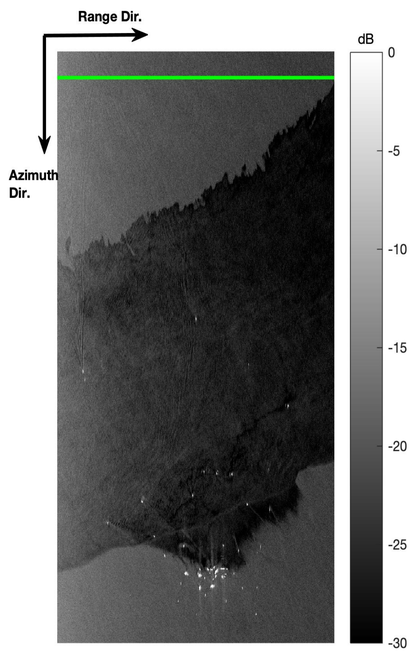


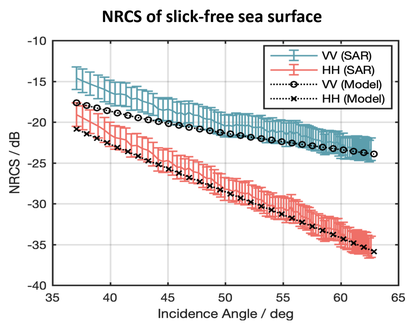
(2) Structure of ANN

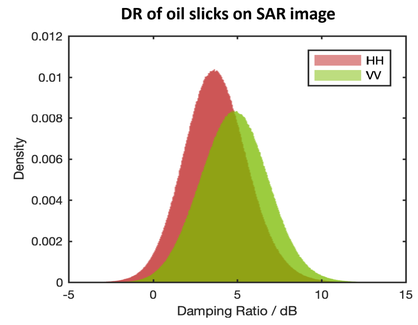


3. Inversion Results

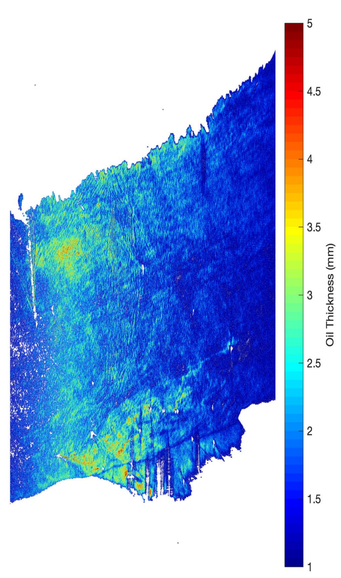
(1) UAVSAR data



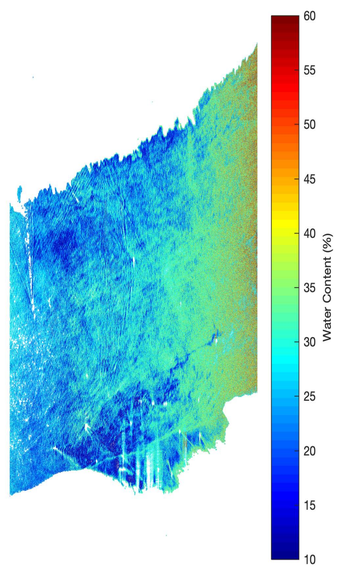




(2) Inversion Results



Inversion results of oil thickness



Inversion results of water content

4. Conclusion

- An inversion method based on ANN to estimate parameters of emulsion oil, namely the thickness of the oil slick and the volumetric fraction of seawater, has been proposed based on the forward scattering model. The NN is trained and tested by the model simulated datasets, and then it can be applied to L-band dual-polarimetric radar imagery collected by UAVSAR during the DWH oil spill accident.
- The inversion results indicates that the thicker emulsion oil with thickness about 2 – 4 mm locates in the middle of the slick, while thin films have thickness less than 1 mm. And the DWH oil slick has about 20% - 30% seawater mixed with the crude oil.
- Future efforts will be made to collect actual oil parameters including thickness, volume fraction, and viscosity etc. in the real marine environment to correct the training of NN and the scattering model.

References

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