Machine Learning Receiver Deghosting - Shallow Water OBN Data Example

Rolf Baardman[1], Rob Hegge[1], Jewoo Yoo[1]

[1]Aramco Overseas Company BV.

Abstract

Objectives/Scope:
Receiver deghosting for multi-component acquisition is a crucial early step in the processing flow. The complimentary behavior of the notches in the recorded pressure P (hydrophone) and particle velocity V_z (geophone) fields is utilized in the commonly used PZ-summation method. This method can offer good deghosting results but relies on a few pre-processing steps that can be cumbersome and user-intensive. A supervised machine learning (ML) approach is introduced to offer a user-friendly, parameter-free method that can be applied to the recorded gathers without any preprocessing. Shallow-water synthetics and field data tests are conducted to investigate the generalization and robustness of the method.

Methods, Procedures, Process:
The proposed supervised ML-method uses a convolutional neural network (CNN) with a two-channel input layer (P and V_z) and an output layer containing the up-going pressure data as label. Synthetic gathers modeled from simple 1.5D subsurface models are used to train the network. This way, the generation of training data and the network training itself are kept very efficient to reduce turn-around time. The learned deghosting network is first tested on a controlled shallow-water data example including the impact of the typically noisier geophone recordings, and afterwards on a shallow water OBN field data example. For both examples, the proposed ML method is compared to an industry-standard PZ-summation approach.

Results, Observations, Conclusions:
Training data are modelled on three 1.5D models with water depths of respectively 50, 120 and 200m. Approximately 18.000 patches of 120 samples by 50 traces are randomly selected as training data. The trained network is first tested on a controlled 25m shallow-water data example modelled with a different wavelet compared to the training data. To mimic a more realistic situation, geophone data with a SNR of 20 was used while the hydrophone data was kept noise free. Both the ML and an industry-standard PZ-summation methods were applied to this data. Looking at the mismatch with the reference, the ML method showed better signal reconstruction. The noisy geophone data prevented the PZ-summation method to retrieve the optimal matching filter leading to suboptimal results. Next, we ran and compared the ML and PZ-summation methods for a shallow water OBN data example. To obtain the matching filters for the PZ-summation method, the data was stacked in the receiver domain from which a user-defined window was selected with optimal SNR. The ML method could be directly applied to the input P and V_z gathers without any additional processing. Comparing the final stacked sections showed better sharpness and continuity for the ML method. This, in combination with the higher user-friendliness, shows that the proposed ML multi-component deghosting method offers a good alternative to existing methods.