Ground Roll Suppression Via a Blind-fan Network

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Abstract

Objectives/Scope:
Ground roll is a type of coherent noise characterized by high amplitude, low velocity, and low frequency in land seismic data, badly masking useful signals. Seismic data acquired in desert environments, typical in the Middle East, especially suffer from ground roll contamination. The proposed blind-fan network suppresses ground roll by training a network without requiring clean labels - using the raw field data as the network’s target and a corrupted version as its input.

Methods, Procedures, Process:
In this study, a UNet is trained to predict a central pixel’s value without using pixels along the ground roll direction. The network’s target is the raw field data while the input is a corrupted version of the target. To corrupt, all the pixels along the slope between a randomly chosen pixel within a shot gather and the source location are replaced by random values. A similar signal density is ensured by removing some mask lines at shallow layers. The training loss is only computed on the corrupted pixels. Once trained, the network is applied to the full shot gathers.

Results, Observations, Conclusions:
The procedure is applied to both synthetic and field data. For synthetic data, the denoised result shows that the method can recover the reflection events and suppress the ground roll well, especially at shallow layers, with a higher Peak Signal-to-Noise Ratio (PSNR) of 39.59dB in comparison to the original noisy data that had a PSNR of 33.81 dB. For field data, the ground roll and reflections are well separated, with noticeably more continuous reflections in the denoised result, especially at shallow layers. In both scenarios, a slight amount of signal leakage is observed for both synthetic and field data - a topic for continued research. Training a network on corrupted data utilizing a blind-fan mask, with the raw data as the network’s target, can suppress ground roll without requiring clean labels. The masking scheme blinds the ground roll information and only exposes the signal information within the receptive field to be learned for a central pixel’s prediction. By training the network by utilizing the loss on only the corrupted pixels, the resulting trained network can predict a pixel’s value by only utilizing the pixels outside of the predefined ground roll fan area.

Novel/Additive Information:
Previous self-supervised procedures suppress simple noise signals where the mask design is trivial, e.g., trace-wise. Since ground roll is source-generated, hiding the ground roll in noisy data requires a fan-shaped mask. A network trained on noisy data-masked data pairs predicts a central pixel’s value based on the pixels outside of the masked area. The ground roll suppression results highlight the scheme’s potential in noise attenuation applications of other inherently complex and coherent seismic noise signals.