The Borga transform and some applications in seismic data analysis

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The Borga transform

In recent years the Gabor transform has seen an increase usage in seismic data processing and analysis. We present the adjoint of the Gabor transform: the Borga transform. The Gabor transform uses the operation of first windowing and then Fourier transform while the Borga transform reverses the order so that the window is applied in the frequency domain. The result is a real-valued time-frequency decomposition that is essentially a complete set of filter slices.

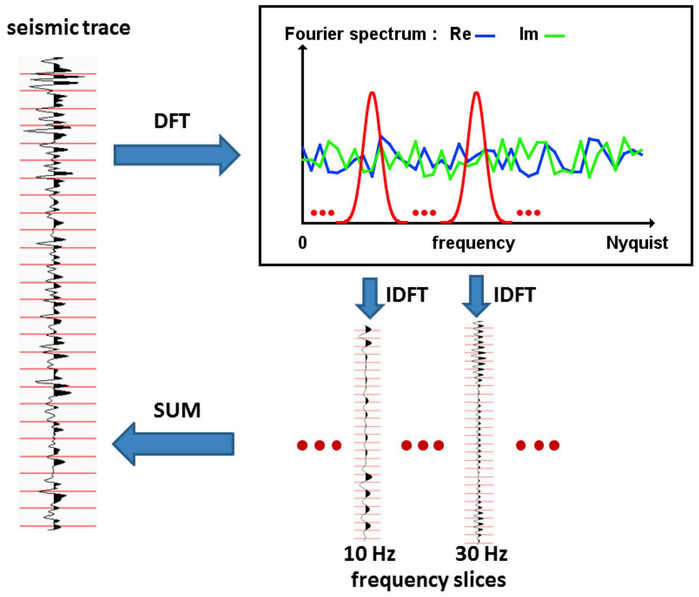

Fig. 1: Flow chart of the Borga transform.

Computational steps:

- Compute the complex Fourier spectrum of the seismic trace via DFT
- For each frequency, multiply the spectrum with a Gaussian window, centered at the frequency
- IDFT of the windowed spectrum

After repeating for all frequencies we compute a series of frequency slices.

The inverse Borga transform is completed by summing all frequency slices. The inverse process reconstruct the input seismic trace exactly.

CMP gather noise attenuation

Seismic noise can be band-limited in nature and have anomalous amplitudes.

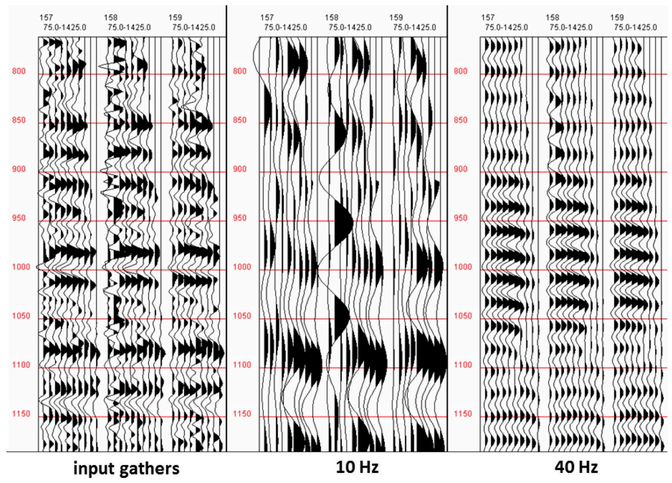

Fig. 2: Blackfoot CMP NMO-corrected gather and two Borga frequency slices at 10 Hz and 40 Hz. The 10 Hz slice shows a trace with high amplitude noise, while the 40 Hz is relatively clean.

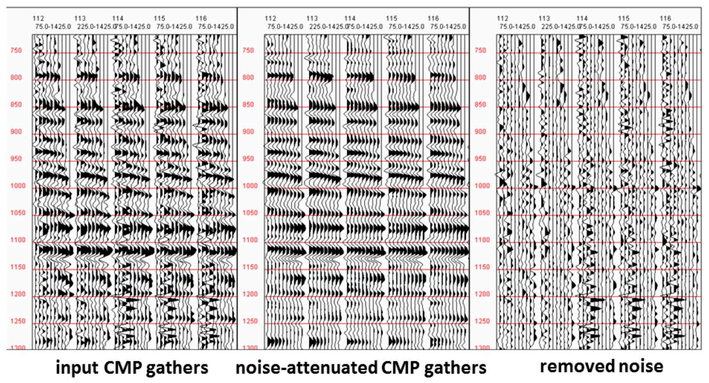

Fig. 3: CMP NMO-corrected gather noise attenuation. The gather is decomposed into frequency sliced gathers. For each time, the amplitudes are estimated by local linear least-squares fit. The amplitude with the largest error is corrected. The process is repeated until the error is small. The noise attenuated gather is reconstructed by summing all frequency-sliced gathers.

Frequency-dependant high-amplitude data separation

The Borga transform decomposes the single sample seismic amplitude into frequency dependant amplitudes. By sorting and defining a cutoff value one can separate the anomalously high-amplitudes.

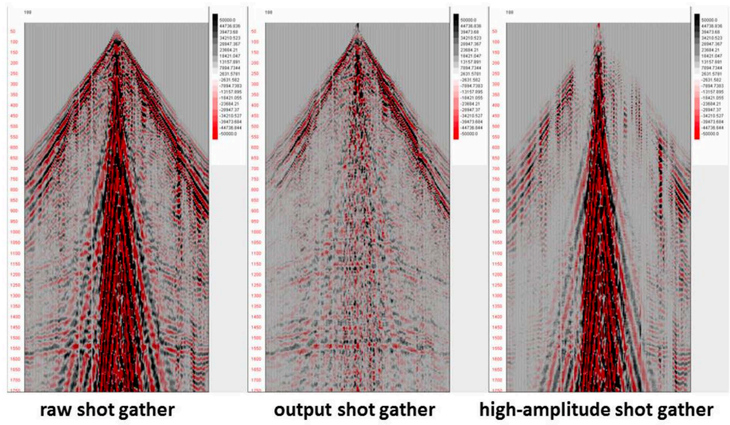

Fig. 5: Input shot gather from the Blackfoot survey has been separated into two gathers, one with ‘reasonable’ amplitudes and one with very high amplitudes, mostly ground roll.

Time-variant spectral whitening

The Borga transform decomposes the seismic trace into a complete set of filter slices, which makes it a natural candidate to perform time-variant spectral whitening.

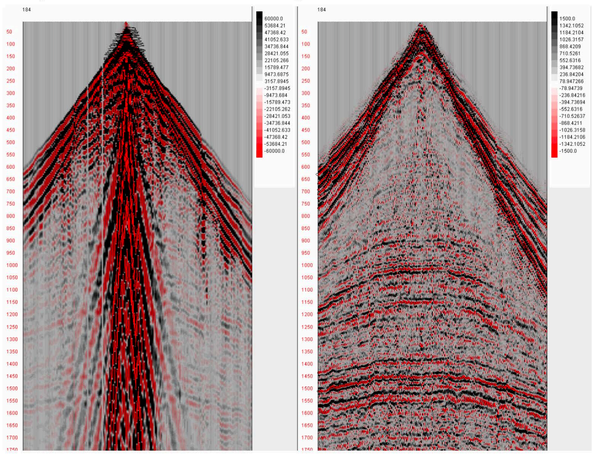

Fig. 6: Shot gather time-variant spectral whitening.