Wavelet Compression and Error Analyses on Processing in Wavelet Domain

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Innovations in seismic data recording technology has brought about an increase in recorded data which also increases the necessity to look at improving data storage and data motion options. Lossy compression presents a way of reducing storage costs at the cost of a little reduction in data quality.

Our research focus is on using wavelet decomposition and thresholding as a way to perform lossy compression as well as improving the efficiency of processing for passive seismic data. Wavelet decomposition expresses signals as a linear combination of wavelets. The wavelet coefficients are then thresholded to achieve compression. The sparsity in the wavelet coefficients means we can retain high quality data even after thresholding. Another advatage is the localization of wavelets in time and frequency which allows a good chance of retaining the resolution in the data after compression. There are some processing steps that can be carried out in the wavelet domain, reducing the computational effort needed to decompose and reconstruct data between storage and processing.

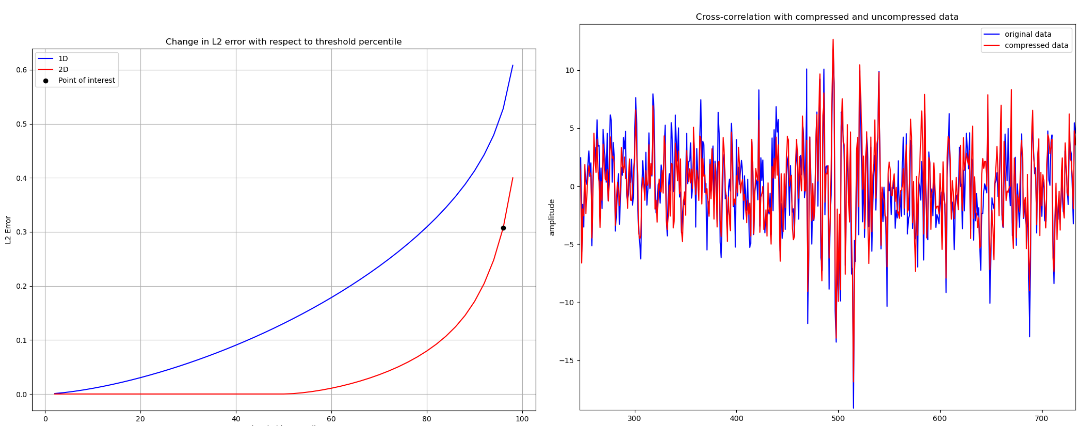

Figure 1. Comparison of 1D and 2D wavelet compression(left) with point showing level of compression for data used in cross-correlation in image on the right

One aspect of our research involves investigating the errors produced in passive seismic data for different levels of thresholding, the dependence of these errors on the distribution of coefficients for the data and developing a way of computing an adaptive threshold based on this distribution. We also investigate how these errors are propagated when processing thresholded data. The images illustrate the difference in cross-correlation we may get when we use compressed data. Here, even with a threshold percentile as high as 96%, we only see differences in amplitude but the location of various peaks seem to be preserved. The research is particularly relevant to Distributed Acoustic Sensing (DAS) data which are often recorded at dense spacing and can become large very quickly. This type of data can be viewed as a two-dimensional data recorded in time and space. To investigate how doing a two-dimensional decomposition on this form and doing one-dimensional decomposition on each individual channel compare, we study the amount of compression that can be achieved (left image), processing advantages and effects of compression on event detection in each case.