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Research paper

Random noise attenuation in seismic data using Hankel sparse low-rank approximation

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Abstract

The Hankel matrix's low-rank property derived from the noise-free seismic data describing a few linear events and has been successively leveraged in many low-rank seismic data de-noising approaches. In such rank reduction methods, the typical scheme is to determine the best low-rank estimation of the formulated Hankel matrix, and then obtain the de-noised data. However, if the noisy data has been rearranged for the low-rank approximation in a Hankel matrix, it is usually not precisely low-rank. In the presented research, we propose a multivariate generalization of the minimax-concave penalty (MCP) function inducing sparsity on seismic data in the time-space domain. Initially obtained sparse representation of data would be decomposed into semi low-rank and the sparse components with the best approximate of noisy measurement matrix would be defined. This would be performed through the low-rank matrix extraction by optimal (re)weighting of the singular vectors of the observed matrix. The efficiency of the proposed method was evaluated on synthetic and real land data examples. Results were also compared with the state-of-art methods such as the non-local means (NLM), the Optimum Shrinkage Sparse Low-Rank estimation, the Optimum Shrinkage Synchrosqueezing Wavelet Transform and the damped rank reduction (DRR) methods. Qualitative and quantitative comparison of results approved capabilities of the proposed method compared to other selected noise attenuation method.