

A Compressive Sensing Seismic Data Reconstruction Approach Based on Accelerated Iterative Threshold

Lieqian Dong, Mugang Zhang, Xueyong An, Datong Zhou, Yunlei WangDong

BGP, CNPC

Abstract

Compressive sensing (CS) breaks through the limitation of Nyquist theorem and provides a new framework for sampling signals and wave-fields, which suggests that a signal can be recovered from a small number of “advantageous” samples if certain criteria are met (a sparse representation of the target signal in some transform domain). Borrow the idea of CS to seismic exploration, CS seismic exploration can reduce production cost or increase trace density at the same cost, which brings much attention to industry. However, the major challenge of CS seismic exploration is from the missing data reconstruction, especially the reconstruction speed and accuracy of massive CS seismic data. In the paper, a compressive sensing seismic data reconstruction approach based on accelerated iterative threshold in 3D curvelet domain is proposed and the approach has the following highlights. First, an accelerated iterative threshold algorithm is developed to boost the convergence speed and improve reconstruction accuracy. Compared with conventional iterative threshold algorithm with computational complexity of $O(1/k)$, the convergence speed of the new algorithm is only $O(1/k^2)$. Therefore, the reconstruction speed is greatly improved. Second, the parallel 3D block-curvelet transform is adopted to improve the high computational redundancy of 3D curvelet transform and boost the computational efficiency of the reconstruction algorithm. Third, an interpolation CS operator is built to relieve the adversary influence to reconstruction accuracy because of source/receiver point deviation from pre-defined grid. Finally, we demonstrate the effectiveness of the proposed approach by simulated and field datasets.