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Seismic signal time-frequency analysis based on multi-directional window using greedy strategy

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Abstract

Wigner-Ville distribution (WVD) is an important time-frequency analysis technology with a high energy distribution in seismic signal processing. However, it is interfered by many cross terms. To suppress the cross terms of the WVD and keep the concentration of its high energy distribution, an adaptive multi-directional filtering window in the ambiguity domain is proposed. This begins with the relationship of the Cohen distribution and the Gabor transform combining the greedy strategy and the rotational invariance property of the fractional Fourier transform in order to propose the multi-directional window, which extends the one-dimensional, one directional, optimal window function of the optimal fractional Gabor transform (OFrGT) to a two-dimensional, multi-directional window in the ambiguity domain. In this way, the multi-directional window matches the main auto terms of the WVD more precisely. Using the greedy strategy, the proposed window takes into account the optimal and other suboptimal directions, which also solves the problem of the OFrGT, called the local concentration phenomenon, when encountering a multi-component signal. Experiments on different types of both the signal models and the real seismic signals reveal that the proposed window can overcome the drawbacks of the WVD and the OFrGT mentioned above. Finally, the proposed method is applied to a seismic signal's spectral decomposition. The results show that the proposed method can explore the space distribution of a reservoir more precisely.

Key words: Greedy strategy; Cohen distribution; Fractional Gabor transform; Cross terms suppression; Spectral decomposition of seismic signals.

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