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Finite-aperture slant-stack transforms

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ABSTRACT

I derive accurate and efficient algorithms for computing least-squares inverses of the slant-stack and related time-invariant linear transforms. Conventionally, the inverse transform is computed assuming inifinite aperture of the array - then the inver is simply the conjugate of the forward transform followed by a rho-filter. While considerably cheaper to compute, the infinite-aperture transform introduces more artifacts than the finite-aperture least-squares inverse transform. The new algorithms bring down the cost of applying the least-squares inverse transform to nearly the cost of applying the infinite-aperture inverse. The efficiency of the algorithms results from the observation that the matrix of normal equations has a Toeplitz structure, even for data that are irregularly sampled or non-uniformly weighted in offset. To ensure the numerical stability of the least-squares inverse, I introduce a sampling rate in ray-parameter that depends on frequency and corresponds to a uniform sampling in wavenumber.

Examples with synthetic and field data illustrate two applications of the slant stack transform interpolation and dip-filtering. The examples confirm that pairs of finite-aperture forward and least-squares inverse transforms introduce less artifacts than other, conventional transform pairs.

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