Multiwindow Gabor-type Representations and Signal Representation by Partial Information

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ABSTRACT

Harmonic analysis has been the longest lasting and most powerful tool for dealing with signals and systems which involve both periodic and transient phenomena. Further impact on signal processing was facilitated by what we refer to as representations in combined spaces. These representations, motivated by Gabor's concept of time-frequency information cells have evolved in recent years into a rich repertoire of Gabor-type windowed Fourier transforms, relating Fourier analysis to the Heisenberg group. Such localized bases or frames are useful in the representation, processing, compression and transmission of speech, images and other natural signals that by their very nature are nonstationary. To incorporate scale that lends itself to multiresolution analysis as is the case with wavelets, the Gabor scheme is generalized to multiwindow Gabor frames. The properties of such sequences of functions are characterized by an approach that combines the concept of frames and the Zak Transform. Results on signal representation and reconstruction from partial information in the frequency domain are related to and derived, using relevant results obtained in the time or positional information domain. Some results concerning the representation of Fourier-transformed discrete time (finite) sequences by partial information are rederived by exploiting the duality of the Fourier-Stieltjes transform and its inverse. Results related to discrete signals are extended to continuous one-dimensional signals. Signal and image representation by phase only information is considered also in the context of localized (Gabor) phase, where restoration of magnitude by iterative techniques is much more efficient than in the case of global (Fourier) phase.