ABSTRACT

We have carried out the analysis of various signals using chirp transform employing chirps as an expansion set. The orthogonality, linear dependency of the expansion set, and some simple properties, like the magnitude response, have been investigated. A divide and conquer approach has been used to iteratively estimate the components in a multicomponent scenario. Wigner-based estimation of the spectrum and short-time Fourier transform with optimized windows has been proposed. Since, we have been using chirp signals as the expansion; we have considered its use in system identification.

With enough motivation given to tile the time-frequency plane in an arbitrary fashion, we have considered chirplets to represent the signal. A unified approach to signal analysis/synthesis based on these chirplets has been proposed. The spectrogram of the signal to be analyzed/synthesized has been modeled as a mixture of bivariate normal pdfs. The parameters of the chirplets are estimated using the incremental variant of the EM algorithm. K-Means clustering algorithm has been used prior to mixture modeling to classify the realizations generated from the band-rejection algorithm that acts as initial estimate to the EM algorithm. By comparing a bivariate normal pdf and spectrogram of a Gaussian amplitude modulated chirp signal, a set of mapping rules have been derived that will directly synthesize the signal corresponding to the component of the mixture density. The rules have been analyzed with an insight into chirplet decomposition and how different t-f tilings can be obtained.

While addressing the implementation aspects of the time-frequency representations using time-recursive approach, we have reviewed the architectures of the short-time Fourier transform (STFT). We have proposed a trivial, yet novel, pre-processor to avoid buffering time in computing the discrete Fourier transform of non-sequential data using the time-recursive approach. The architectures of the STFT have been extended to generalized time-frequency distributions (GTFDs) having real-valued kernels. The algorithm exploits the symmetry and real-valuedness of the GTFDs to reduce the computational complexity. Later, the concept has been extended to running windowed GTFDs that takes into account the overlapping between adjacent window shifts.