Parameter Estimation of Multicomponent Transient Signals Using Deconvolution and Arma Modelling Techniques

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Abstract

Parameter estimation of transient signals, having real decaying exponential constants, is a difficult but important problem that often arises in many areas of scientific disciplines. The frequency domain method of analysis that involves Gardner transformation and conventional inverse filtering often degrades the quality of the deconvolved data, leading to inaccurate results, especially for noisy data. An improved method that is based on the combination of Gardner transformation, optimal compensation deconvolution, and signal modelling techniques is suggested in this paper. In this method of analysis the exponential signal is converted to a convolution model whose input is a train of weighted delta function that contains the signal parameters to be determined. The resolution of the estimated decay rates is poor if the conventional fast Fourier transform (FFT) algorithm is used to analyse the resulting deconvolved data. Using an autoregressive moving (ARMA) model whose AR parameters are determined by solving high-order Yule–Walker equations (HOYWE) via the singular value decomposition (SVD) algorithm can alleviate this shortcoming. The effect of sampling conditions, noise level, number of components and relative sizes of the signal parameters on the performance of this modified method of analysis is examined in this paper. Simulation results show that high-resolution estimates of decay constants can be obtained when the above signal processing techniques are used to analyse multiexponential signals with varied signal-to-noise ratio (SNR). This approach also provides a graphical procedure for detecting and validating the number of exponential signals present in the data. Some computer simulation results are presented to justify the need for this modified method of analysis.

Keywords: Parameter Estimation, Multicomponent Transient Signals, Deconvolution, Arma Modelling Techniques

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