Abstract

Due to the properties of preserving phase and magnitude and suppressing Gaussian noise, the higher-order spectra (especially bispectrum) has been used for many applications in signal processing.

The thesis mainly deals with the problems related to recovery of the phase of system (or signal) from the bispectrum, recovery of the noise corrupted signal from the bispectrum, deconvolution of signals in the presence of noise and identification of nonminimum phase systems.

In this thesis four new algorithms which provide interesting extensions to some of the existing algorithms are proposed. The proposed algorithms are computationally attractive since they do not require any phase unwrapping or any solution of system of equations. The effects of aliasing in the phase estimates of the proposed algorithms have been discussed in the thesis. It has also been shown that two of the proposed algorithms give the least squares estimate. It has been shown by simulations that the methods presented in this dissertation are not restricted to linear stochastic processes only; they can as well be used for phase recovery of discrete deterministic signals from the bispectrum.

In this thesis the problem of reconstruction of a discrete deterministic signal from bispectrum of noisy observations have been addressed. The signal is reconstructed by estimating the complex cepstrum from its bispectrum. If the z-transform of a signal consists of zeroes on or close to the unit circle then the computations of the complex cepstrum from the bispectrum become practically difficult and sometimes impossible. The 2-D exponential weighting on the estimate of third-order moment sequence has been used to overcome this problem. Two new strategies to reconstruct signal from exponentially weighted third-order moment have been developed. One of these algorithms utilizes partial information, while the other uses complete information of the partial derivative of the complex logarithm of the Fourier transform of

exponentially weighted third-order moment. The exponential weighting has been effectively utilized, and an efficient algorithm requiring only magnitude information of the Fourier transform of exponentially weighted third-order moment has been developed for the reconstruction of the signal. It has also been shown that the estimates of bispectral phase of a non-zero mean signal are unbiased at all frequency pairs. Using the techniques developed in the thesis the phase of the signal from the bispectrum is estimated and existing phase-only reconstruction algorithms are applied on the estimated phase to reconstruct the desired signal. In addition, the simplified versions of the existing closed-form solution for phase-only reconstruction of the signal have been derived. Based on the closed-form techniques the least squares solution for phase-only reconstruction has been given. The simulation results for the reconstruction of noisy signals are presented in the thesis.

Several schemes for phase-only blind deconvolution in the presence of observation noise through the bispectrum using closed-form solutions and iterative techniques have been proposed in this thesis. The Gaussian observation noise is filtered by computing the average bispectrum of the observed signal. The phase of the desired signal is estimated from the bispectrum using the techniques presented in the thesis. The phase-only reconstruction algorithms have been applied on the estimated phase to reconstruct the desired signal. A computationally efficient method which utilizes only magnitude information for phase-only blind deconvolution using bicepstrum iterative reconstruction algorithm (BIRA) has been proposed.

In this thesis methods for identification of nonminimum phase MA, AR and ARMA linear time-invariant systems driven by non-Gaussian white noise have been proposed. The complex cepstrum of the system is estimated from the bispectrum of the system output using the methods proposed in the thesis. Once the complex cepstrum of MA or AR system is computed, the estimation of parameters is a straightforward process. The identification of parameters of ARMA model is based on the theory of phase-only reconstruction. The complex cepstrum estimated from the bispectrum of the output of ARMA system decomposes the maximum and minimum phase parts of the system. From the phase information of the minimum and maximum phase parts of the system, MA and AR parameters are identified separately by using phase-only reconstruction algorithms. The existing phase only reconstruction algorithms (closed-form solution and iterative techniques) have been used to identify the parameters of the system. The procedure for determination of order of an ARMA model has also been presented.

At the end, future direction of possible work in this area has also been suggested