Abstract

The nonparametric power spectrum estimation methods are very popular among researchers as these methods do not require any modeling of the data sequences. The nonparametric techniques of spectrum estimation are based on the idea of estimating the autocorrelation sequence of a random process from a set of measured data, and then taking the Fourier transform to obtain an estimate of the power spectrum.

Though the nonparametric spectral estimation has good dynamic performance, it has a few drawbacks such as spectral leakage effects due to windowing, requires long data sequences to obtain the necessary frequency resolution, assumption of auto correlation estimate for the lags greater than length of the sequences to be zero which limits the quality of the power spectrum and the assumption of available data are periodic with period N which may not be realistic. Hence alternatives must be explored to reduce the spectral leakage effects, to decease the uncertainty in the low frequency regions, to improve the frequency resolution, to reduce variance with the increased percentage of overlapping data samples and to achieve a consistent spectral estimate with minimum amount of bias and variance.
To reduce the variance of a spectral estimate, a non parametric spectral estimation method based on interpolated nonlinear overlapping of samples of nonuniform data sequence is proposed. The existing Welch nonparametric power spectrum estimation method has increased variance with the increased percentage of overlapping of samples. Welch estimate uses the linear overlapping of the samples. Hence the Welch estimate is not a consistent spectral estimate. To overcome this, nonlinear overlapping of samples is proposed. The variance of the proposed estimate decreases with increased percentage of circular overlapping of samples, the spectral variance is found to be a nonmonotonically decreasing function. The simulation results show the robustness of the proposed estimate compared with the existing Welch estimate.

To reduce the spectral leakage effects and to resolve the spectral peaks over the large dynamic range of power values of nonuniform data sequences, a nonparametric power spectrum estimation method using prewhitening and post coloring technique is proposed. The combination of nonparametric with parametric method as preprocessor is proposed in large active range situations. Though the true spectrum of the data sequences contains the spectral peaks over the large active range, using the nonparametric methods alone the spectral peaks are not resolved with good resolution. Hence the interpolation and parametric modeling as the preprocessor can be used with the combination of a nonparametric method to resolve the narrow spectral peaks over the large active range of power values. This
method provides the high dynamic range of powers of the nonuniform data sequences.

To study the spectral analysis of nonuniform data sequences, nonparametric power spectrum estimation methods based different interpolations techniques as resampling methods have been discussed. The simulation results show the reduction in spectral leakage, improved spectral estimation accuracy and shifting of frequency peaks towards the low frequency region. The simulation results show a good performance for the power spectrum analysis.