Adaptive Filtering Based on Time-Averaged MSE for Cyclostationary Signals

Abstract:

Adaptive filters are commonly used in many signal processing and communications systems. In many practical digital communications scenarios, including, for example, interference-limited wireless and wireline communications, as well as narrowband power line communications, the considered signals are jointly cyclostationary. Yet, most works on adaptive filtering of cyclostationary signals used ad hoc application of adaptive algorithms designed for stationary signals, e.g., the least-mean-squares (LMS). It is known that these algorithms may not converge for jointly cyclostationary signals. In this paper, we rigorously study the optimal adaptive filtering of jointly cyclostationary signals. We first identify the relevant objective as the time-averaged mean-squared error criterion (TA-MSE), and obtain an adaptive algorithm as the stochastic approximation of the TA-MSE minimizer. When the considered signals are jointly stationary, the algorithm specializes to the standard LMS algorithm. We provide a comprehensive transient and steady-state performance analysis without imposing a specific distribution on the considered signals, and derive conditions for convergence and stability. The algorithm, which we call time-averaged LMS, is applied to practical scenarios in a simulations study, and an excellent agreement between the theoretical and the empirical performance is observed.