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Fast RLS Fourier analyzers capable of accommodating frequency mismatch. (English)

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Summary: Adaptive Fourier analyzers are used to estimate the discrete Fourier coefficients (DFC) of sine and cosine terms of noisy sinusoidal signals whose frequencies are usually assumed known a prior. The recursive least squares (RLS) Fourier analyzer provides excellent performance, but is computationally very intensive. In this paper, we first present four fast RLS (FRLS) algorithms based on the inherent characteristics of the DFC estimation problem. These FRLS algorithms show approximately the same performance and indicate estimation capabilities that are quite similar to those of the RLS, while requiring considerably less computational cost. Second, the performance of the proposed FRLS algorithms is analyzed in detail. Difference equations governing their dynamics as well as closed-form expressions for their steady-state mean square errors (MSE) are derived and compared with those of the LMS Fourier analyzer. Third, the RLS and four FRLS algorithms are modified by incorporating an adaptive scheme, to alleviate the influence of undesirable frequency mismatch (FM) on their performance. Extensive simulations as well as application to real noise signals are provided to demonstrate the relative performance capabilities of the RLS and four FRLS algorithms, the validity of analytical findings, and ability of the modified RLS and FRLS algorithms to mitigate the influence of the FM.

MSC:

94A12 Signal theory (characterization, reconstruction, filtering, etc.)

Keywords:

adaptive Fourier analysis; RLS; LMS; performance analysis; convergence properties; frequency mismatch

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