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An Investigation on the Performance of Adaptive IIR Filters for Active Noise Control in One-Dimensional Systems

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Analysis of the Filtered-x least mean square and Filtered-u least mean square algorithms reveals that they have some intrinsic robustness against errors in the estimation of the secondary path, and the stability of these algorithms will be maintained despite of some errors in the estimation of the secondary paths [1, 2]. However one major problem of utilizing this family of algorithms in realistic scenarios is the inherent slow adaptation assumption considered in derivation of such algorithms. This assumption enables interchanging the place of the control filter and the secondary path [3]; however in the implementation and evaluation of the algorithm any increase of the adaptation gain will cause instability of the algorithm and hence will lead to design of algorithms with inherent slow adaptation characteristic. This is especially true in design of the recursive least square based filtered-x algorithm due to fast convergence and tracking capability of RLS algorithm.

To exploit the ultimate performance of the RLS algorithm in design of ANC systems and to alleviate the inherent slow convergence property of the algorithms designed based on the filtered-x family, in this paper an approach based on the modified filtered-x scheme has been proposed. The stability of robustness analysis of the proposed algorithm has been investigated in series of papers [4, 5, 6], nevertheless it is necessary to investigate the performance of the developed algorithm in comparison of the available algorithms to reveal its effectiveness more clearly. To achieve this end an evaluation using both numerical and experimental data has been carried out to assess the effectiveness of the proposed algorithm in a one-dimensional duct system. The results confirm that the algorithm has not only faster convergence rate but also it will lead to very smaller minimum-mean-square error in comparison with FuLMS and SHARF algorithms. This can be achieved by having the required trade-off between the stability robustness and performance of the proposed algorithm by relaxing some of the sufficient conditions derived in [6].

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