Application of Adaptive Algorithms for Echo Cancellation and Fault Signal Analysis in Vehicles

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ABSTRACT

This study proposes an adaptive algorithm for echo cancellation and fault signal analysis in vehicle. The work includes three parts: the first part is in an audio system, acoustic feedback often limits the maximum usable gain of the system and degrades the overall system response. This proposal proposed a variable step-size affine-projection algorithm (VSS APA) for acoustic feedback cancellation in audio systems. The proposed adaptive filter is based on the filtering affine-projection algorithm with variable step-size for improving convergence speed in acoustic feedback cancellation. A performance evaluation and simulation comparison was conducted to compare the proposed algorithm and various traditional adaptive filtering algorithms. In the second part of this study, an adaptive line enhancement (ALE) system for improving sensor response using a VSS APA is proposed. Impulsive sound and vibration signals in rotating machinery are often caused by the impacting of component and are commonly associated with fault. However, it tends to be difficult to make objective measurements of impulsive signals because of the high levels of background noise. The ALE system is an adaptive technique that may be used to detect a periodic signal buried in a broadband noise background such as in rotating machinery fault diagnosis. However, most of the conventional methods for ALE system are based primarily on an adaptive filter with the least-mean-square (LMS) error algorithm. This study proposed a VSS APA for improving both the convergence speed and the performance of the ALE system. Two applications were conducted to compare the performance of the proposed algorithm and various traditional adaptive filtering algorithms. Both of the -viiexperimental results indicated that the ALE with VSS APA has an effective performance and convergence for both applications. In the third part, a mechanical signal enhancement system for fault diagnosis using two-stage adaptive filtering is proposed. In the first stage, the least-mean-square adaptive filtering algorithm for canceling the unwanted periodical signal is used. In the second stage, an ALE with a novel adaptive filtering algorithm is proposed to defect the periodic signal buried in a broadband noise background. In the experimental work, the proposed technique is used for cooling fan fault diagnosis in an internal combustion engine cooling system. The experimental results indicated that the proposed two-stage filter improved the effective for cooling fan fault detection.

Keywords : Acoustic feedback, Adaptive filter, Fault diagnosis, Adaptive line enhancement, Affine-projection algorithm

Table of Contents

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