New Method of LMS Variable Step-Size Formulation for Adaptive Noise Cancellation

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Abstract: Least mean square (LMS) is a widely used steepest descent algorithm known with efficient tracking ability of small mean square error (MSE) but with low convergence speed. In contract to the fixed step size, variable step size was introduced to improve the convergence speed while maintaining the minimal MSE. In this work, a new method was formulated to determine the variable step size of the LMS algorithm. Simulation results are presented to support the experimental analysis for the performance evaluation and comparison. Result reveals that the performance the of new formulated variable step size algorithm is better compare to the conventional LMS algorithm.

1. Introduction

In the field of adaptive filtering, the least-mean-square (LMS) adaptive filter is one of the most popular and widely used adaptive algorithm in numerous commercial, scientific and industrial applications. It implementation is relatively easy both in software and hardware due to its computational simplicity, robustness and efficient use of memory [1]. In a noisy environment, LMS adaptive filter also find its application in the adaptive cancellation of the background noise and interference [2].

Adaptive noise cancellation (ANC) is a noise filtering technique used to remove an unwanted noise from a received signal, the operation is controlled in an adaptive way in order to obtain an improved signal-to noise ratio (SNR) [3]. ANC techniques involve the passing of corrupted signal through a filter that tends to suppress the noise while leaving the signal unchanged. In contrast to the conventional filter design techniques, ANC do not have constant filter coefficients and no priori information is known, hence it uses an adaptive algorithm to adjust the filter parameters resulting in optimal solution [2].

The step size (μ) of LMS is a very important parameter in the adaptation performance of the adaptive noise cancelling system [4]. In a noisy environment where the statistical characteristics of the signal is time varying, choosing a fixed step size μ for the LMS adaptive filter may not effectively meet the system's performance requirements. Since the system signals are time- varying, it therefore requires a time-varying step size $\mu(n)$ which if properly computed, can provide stable, robust, and accurate convergence behaviour for the LMS adaptive filter in noisy situations.

For further analysis, the VSS-LMS is evaluated with the LMS and NLMS algorithm for performance comparison. Table 3 show the filter convergence of the algorithms.

Table 3
Convergence speed comparison of LMS, N-LMS and VSS-LMS

Algorithm	*Filter Convergence Speed*
LMS	*320*
N-LMS	*270*
VSS-LMS	*150*

The LMS and NLMS algorithm is used to benchmark the formulated VSS-LMS. From Table 2, the LMS converges at about 320 iterations, NLMS at 270 and VSS-LMS at 50, the results shows clearly that the formulated VSS-LMS perform better in terms of filter coefficient convergence speed.

8. Conclusion

The new formulated variable step size LMS was simulated and tested for noise cancellation in speech and sinusoidal signal. The formulation is easy as it involve less computational complexity. The result analysis also reveals an improvement in the LMS adaptive filter in terms of the MSE and convergence speed. The improvement arise from the concept of estimating the error signals to effectively adjust the step size while updating the filter coefficient. Hence reduction in the system output error and faster convergence time was achieved.

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