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Abstract

The recursive adaptive system is the main theme of this research because of its low computations and high convergence rate efforts which makes it preferable in many practical applications. This work searches on performance evaluation and enhancement of an adaptive IIR system using variable step size algorithm. The two primary problems associated with the recursive structure are: (i) Stability, (ii) Tradeoff between fast rate of convergence, and low level of misadjustment at the steady state.

In this work, a Fast Variable Step Size LMS (FVSSLMS-1) algorithm is proposed, which overcomes and avoids these drawbacks. In this algorithm, an appropriate time varying of the step size is calculated based on gradually decreasing maximum step size to the minimum value. This time varying step size is based on the square value of the current estimation error.

A comparison between Least Mean Square (LMS), proposed, and another variable step size Normalized Least Mean Square (NLMS), adaptive algorithms are carried out. System identification was built and training using MATLAB simulation program as a form of software to test the right operation of adaptive system identification. The results show that the proposed algorithm has fast convergence rate (40) compared with the LMS (200) and NLMS (80) iterations. Where the value of misadjustment for LMS algorithm is (0.0383), NLMS is (0.189), and for the proposed algorithm is (0.114). Also the system was tested under another environment that added some noise to the system about (-30 dB). The results show the proposed algorithm has faster convergence rate (120) compared with NLMS (250) and LMS (800), while the values of misadjustment for proposed is (0.1185), NLMS (0.196) and LMS (0.0406). The stability problem has been solved, by triangle stability for the feedback coefficients of a second-order adaptive filter. One of the simplest tests of stability is to check after each update of the algorithm that the sum of $|b(k)|$ is less than 1.

The main drawback of FVSSLMS-1 is how to choose the upper values of the step size. Therefore, another algorithm (FVSSLMS-2) was proposed, that time varying upper bound value of the step size is used to guarantee the stability of adjusted step size of the algorithm. A comparison between FVSSLMS-1 and FVSSLMS-2 algorithms shows that the FVSSLMS-2 has faster convergence rate (20) and low misadjustment (0.0195) compared with FVSSLMS-1 that has convergence rate (40) and misadjustment (0.114). Also, the system was tested under another environment that added some noise to the system about (-40 dB). The results show the FVSSLMS-2 algorithm has faster convergence rate (70) and misadjustment (0.0341), compared with FVSSLMS-1, with convergence rate (120) and misadjustment (0.1185).

The proposed algorithms are tested and applied in other applications (adaptive noise cancellation and adaptive equalizer), and the results enhanced the performance compared with LMS and NLMS algorithms in convergence time and ability of tracking.

Keywords: Adaptive Filters, IIR, System Identification, LMS, NLMS, Adaptive Noise Cancellation, Adaptive Equalizer.