Adaptive and Array Signal Processing/Processamento de Sinais Adaptativo

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Tutorial Questions/Lista de Exercícios - 5

1. Consider the single-weight adaptive filter shown in the figure below

a) Write down the LMS algorithm to update the weight w.

b) Suppose that is a constant:

Find the system function relating d[i] to e[i] using the LMS algorithm, i.e., find in the figure below

c) Determine the range of values for for which is stable.

2. The LMS adaptive filter minimizes the instantaneous squared error

Consider the modified cost function

where

a) Derive the LMS coefficient update equation for that minimizes .

b) Determine the condition on the step size that will ensure that converges in the mean.

c) If is small enough so that converges in the mean, what does converge to?

3. Consider a system identification problem as shown below

where is an N x 1 input vector, d[i] is the desired signal, is the measurement noise, is the system to be identified that can be modelled as an FIR filter with N coefficients and is an adaptive filter with N coefficients used to identify . Use complex Gaussian random variables with zero mean and a chosen variance to model , and , define the signal-to-noise ratio (SNR) as appropriate and employ at least 100 repetitions to obtain well behaved curves.

a) Write a Matlab programme to simulate the mean-square error (MSE) curves that describe the learning behaviour of an LMS algorithm.

b) Plot curves for different step sizes , SNRs and filter lenghts. What is the effect of large step sizes , high SNRs and large filter lengths on the performance of the LMS algorithm.

c) Compare the simulated MSE curves at steady state with the analytical values available to predict the MSE.

d) Consider a correlated input signal and observe the effects on the MSE curves.

e) Simulate the NLMS and the affine projection algorithms, and compare their performances with that of the LMS algorithm.