Digital Signal Processing/Processamento Digital de Sinais

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Tutorial Questions/Lista de Exercícios - 7

1. Consider a Wiener filtering problem characterised as follows: The correlation matrix of the input data vector is

The cross-correlation vector between and the desired signal is

1. Compute the Wiener filter using both analytical and numerical values.
2. What is the minimum mean-squared error produced by this Wiener filter?
3. Write down a representation of the Wiener filter in terms of eigenvalues of and associated eigenvectors.

2. A complex-valued linear predictor of discrete-time waveforms can be built by forming an estimate of a sample samples later by observing p consecutive data samples. Consider the estimate of the predictor given by

The predictor coefficients should be chosen to minimize

a) Derive the equations required to compute the optimal set of coefficients.

b) If , how is the formulation of the problem different. Please explain.

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.