EE 504

Homework #6
Due: May 21, 2004 (Friday)

Pr.1 Comparison of LMS and RLS - Matlab Assignment (Hayes C9.6, p.568)
(will be graded out of 20 points)

In this problem we will compare LMS and RLS for adaptive linear prediction. As in Example Hayes 9.2.1, let $x(n)$ be a process that is generated according to the difference equation

$$x(n) = 1.2728x(n-1) - 0.81x(n-2) + v(n)$$

where $v(n)$ is unit variance white Gaussian noise. The adaptive linear predictor will be of the form

$$\hat{x}(n) = w_n(1)x(n-1) + w_n(2)x(n-2) \tag{1}$$

a) Implement an RLS adaptive predictor with $\lambda = 1$ (growing window RLS) and plot $w_n(k)$ versus n for $k = 1, 2$. Compare the convergence of the coefficients $w_n(k)$ to those that are obtained using the LMS algorithm for several different values of the step size μ.

b) Make a plot of the learning curve for RLS and compare it to the LMS learning curve (See example 9.2.2. on how to plot learning curves). Comment on the excess mean-square error for RLS and discuss how it compares to that for LMS.

c) Repeat part b) for exponential weighting factors of $\lambda = \{0.99, 0.95, 0.92, 0.90\}$ and discuss the trade-offs involved in the choice of λ.

d) Modify the m file for the RLS algorithm to implement a sliding window RLS algorithm.

e) Let $x(n)$ be generated by the time-varying difference equation

$$x(n) = a_n(1)x(n-1) - 0.81x(n-2) + v(n)$$

where $v(n)$ is unit variance white noise and $a_n(1)$ is a time-varying coefficient given by

$$a_n(1) = \begin{cases} 1.2728 & ; \quad 0 \le n < 50 \\ 0 & ; \quad 50 \le n < 100 \\ 1.2728 & ; \quad 100 \le n < 200 \end{cases}$$

Compare the effectiveness of the LMS, growing window RLS, exponentially weighted RLS and sliding window RLS algorithms for linear prediction. What approach would you propose to use for linear prediction when the process has step changes in this parameters ?

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A Matlab implementation of the RLS algorithm is given on page 546 of Hayes' book.