Adaptive Equalization

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***Abstract*—This manual provides an introduction to the LMS algorithm.**

1 Problem Statement

Problem 1.1. Generate

$$x(n) = \sum_{k=1}^{3} h(k) b_{n-k} + v(n) \tag{1.1}$$

where

$$h(n) = \begin{cases} \frac{1}{2}\left[1 + \cos\left(\frac{2\pi}{F}(n-2)\right)\right] & n = 1, 2, 3 \\ 0 & \text{otherwise} \end{cases}, \tag{1.2}$$

$b_n = \pm 1$ and $v(n) \sim \mathcal{N}\left(0, \sigma^2\right)$ for SNR ranging from 0 to 10 dB.

Problem 1.2. Formulate the cost function for the LMS algorithm.

Solution:

$$e(n) = b(n-M) - W(n)^T X(n) \tag{1.3}$$

where all vectors on the R.H.S are of length M and the entries of $X(n)$ are obtained from $x(n)$. The problem can then be expressed as

$$\min_{W} e^2(n) \tag{1.4}$$

2 Adaptive Equalization

Problem 2.1. Execute the **LMS_BER.py** code in the **equalization** directory.

Problem 2.2. The channel is no longer as given by the cosine function. But, now let the channel be modeled by an FIR filter of length 10, and each FIR coefficient be of unit magnitude. Repeat the above channel equalization problem for the equalizer under a narrow band channel.Plot the bit error rate.

Problem 2.3. The data symbols are not binary (BPSK) but are QPSK. You can generalize the method used for generating BPSK to a method for generating QPSK. Plot the bit error rate. Do this for both the cases: (a) the FIR channel specified above, and (b) any other narrow band channel of your choice.

Problem 2.4. Now execute the **RLS_Equalizer.py** program.

Problem 2.5. Repeat relevant problems above using the RLS algorithm.

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