University of Washington
Department of Electrical Engineering

EE 506
Fundamentals of Wireless Communications

Summer 2013

http://courses.washington.edu/ee506

Communication System Analysis Project
Project 3: Equalization

The goal of this project is to implement two equalization schemes (zero-forcing and adaptive LME) and compare their performance on LTI and LTV channels. Specifically, you want to quantitatively analyze the impact of 1) the equalizer length, 2) the amount of training sequence, 3) the channel variations and 4) the step parameter in adaptive equalization, by measuring the BER of the equalizer outputs.

(1) Zero-forcing equalization

Let the multipath channel response c_k be [0 0 0.05 -0.063 0.088 -0.126 -0.25 0.9047 0.25 0 0.126 0.038 0.088 0 0].

(a) Plot the frequency response (amplitude) of this multipath channel. Is it flat or frequency-selective?

(b) Design a 30-tap equalizer g_k based on the zero-forcing principle.

(c) Plot the frequency response of 'equalized' channel against the original channel. What kind of improvement do you observe?

(d) Vary the length (number of coefficients) of the equalizer. How does it impact the performance?

(2) QPSK over multipath channels

In this task, you apply a QPSK modulated sequence to the slowly-varying two-path channel ($p = 0.99$, excluding the ramp-up portion) created in Project 3.

The input signals are grouped into logical blocks, each block has a training sequence of 100 symbols, followed by 900 data symbols). Assuming the multipath channel at the beginning of each block can be perfectly estimated based on the training sequence, evaluate the following

(a) The BER vs. SNR (0 to 30 db, with step size of 2 dB) performance of the zero-forcing equalizer.

(b) Repeat part a) with faster varying channels (e.g., $p = 0.95$).

Note: Signal power is defined as the average signal power at the channel output (how do you calculate this?). The noise is complex Gaussian.

(3) Adaptive Equalization

In this task, you will repeat Task 2 from above with adaptive equalization.

(a) To make sure that your adaptive equalizer works, first fix the multipath channel (i.e., LTI) and assume that all input signals are known to the equalizer (i.e., they are all training symbols).

(b) Carefully adjust the step size and observe the convergence characteristics of the adaptive LME (Example 6.12, page 271). The equalizer is 'converged' when it can no longer reduce the residual error.

(c) Pick the proper step size and equalizer length, apply the adaptive equalizer to input signals with 100 training symbols per block. The coefficients of the equalizer freeze during the data portion of the block.

(d) Evaluate the the BER vs SNR (0 to 30 db, with step size of 2 dB) performance

(e) Slowly increase the channel variation rate and report part d). What do you observe?

Submit your Matlab source code, along with a report (10 pages or less).

(4) Decision-feedback equalization (bonus)

Repeat Task 3(d-e) with decision-feedback equalization. Compare the performance of DFE and adaptive LME and comment on the difference.

Submit your Matlab source code, along with a report (10 pages or less).