HW2a: Error Rate Evaluations for Baseband Systems

due October 24, 23:59

1. You are given a simulation package that evaluates the Monte Carlo performance of the QPSK modulation in the baseband and that plots the bit error probability (BER) as a function of signal to noise ratio (SNR) or E_s/N_0. Examine the code carefully and run it on your own. Notice what happens if you decrease or increase the parameters *ferlim* or the *max-nframe*. Modify the code and run it again so that it simulates the BER performance versus E_b/N_0. What is the difference?

   Modify the code so that it simulates the symbol error rate (SER) performance of QPSK as a function of both SNR and E_b/N_0. In all cases justify that the detector that is used is the maximum likelihood detector. Plot all curves together and explain the graph in a short paragraph.

2. Now modify the MATLAB Monte-Carlo simulation package that implements a transmission system employing BPSK. Assume that the BPSK signals are transmitted over an AWGN channel with zero mean and variance $N_0/2$. Also assume that the receiver is a maximum-likelihood (ML) detector. Run your code to obtain the bit-error rate (BER) as a function of E_b/N_0. How does the E_b/N_0 vs. BER performances of BPSK and QPSK compare? Are they the same or different? Explain the graph in a short paragraph.

3. Repeat part (2) for 4-PAM communication, but obtain the BER as a function of SNR. Employ uniform and gray mapping for bit-to-symbol conversions. Is there a difference in the BER performance due to mapping?

   Hint for 3): Notice that in your QPSK simulation code, the average symbol energy is set to unity. The SNR value is obtained by changing the noise variance. Previous constellations all had unit energy but in 4-PAM, different constellation points have different amplitudes and energies. Therefore you have to normalize the constellation points so that the average constellation energy is equal to 1.

4. Repeat part (2) for binary FSK.

Instructions:

- In each part, All BER/SER curves must be semi-logarithmic, down to at least 10^{-4} BER/SER level and be plotted on the same graph.
- You should prepare a report, where all your explanations, graphs and results are included. You are also required to turn in your MATLAB source codes. At the due date, submit your report and your Matlab codes (4 m-files in total, one for each constellation). All submissions are on MOODLE. Late submission is penalized with 10% per day.