ECE 435/535a Digital Communications I
Spring 2016

Project due date: Thursday, Apr. 28 2016, 11:11am.

Simulation of Modulation Schemes

Project description

In this project, you will simulate the M-PSK and compare the probability of error with the theoretically formula. The block diagram of the system you will implement is shown below.

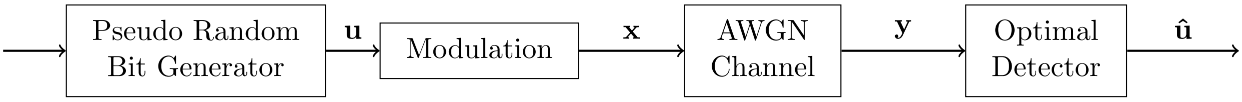
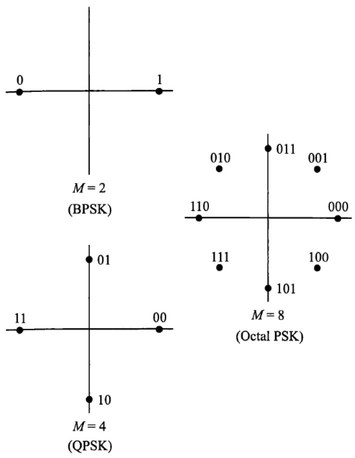


Figure 1: Block diagram of the communication system.

The general idea is to generate a sequence of K bits (denoted by the vector $\mathbf{u}$), and then map this sequence of K bits into a sequence of symbols using an M-ary modulation scheme such that the resulting sequence of symbols (denoted by the vector of $\mathbf{x}$) has a length $K/\log_2(M)$. Then an additive white Gaussian noise (AWGN) channel is corrupting the symbols. The output vector of the AWGN channel is denoted $\mathbf{y}$. Finally, an optimal detector provides an estimate of the original symbols based on $\mathbf{y}$, thus the original sequence of K bits sent.
Your work is then to simulate this entire communication system, and obtain the symbol error-rate, the bit error-rate, and the frame error-rate curves as a function of SNR (E_b/N_o), where E_b is the energy per bit, and N_0 is the noise power.
The modulation scheme to be simulated is M-ary PSK. These schemes are shown below. The mapping between the bits and the symbols is given. For the QAM we will only consider the "rectangular" modulation. You may assume an arbitrary mapping between the bits and the symbols.



PSK

Work to be done

1. (Graduate Students) Derive properly the theoretical bit error probability for the three modulation schemes considered (M-PAM, M-QAM, M-PSK). Do not copy/paste from the notes/book, you are expected here to rather show that you understand fully the derivation of these probabilities.

2. Simulate the general schemes using the model depicted above for the three modulation schemes considered. The schemes expected are (at least) BPSK, QPSK and 8-PSK. You can choose different length for the frames ($K = 64$, $K = 256$, $K = 1024$).

3. Plot the results, and (graduate students) compare the theory with your simulations. Compare the effect of K on the frame error-rate.

4. You are free to write the program in C or Matlab, BUT you are not allowed to use the functions that might already exist (C or Matlab) which perform the modulation and/or detection.

5. It is strongly recommended that your programs work for any M-ary modulation and not for only a particular M.

Project submission details

The derivation of the bit error probabilities can be handwritten and returned during class.

As in the previous projects, you are required to submit a single zip file containing:

1. Your commented functions performing the simulations.

2. The plots of SNR vs. BER (or SER or FER). The simulations of the BER need to show a BER from 10^{-1} to 10^{-6} (at least).

3. A short LaTex report (2-3 pages) in IEEE Transactions format detailing the problem statement, a brief description of the solution, and a discussion on results of the study. Please cite references as needed.

Submit by e-mail this single zip file. If your name is Bane Vasić, the attached file should have the following name: bane_vasic.zip. The subject of the e-mail should be: ECE535 Project 3.

Remark 1: For this last project, we intentionally did not give all the details of the functions or methods to be used. You can choose and justify any way to proceed in order to complete this project. You can also report the main issues you had completing this project as well as the solution you implemented to circumvent them.
Remark 2: The due date for this assignment has been set to give you the necessary time to understand what you are supposed to do, and more importantly the time to perform the simulations.