EE 597 Fall 2020

Assignment 1

Assigned: September 1, 2020
Due: September 10, 2020

Problem 1. Simulate and plot the bit error rate versus E_b/N_0 curve for BPSK on a log-log scale, and compare with the theoretical expression for it.

Note: The bit error rate for BPSK can be represented by:

$$P_b = Q\left(\sqrt{\frac{2E_b}{N_0}}\right)$$

where E_b is the symbol magnitude squared, N_0 represents the variance of the circularly symmetric complex Gaussian random variable for noise, and Q is the Q-function (the tail probability of the standard normal distribution).

Problem 2. Simulate and plot the symbol error rate versus E_b/N_0 curve for 4-PSK over an AWGN channel. Plot also the bit error rate versus E_b/N_0 curve under two assumptions: sequential encoding of bits (i.e. 00 - 01 - 10 - 11) to symbols in counter-clockwise order and gray encoding (00 - 01 - 11 - 10) which tries to minimize the chance of 2-bit errors. Comment on how the two curves differ from each other, and from the BPSK curve you got for Problem 1.

Problem 3. This question pertains to determining the model parameters of the simple path loss model with log-normal fading for the real measurement dataset provided in the attached zip file. Read through the EE597-HW1-Problem3.pdf file to understand the data set and its format.

(a) Using all valid data-points in the dataset, create a scatter-plot of the received power in dBm as a function of log(distance).

(b) Use linear regression to determine the best fit parameter value for η and K, assuming $d_0 = 1$m.

(c) The line you derive above corresponds to the mean received power at each given distance. Subtracting this mean received power from actual received power value will yield samples of the zero-mean normal random variable that represents fading, i.e. $\psi(dB)$.

Determine the standard deviation of fading (σ_{dB}) from these samples. You may use any programming language of your choice. Submit the plot of received power versus distance that contains the experimental data along with your estimated curve that fits the data. On this plot indicate the numerical values of the estimated model parameters.

(d) In the dataset, there are many missing samples (indicated as received power of -500dBm) which correspond to lost packets. Comment on whether leaving these samples out might bias the estimated values of η, σ_{dB} , and if so, in what way?