EE538 Principles of Modern Digital Communications: Final Project

(Due right before the final exam)
(Final exam schedule: 9:00am-11:00am, Dec. 15, 2017, in Talbert 115)

Use Matlab to simulate a communication system with optimum receiver detection: We assume that the communication channel is AWGN channel with noise power spectral density of $N_0/2$ and $N_0 = 4.1\times10^{-21}$ W/Hz. The system uses either PAM or QAM modulation and demodulation. The PAM signal waveforms are specified as:

$$s_m(t) = A_m g(t)\cos(2\pi f_c t), \quad A_m = 2m-1-M, \quad 1 \le m \le M.$$

The QAM signal waveforms are specified as:

$$A_{I,m_1} g(t)\cos(2\pi f_c t) - A_{Q,m_2} g(t)\sin(2\pi f_c t),$$

$$A_{I,m_1} = 2m_1 - 1 - \sqrt{M}, \quad A_{Q,m_2} = 2m_2 - 1 - \sqrt{M}, \quad 1 \le m_1,\ m_2 \le \sqrt{M}.$$

We assume that for both the PAM and QAM modulation schemes, the pulse signal $g(t) = \begin{cases} A, & 0 \le t \le T; \\ 0, & \text{otherwise,} \end{cases}$ in which T is the symbol interval and A is the signal amplitude. The signal-to-noise ratio (SNR) per symbol is defined as:

$$\gamma_s = \frac{E_{s,avg}}{N_0}.$$

We can increase the signal amplitude A, which results in larger SNR per symbol, to obtain smaller error probability at the receiver. Gray bit mapping is considered.

1. Simulate the system with binary-PAM modulation/demodulation, and plot symbol error rate (SER) curve in terms of various SNR levels. In the same figure, also plot the theoretical SER curve and compare it with the simulation result. (Use semilogy(.) to plot SER curve, show SNR in dB.)
2. Simulate the system with 4-PAM modulation/demodulation, and plot the SER curve in terms of SNR. In the same figure, also plot the theoretical SER curve and compare it with the simulation result.
3. Simulate the system with 4-QAM modulation/demodulation, and plot the SER curve in terms of SNR. In the same figure, also plot the theoretical SER curve and compare it with the simulation result.
4. Based on the simulation results in (1)-(3), plot in one figure the SER curves of the three modulation schemes (Binary-PAM, 4-PAM, and 4-QAM). What do you observe?
5. Based on the simulations in (1)-(3), plot in one figure the bit-error-rate (BER) curves of the three modulation schemes (Binary-PAM, 4-PAM, and 4-QAM) in terms of SNR per symbol. What do you observe?
6. Based on the simulations in (1)-(3), plot in one figure the BER curves of the three modulation schemes (Binary-PAM, 4-PAM, and 4-QAM) in terms of SNR per bit. What do you observe?

Notes: (i) A hardcopy report should be submitted at the final exam, in which Matlab codes should be attached (hardcopy). (ii) Parallelism or similar reports will result in zero grade.