CSE 4214 :: Lab 3/4

Issued November 13, 2007; due December 3, 2007
Lab will be accepted with no late penalty until Monday, December 17, 2007

Part 1

1. Give the generator matrix and the parity check matrix for a (7,4) Hamming code. Give the assumed error pattern corresponding to each syndrome (including the all-zero syndrome). Show that the minimum Hamming distance for this code is 3.

2. Consider a convolutional code with the following generator polynomials:

$$g^{(1)}(D) = 1 + D + D^3$$
$$g^{(2)}(D) = 1 + D^2 + D^3$$

   Draw a circuit diagram (depicting the mod-2 sums and flip-flops), a state machine, and one section of the trellis for this convolutional code.

Part 2

For this part, assume that bits are sent over the channel using polar NRZ signaling, with energy per bit E_b, noise power spectral density $N_0/2$, and a signaling time of 1 second. Similarly to lab 2, you are only required to implement the matched filter outputs.

1. Implement a Hamming code encoder and decoder in MATLAB for the (7,4) Hamming code that you obtained in part 1.

2. Run simulations of the channel to determine roughly the range of E_b/N_0 so that the probability of bit error varies from 0.2 to 0.01. Plot the probability of error for the Hamming code versus E_b/N_0 over this range, on a log-log scale. On the same plot, plot the probability of error for an uncoded system with $E_b^* = (7/4)\,E_b$ (this scaling is used to make the energy per information bit constant). No need to simulate the uncoded system; you may simply plot the erfc() function.

3. Implement a convolutional code encoder and a Viterbi algorithm decoder for the convolutional code that was given in part 1.

4. Run simulations of the channel to determine roughly the range of E_b/N_0 so that the probability of bit error varies from 0.2 to 0.01. Plot the probability of error for the convolutional code versus E_b/N_0 over this range, on a log-log scale. On the same plot, plot the probability of error for an uncoded system with $E_b^* = 2\,E_b$. Again, you may directly plot the erfc() function for the uncoded case.

Deliverables

Your deliverables for this lab are:

- Answers for the questions in part 1;
- Your MATLAB code for part 2; and
- Plots from part 2.