CSE 4214 :: Lab 2

Issued October 23, 2008; due November 6, 2008

This lab extends Lab 1 and introduces you to passband modulation.

Although you are allowed (and encouraged) to consult with other students in performing this lab, your work must be submitted individually. Group submissions are not allowed.

Section 1. Signals and matched filters.

Here are two signal sets:

1	$r_0(t) = \begin{cases} \sin 2\pi t/T, & 0 \le t \le T \\ 0, & t < 0, t > T \end{cases}$	$r_1(t) = -r_0(t)$
2	$s_0(t) = \begin{cases} \cos 2\pi t/T, & 0 \le t \le T \\ 0, & t < 0, t > T \end{cases}$	$s_1(t) = -s_0(t)$

For each signal set, do the following:

1. Derive and sketch/plot the impulse response h(t) of the matched filter (matched to $s_0(t)$).
2. Show that, if $r_0(t)$ is applied to the matched filter for $s_0(t)$, the output at time T is zero, and vice versa.
3. Using the property from part 2, design a modulation scheme and a detector such that two bits can be transmitted simultaneously.
4. Assuming T=1, find the value of N_0 such that the probability of bit error is 0.25, and the value of N_0 such that the probability of error is 0.01.

Section 2. Simulating the matched filter.

In this part you will implement the system you designed in part 1. Assume T = 1, and use the same simulation method you used in Lab 1, with sampling frequency 20/T.

Do the following:

1. In part 4 of section 1, you found two values of N_0 for different probabilities of error. Between these two values of N_0, find three equally spaced additional values (e.g., if the lower value is 1, and the upper value is 5, the intermediate values would be 2, 3, and 4). You will end up with a total of five values (in the example, you have 1, 2, 3, 4, 5).
2. For each of the five values, generate 2000 bits of binary data at random (where the digits 0 and 1 have equal probability). For each pair of bits, generate the modulated (sampled) signal, as appropriate; add Gaussian noise; pass the noisy signal through the (discrete-time) matched filter(s); and (based on the matched filter output) decide whether the bit is

0 or 1. Calculate the probability of bit error from the simulation (e.g., if the decision is correct 800 times and incorrect 200 times, the error rate is 0.2).

3. Using the MATLAB plotting features, plot the simulated error rate versus N_0 on a log-log scale. Note that your results should match reasonably well with the values you found in part 4 of section 1.

Deliverables

Your deliverables for this lab are:

- Answers for the four parts in section 1;
- Your MATLAB code for section 2; and
- Plots from part 3 of section 2.