

CSE 4214 :: Lab 1

Issued October 4, 2007; due October 25, 2007

This lab will familiarize you with matched-filter detection of signals, and will give you experience in running numerical simulations of communication systems in MATLAB.

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 three signal sets:

1	$s_0(t) = \begin{cases} 1, & 0 \leq t \leq T \\ 0, & t < 0, t > T \end{cases}$	$s_1(t) = -s_0(t)$
2	$s_0(t) = \begin{cases} \sin(2\pi t/T), & 0 \leq t \leq T \\ 0, & t < 0, t > T \end{cases}$	$s_1(t) = -s_0(t)$
3	$s_0(t) = \begin{cases} \sin(2\pi t/T), & 0 \leq t \leq T \\ 0, & t < 0, t > T \end{cases}$	$s_1(t) = \begin{cases} \cos(2\pi t/T), & 0 \leq t \leq T \\ 0, & t < 0, t > T \end{cases}$

For each signal set, do the following:

1. Sketch (or plot using MATLAB) the signals $s_0(t)$ and $s_1(t)$;
2. Derive and sketch/plot the impulse response $h(t)$ of the matched filter (matched to $s_0(t)$);
3. Calculate the probability of error for each signal set assuming that $T = 1$; and
4. Again assuming $T=1$, find the value of N_0 such that the probability of 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 matched filters you derived in part 1. Assume $T = 1$.

Clearly, the signals and matched filter operate in discrete time, but MATLAB requires you to work in discrete time. Propose a way to simulate the operation of the matched filter using MATLAB (e.g., by sampling the filter and signals at many points from $t = 0$ to $t = T$, and performing operations in discrete time).

For all signal sets, 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 1000 bits of binary data at random (where the digits 0 and 1 have equal probability). For each bit, according to the simulation scheme you proposed, generate the signal $s_0(t)$ or $s_1(t)$, as appropriate; add Gaussian noise; pass the noisy signal through the matched filter; and (based on the matched filter output) decide whether the bit is 0 or 1. Calculate the probability of 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;
- A description of your simulation scheme;
- Your MATLAB code for section 2; and
- Plots for the three signal sets, from part 3 of section 2.