York University

Department of Electrical Engineering and Computer Science

EECS 4214

Lab #5 Likelihood Functions and Baseband Detection

Optimal Design, Simulation, and Analysis

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1. Purpose

In this lab, you will be introduced to the concept of likelihood functions, modeling and simulation of data detection in a receiver, and the concept and origin of bit-error rate. Using a computer, you will learn how to analyze the operation and performance of such blocks according to the results achieved during the operation of a digital communication system.

2. Objectives

By the end of this project, you will be able to: 1) Explain and find the likelihood functions for the binary symbols receiving through a noisy channel, 2) Statistically analyze the operation of the decision-making block when the input is influenced by noise, and 3) Characterize the performance of the detector in terms of bit-error rate as a function of the input signal-to-noise ratio.

3. References

1) Handouts available on the course homepage on Lassonde.

2) Bernard Sklar text: Chapter 3.

Problem 1 Likelihood Functions and Baseband Detection

In MATLAB®,

1.1 ***Test Vector--*** Generate and plot an NRZ-L baseband signal, $s(t)$, for the 8-bit binary sequence of 10110001 with

- 1's represented by $s_1(t)$ = A = +5V,
- 0's represented by $s_2(t)$ = –A = –5V,
- Bit time: T_B=1μs, and
- Time step: T_S=10ns
- Transition time for both 0→1 and 1→0: T_T=10ns.

Now, repeat the above 8-bit binary sequence 100 times to make an 800-bit binary test vector.

1.2 ***Additive Noise--*** Add *additive white Gaussian noise* (*AWGN*), $n(t)$, to the baseband signal in part 1.1 in order to make a noisy signal $z(t)=s(t) + n(t)$ as the input to a receiver. Set the signal-to-noise ratio (SNR) of your noisy signal ($z(t)$) to 10dB.

1.3 ***Sampling--*** Sample the noisy signal $z(t)$ in the middle of each bit time: $z_S(k)=z((2k-1)T_B/2)$ for k=1, 2, 3, …, 800.

1.4 ***Detection--*** For the detection of the received bits, try different threshold levels (γ_0) around 0V to achieve the best possible *bit-error rate* (*BER*). Report the BER and the associated threshold level.

1.5 Repeat parts 1.2-1.4 for SNR=8dB, 6dB, 4dB, and 2dB. Plot the achieved BER values vs. SNR.

1.6 ***Likelihood Functions--*** With a statistical approach and using the amplitude of the samples in your noisy signal, plot the *probability density function* (*PDF*) of all the five noisy signals (SNR_{dB}=10, 8, 6, 4, 2) separately. Try to relate the BER in each SNR scenario with the associated PDF plot and threshold level.