ECE 345: Linear Systems and Signals

Fall 2020

**Lab #1 Report**

Note: you can use the equation editor in MS Word or a tool such as LaTeXiT to generate formulas for questions which ask about formulas. Alternatively, you can write your derivation and put a photo into the box.

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| **Part 1 (18 points)** | **Part 2**  **(14 points)** | **Part 3**  **(14 points)** | **Part 4**  **(18 points)** | **Part 5**  **(12 points)** | **TOTAL (76 points)** |
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Group members:

* A
* B
* C
* D

**Part 1: simulating the received signals (18 points)**

1. (4 points) Write the formula that you derived for the two delays. Show your work.
2. (2 points) What is the frequency of the *s(t)* in Hertz?
3. (4 points) Provide a plot of the received signals. Make the plots vertically stacked, so the signal from the first microphone is above the signal from the second microphone.
4. (8 points) Provide your function lab1sim() in the .zip file and upload it with this report.

**Part 2: estimating the location (14 points)**

1. (2 points) Why can’t the receiver use its two antennas to find the absolute delay to each microphone?
2. (4 points) Give the plots of the xcorr() function requested in the lab. Give both the full plot and the zoomed in plot. Label where the estimate of the relative time shift is on the plot
3. (4 points) Provide the formula for *L*. Show your work.
4. (4 points) Give the true and estimated values of *L*. Explain why they are the same or different.

**Part 3: automating the estimates (14 points)**

1. (nothing to turn in)
2. (8 points) Upload your function lab1est()in the .zip file and upload it with this report.
3. (6 points) Provide your plot of the true *L* versus the estimated *L*. Explain in words why the plot looks the way it does.

**Part 4: impact of noise (18 points)**

1. (8 points) Give the values of the estimated *L*, true *L*, and the difference for the two given values of alpha.
2. (6 points) Provide a plot of the mean squared error (MSE) as a function of alpha. Explain in words why the plot looks the way it looks.
3. (4 points) Where does the noise affect the estimator, causing errors?

**Page 5: the bigger picture (12 points)**

1. (4 points) What should be the effect of decreasing *A* on the estimates and why? (Make sure you think about the noise)
2. (4 points) How would a third microphone in the array help you in the estimation task?
3. (4 points) Where would you place a third microphone and what might it let you do? (Think about GPS)