

This homework is due Nov 8, 2016, at 1PM.

1. Homework process and study group

Who else did you work with on this homework? List names and student ID's. (In case of hw party, you can also just describe the group.) How did you work on this homework?

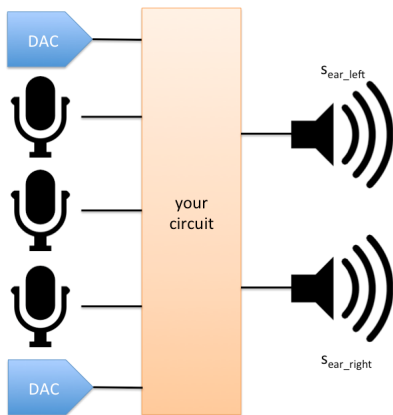
Working in groups of 3-5 will earn credit for your participation grade.

2. Noise Cancelling Headphones

Implement the full noise-cancelling headphone amplifier seen in discussion. Recall that the stereo output is calculated using the following matrix equation:

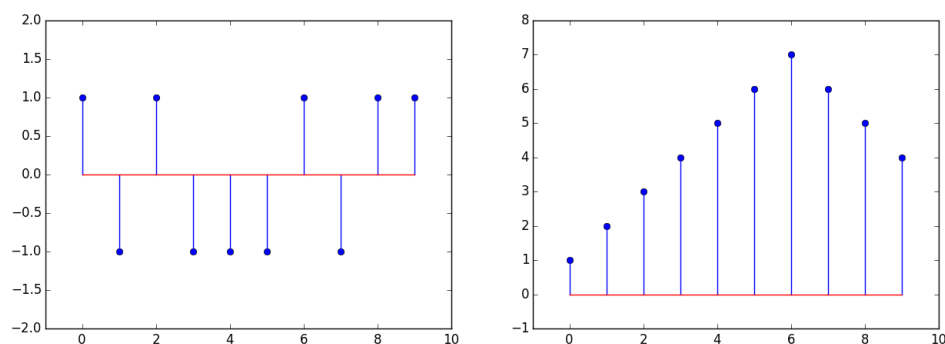
$$\begin{bmatrix} s_{ear_left} \\ s_{ear_right} \end{bmatrix} = \begin{bmatrix} a_{1left} & a_{2left} & a_{3left} \\ a_{1right} & a_{2right} & a_{3right} \end{bmatrix} \cdot \begin{bmatrix} s_{mic1} \\ s_{mic2} \\ s_{mic3} \end{bmatrix} + \begin{bmatrix} s_{left} \\ s_{right} \end{bmatrix}$$

A block diagram of the circuit is given below:



Remember the outputs of the DAC range from 0 – 1V and outputs of the microphones range from –1.5V to 1.5V. The output should range from –1.5V to 1.5V. Refer back to discussion 9B and 10A for help.

3. Mechanical: Correlation



- Calculate and plot the **autocorrelation** (the inner products of one period of the signal with all the possible shifts of one period of the same signal) of each of the above signals. Each signal is periodic with a period of 10 (one period is shown).
- Calculate and plot the **cross-correlation** (the inner products of one period of the first signal with all possible shifts of one period of the second signal) of the two signals. Each signal is periodic with a period of 10 (one period is shown).

4. Inner products

The Cauchy-Schwarz inequality states that for two vectors $\vec{x}, \vec{y} \in \mathbb{R}^n$:

$$|\langle \vec{x}, \vec{y} \rangle| = |\vec{x}^T \vec{y}^*| \leq \|\vec{x}\| \cdot \|\vec{y}\|$$

Use the Cauchy-Schwarz inequality to verify (i.e. prove or derive) the triangle inequality:

$$\|\vec{x} + \vec{y}\| \leq \|\vec{x}\| + \|\vec{y}\|$$

(Hint: Start with $\|\vec{x} + \vec{y}\|^2$)

5. Redo the midterm.

Redo the midterm problems (released Thursday after the midterm).

- Your Own Problem** Write your own problem related to this week's material and solve it. You may still work in groups to brainstorm problems, but each student should submit a unique problem. What is the problem? How to formulate it? How to solve it? What is the solution?