

Two Microphones: Exercises

DSP Lab (ECE 4163 / ECE 6183)

We use the cross-correlation of stereo channels to estimate the angle of arrival of an audio signal.

Demo files:

```
record_stereo.py
demo_two_microphones.m
stereo_audio-ah.wav
stereo_audio-sh.wav
stereo_audio-whistle.wav
```

Figures should be submitted as a single pdf file with multiple pages.

Exercises

1. Read and run the Matlab demo file. Understand each step of the file. Run the file with each of the three provided wave files. (Nothing to submit.)
2. **Sound in line with microphones.** Make your own stereo recordings like those provided in the demo. Place yourself at a point that is collinear with the two microphones. Record yourself saying ah, sh, and whistling. Identify an approximately stationary segment in each case. As in the demo, compute and display the autocorrelation and cross-correlation functions in each case. (They may look quite different than those in the demo due to variation among people.) Comment on the autocorrelation and cross-correlation functions you get.

Use the stereo recordings to compute the time delay between the two microphones by finding the peak of the cross-correlation function. Convert the time delay to distance using the speed of sound. Is the distance between the two microphones accurately estimated?

To submit: Your stereo wave file. Plots of autocorrelation and cross-correlation functions. Indicate the peak of your cross-correlation function.

3. **Sound at angle to the microphones.** Repeat the experiment, this time standing at some angle θ with respect to the line formed by the two microphones (see Fig. 1). Using the known distance between the two microphones (measure the distance with a ruler) calculate the angle θ ('angle of arrival') based on the time delay as measured by the peak of the cross-correlation. Does the calculated angle θ agree with the true angle?

To submit: Plots of cross-correlation functions with the peak indicated.

With your submitted work, include explanations and comments.

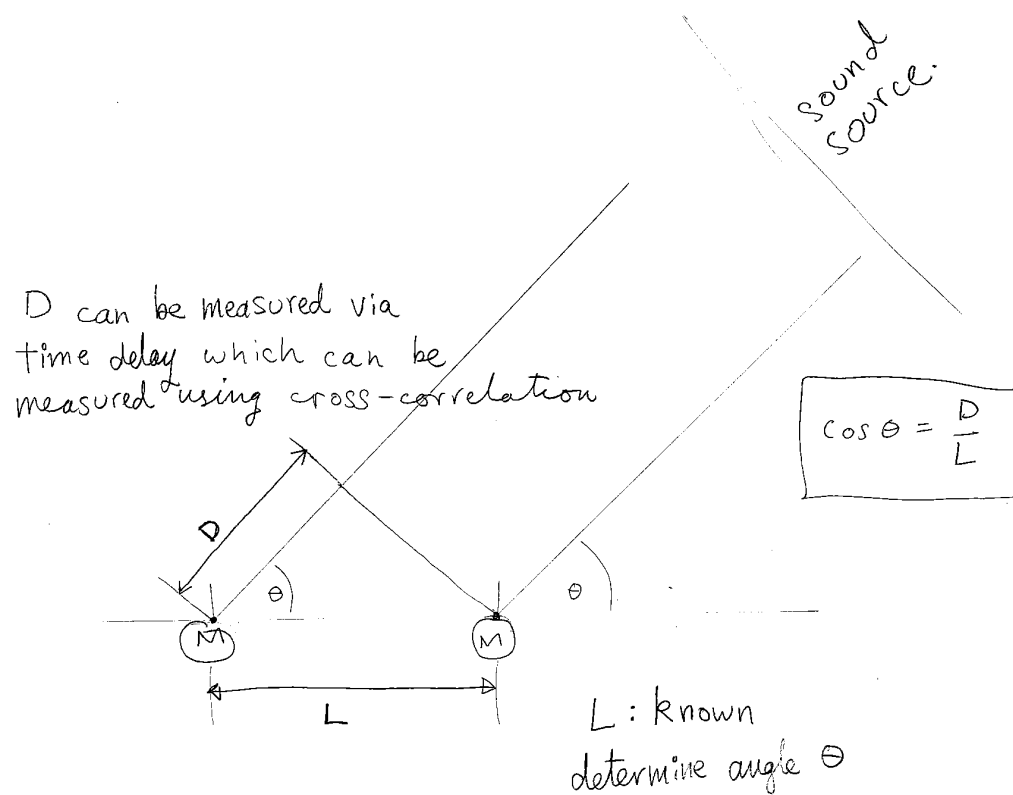


Figure 1: Two microphones and the angle of arrival.