EE 367 Lab 7

Spectral-Based Acoustic Measurements and the DFT

Report by:
Ethan Vosburg (evosburg@calpoly.edu)
Isaac Lake (ilake@calpoly.edu)

March 10, 2024

Table of Contents

1 Implement a DFT

In part 1 we will be implementing a DFT filter.

1. Include a plot of the magnitude spectrum for the cos _1khz _20msec signal

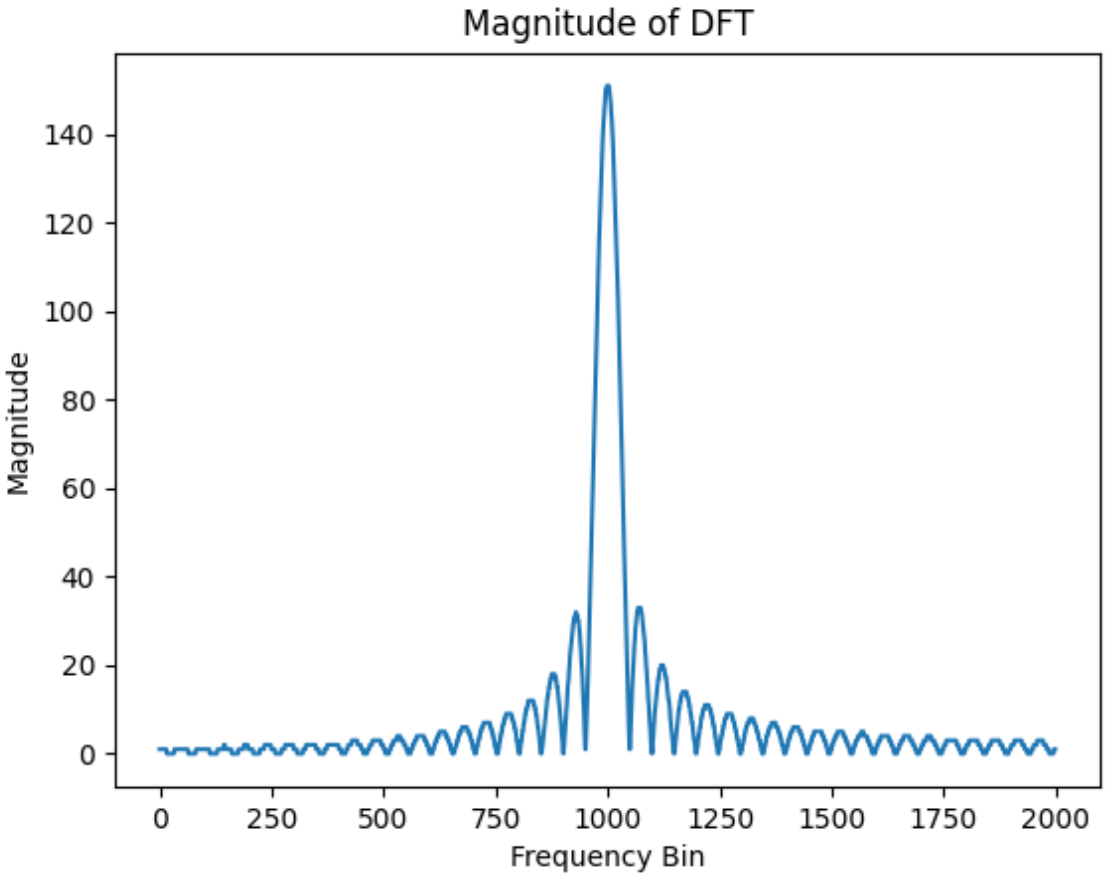


Figure 1: Impulse Sample without Delay

2. What is the width of each side lobe observed in the spectrum? How does it compare to the theoretical value of 1/(pulse duration) = 1/(20mSec)?

   It is roughly 50 Hz for each sidelobe which lines up exactly with what the theoretical would be.
3. Documentation: The Python code that implements the DFT

2 Simulate a Measured Signal

In part 2 of this lab we will implement a sound impulse generator.

1. Include a plot of the magnitude spectrum for the simulated measurement signal

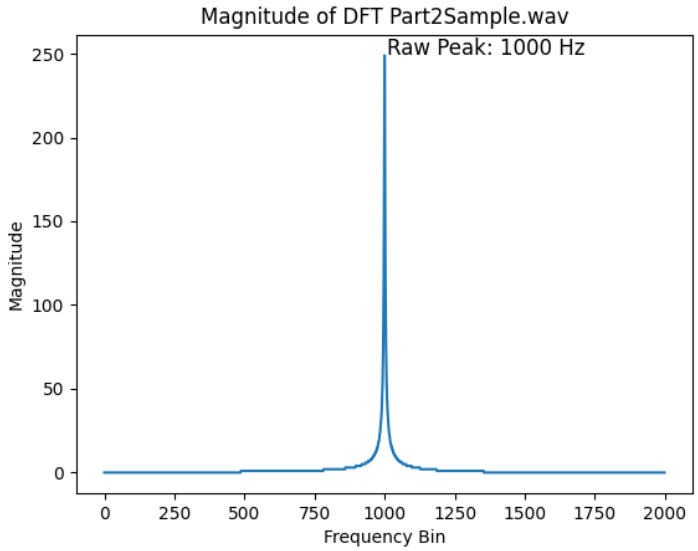


Figure 2: Impulse Sample without Delay

2. Include a plot of the magnitude spectrum for a version of the simulated signal that is delayed by 0.1 Sec

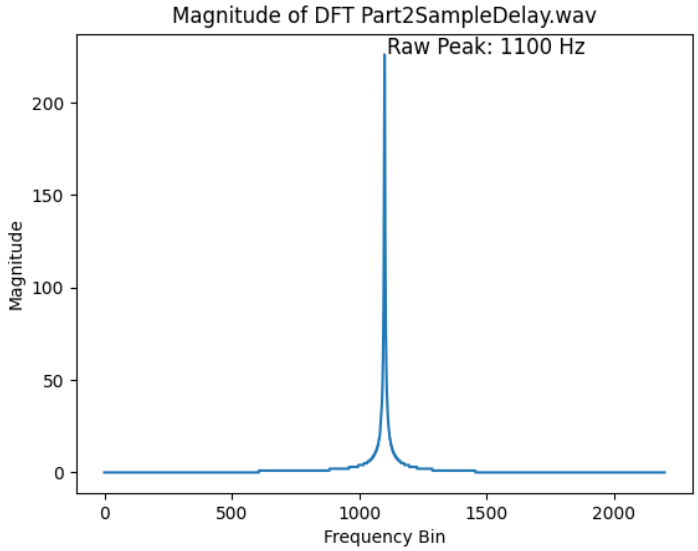


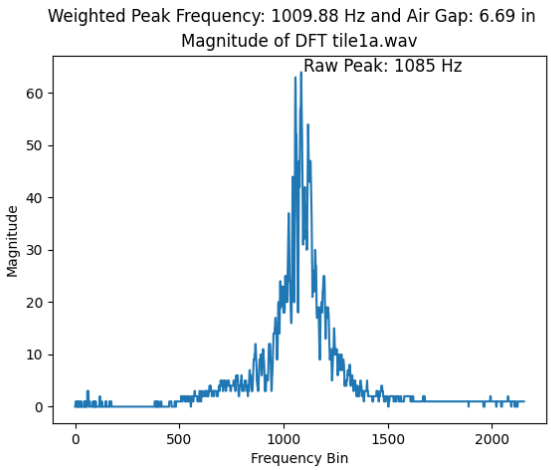
Figure 3: Impulse Sample with Delay

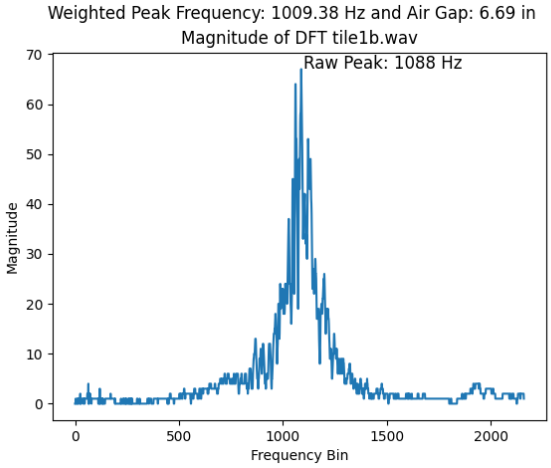
3 Measure the Size of the Air Gap

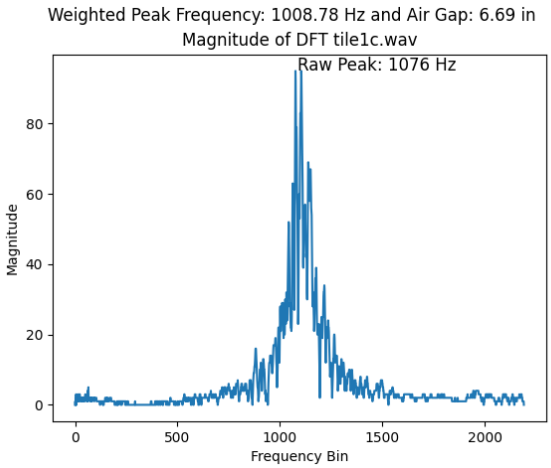
In part 3 of this lab we will be using our DFT and peak finder to calculate the resonant frequency of the air gap.

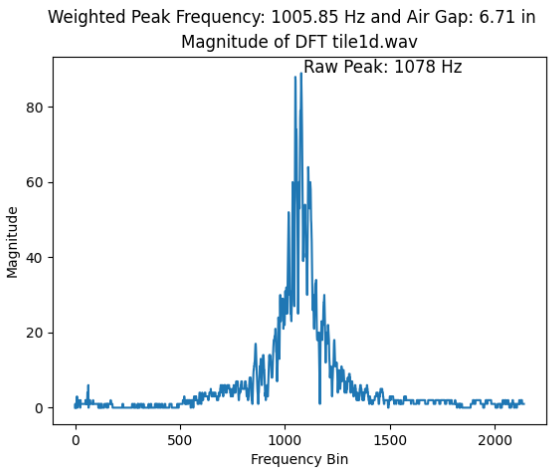
Tile	Raw Peak Frequency (Hz)	Weighted Average Peak (Hz)	Measured Air Gap (in)
1a	1085	1009.88	6.69
1b	1088	1009.38	6.69
1c	1076	1008.78	6.69
1d	1078	1005.85	6.71
1e	1076	1007.58	6.70
2a	895	820.55	8.23
2b	931	821.39	8.22
2c	938	821.93	8.21
2d	920	822.49	8.21
2e	925	819.7	8.24

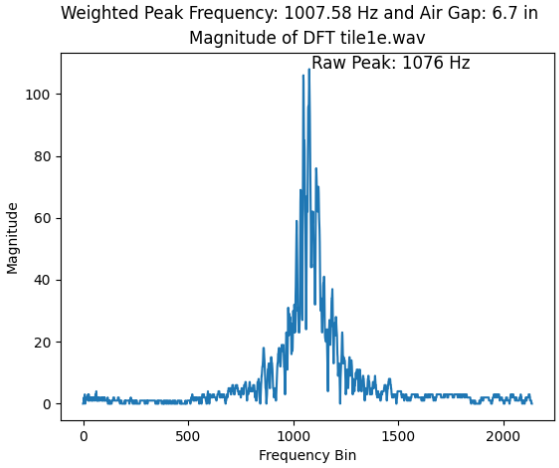
Table 1: Results Table from Frequency Analysis

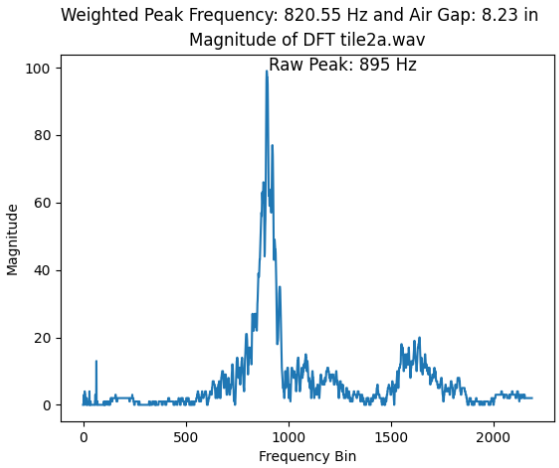


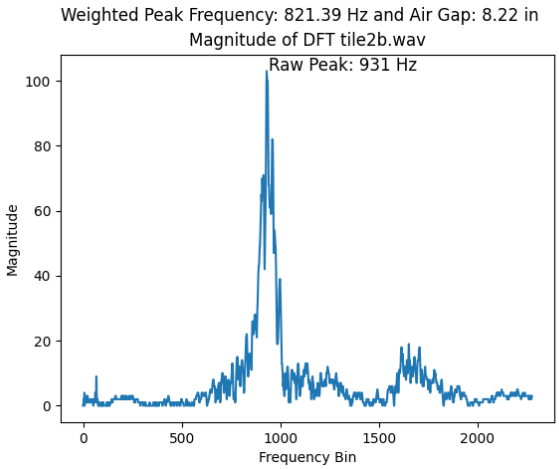

Weighted Peak Frequency: 1009.38 Hz and Air Gap: 6.69 in
Magnitude of DFT tile1b.wav
Raw Peak: 1088 Hz
Magnitude
Frequency Bin
0
10
20
30
40
50
60
70
0
500
1000
1500
2000

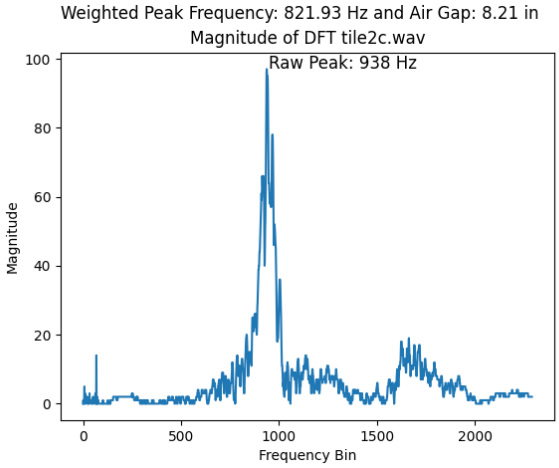

Weighted Peak Frequency: 1008.78 Hz and Air Gap: 6.69 in
Magnitude of DFT tile1c.wav
Raw Peak: 1076 Hz
Magnitude
Frequency Bin
0
20
40
60
80
0
500
1000
1500
2000

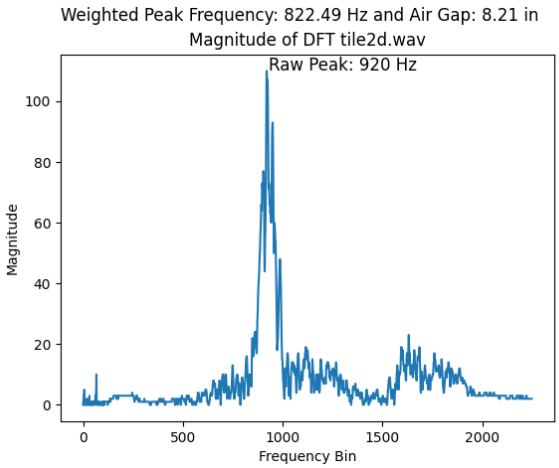

Weighted Peak Frequency: 1005.85 Hz and Air Gap: 6.71 in
Magnitude of DFT tile1d.wav
Raw Peak: 1078 Hz
Magnitude
Frequency Bin
0
20
40
60
80
0
500
1000
1500
2000

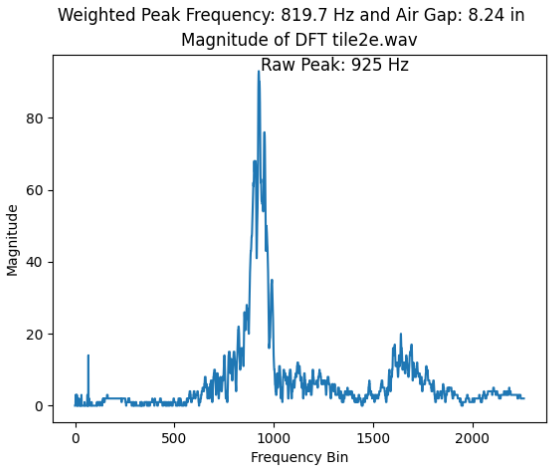

Weighted Peak Frequency: 1007.58 Hz and Air Gap: 6.7 in
Magnitude of DFT tile1e.wav
Raw Peak: 1076 Hz
Magnitude
Frequency Bin
0
20
40
60
80
100
0
500
1000
1500
2000


Weighted Peak Frequency: 820.55 Hz and Air Gap: 8.23 in
Magnitude of DFT tile2a.wav
Raw Peak: 895 Hz
Magnitude
Frequency Bin
0
20
40
60
80
100
0
500
1000
1500
2000


Weighted Peak Frequency: 821.39 Hz and Air Gap: 8.22 in
Magnitude of DFT tile2b.wav
Raw Peak: 931 Hz
Magnitude
Frequency Bin
0
20
40
60
80
100
0
500
1000
1500
2000


Weighted Peak Frequency: 821.93 Hz and Air Gap: 8.21 in
Magnitude of DFT tile2c.wav
Raw Peak: 938 Hz
Magnitude
Frequency Bin
0
20
40
60
80
100
0
500
1000
1500
2000


Weighted Peak Frequency: 822.49 Hz and Air Gap: 8.21 in
Magnitude of DFT tile2d.wav
Raw Peak: 920 Hz
Magnitude
Frequency Bin
0
20
40
60
80
100
0
500
1000
1500
2000


Weighted Peak Frequency: 819.7 Hz and Air Gap: 8.24 in
Magnitude of DFT tile2e.wav
Raw Peak: 925 Hz
Magnitude
Frequency Bin
0
20
40
60
80
0
500
1000
1500
2000