APL Assignment 7

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1 Q and A

1.1 Q1

The plots below show two example sinc pulses. How will you generate pulses that look like this? Which parameter should be changed? What effect do you think this will have on the final image?
sincP is the scaling factor which means that increasing sincP would compress the waveform's graph, and decreasing would decompress the graph. Highly compressed waveforms, give us more resolved reconstructed images.

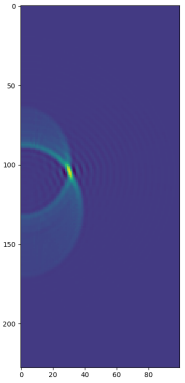

Figure 1: SincP=5

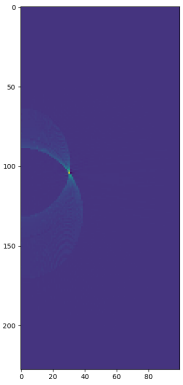

Figure 2: SincP=20

1.2 Q2

Does it make sense to reconstruct up to Nsamp? What value is more reasonable as an upper limit for the x-axis here?
Reconstructing till Nsamp/2 should suffice as that is the farthest the object can be present at.

1.3 Q3

The (x, y) coordinates corresponding to the maximum amplitude (yellow colour) is approximately (30, 22). Explain why this is the correct expected position for the given obstacle.
In DAS imaging, the algorithm aligns signals from multiple microphones to sum constructively at the obstacle's position, creating a peak in amplitude. The yellow color indicates this high amplitude, signifying the exact spot where the sound waves have constructively interfered

1.4 Q4

What is the maximum obstacle x- and y- coordinate that you can use and still have an image reconstructed?
The maximum x-coordinate is

$$\frac{N_{samp}}{2} \times distpersample,$$

because the sound travels to the obstacle and then back to the microphone, using a total of N_{samp} samples.

For the y-coordinate, if the obstacle is at distance x from the origin, the maximum y-coordinate is determined by the distance the sound travels from

the obstacle to the topmost microphone. The y-coordinate of the topmost microphone is

$$\frac{N_{mic}}{2} \times pitch.$$

Thus, the maximum y-coordinate is

$$y_{max} = N_{samp} \times distpersample + \frac{N_{mic}}{2} \times pitch.$$

1.5 Q5

What happens if C is different - if C is decreased it looks like the image becomes sharper. Can you explain why intuitively?
The time step between consecutive samples is proportional to the distance between them, divided by C. Specifically, it's given by:

$$\Delta t = \frac{distpersample}{C}$$

As C decreases, the value of Δt increases, meaning each sample is taken at a greater interval. This results in a less smooth transition between amplitude values, with the signal changing more sharply. Essentially, the signal is sampled less frequently, and the smoother gradual change in amplitude is replaced by a more abrupt drop, which makes the image appear sharper.

1.6 Q6

What happens if Nmics is increased or decreased? Do the experiments with Nmics = [8, 32, 64] and Nsamp = [50, 100, 200] (all combinations). Attach the resulting images.
Increasing the number of Nmics, increases the precision in identifying location of objects.

1. Nmics = 64

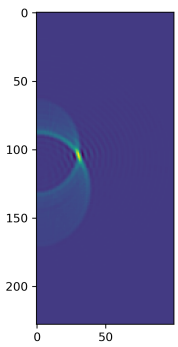

Figure 3: Nsamp = 200

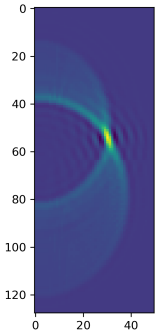

Figure 4: Nsamp = 100

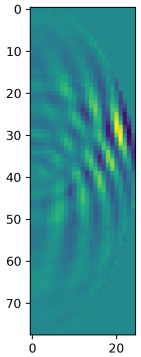

Figure 5: Nsamp = 50

2. Nmics = 32

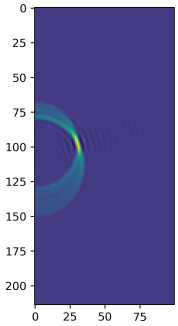

Figure 6: Nsamp = 200

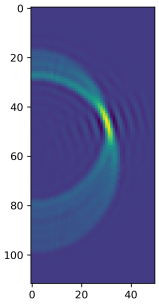

Figure 7: Nsamp = 100

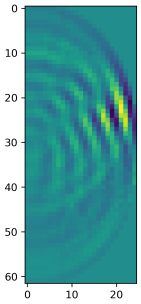

Figure 8: Nsamp = 50

3. Nmics = 8

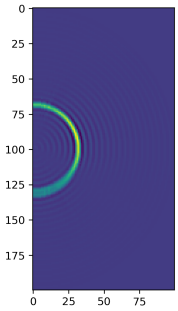

Figure 9: Nsamp = 200

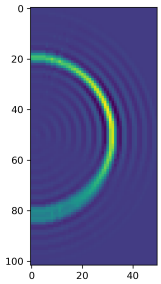

Figure 10: Nsamp = 100

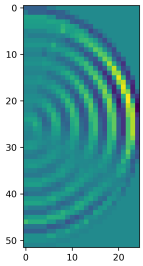

Figure 11: Nsamp = 50

2 Setup and Generating Mic Output

(a) Nmics = 64
(b) Nsamp = 200
(c) C = 2.0
(d) pitch = 0.1
(e) Obstacle Location = (3,-1)

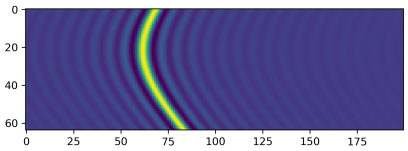

Figure 12: heatmap

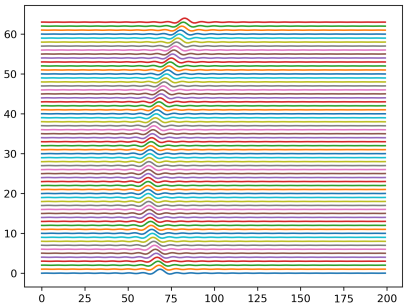

Figure 13: timeplot

Running python3 ee23b008.py generates the heatmap, timeplot, and the reconstructed image as well.

3 Delay-and-Sum algorithm

Reconstruct the image from the data by running the command `python3 ee23b008.py`

3.1 DAS reconstruction output for rx2.txt and rx3.txt

Used `= np.loadtxt("rx3.txt")` right before recontructing in the program to get this output.

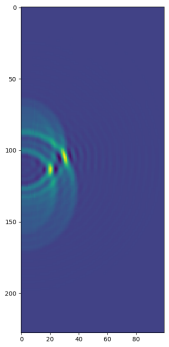

Figure 14: rx2.txt

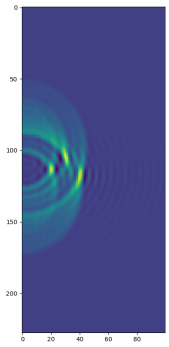

Figure 15: rx3.txt

-rx2 and rx3 have two common objects approximately at (20, 120) and (30, 100). And there is a third object at (40,125) in rx3.