APL Assignment 7

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EE23B140

1 Questions

QUESTION: 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?

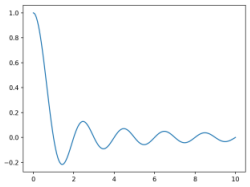
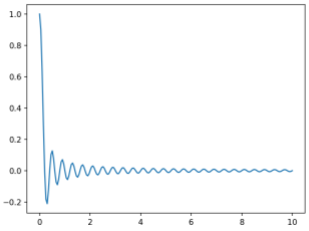


Figure 1: Sinc Pulse 1

ANSWER: The given sinc pulse can be generated without scaling or shifting our sinc function and using it directly on the t array.
Here, the first value in the linspace function can be anything less than 0 as well but then in the plt.plot(t, y) it will show the plot from that value but centered around zero. So to get the perfect plot as shown we should use starting value as 0.

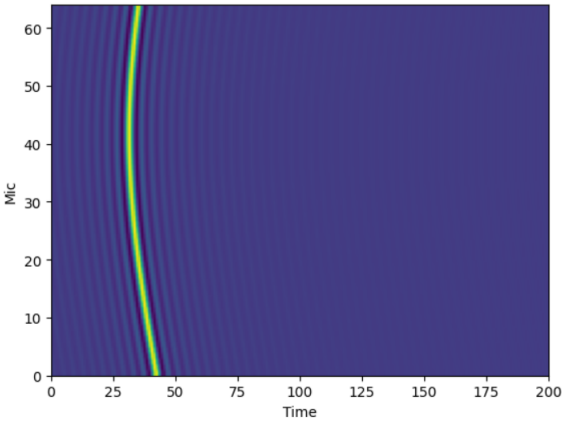
```
# Define time axis
t = np.linspace(0, 10, 200)
# Compute the sinc function
y = np.sinc(t)

# Plot the sinc function
plt.plot(t, y)
plt.title('Sinc Function')
plt.xlabel('t')
plt.ylabel('sinc(t)')
plt.grid()
plt.show()
```



ANSWER: This pulse is obtained by simply scaling up t by a factor greater than 1 for example : y = np.sinc(5*t)

- Construct an (X, Y) grid of points where the Y-axis corresponds to the microphone locations, and the X-axis corresponds to time samples. The simple solution would seem to indicate that we go up to Nsamp.
  - **QUESTION** - Does it make sense to reconstruct up to Nsamp? What value is more reasonable as an upper limit for the x-axis here?

ANSWER: There is no need to reconstruct upto Nsamp. You can just reconstruct upto the value of the maximum sample which records the maximum amplitude (which is 50 in this case).



QUESTIONS

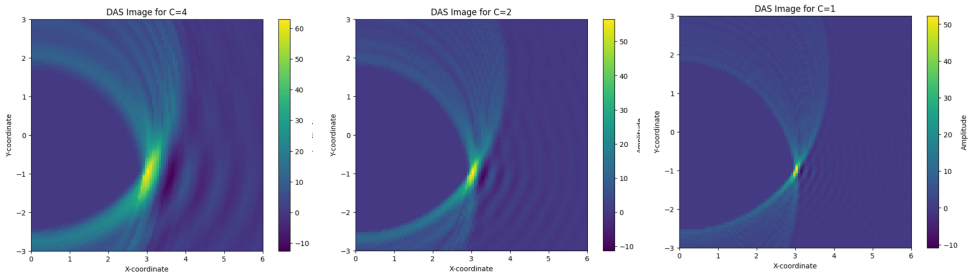
- The (x, y) coordinates corresponding to the maximum amplitude (yellow colour) is approximately (30, 22). Explain why this is the correct expected position for the given obstacle.
- What is the maximum obstacle x- and y- coordinate that you can use and still have an image reconstructed?
- What happens if C is different - if C is decreased it looks like the image becomes sharper. Can you explain why intuitively?
- 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.

ANSWER:
1. The location of the obstacle is (3,-1) is distance coordinates. The microphones start approximately from y coordinate -3.2 with a pitch of 0.1 which means the 22nd microphone will be at y coordinate -1. This indicates the given y coordinate in the question i.e (30,22) is the microphone number.
The distance of microphone from source (0,0) is approximately 3 units. If you divide this by the speed of sound that is 2, we get t = 1.5 units which implies total time to hit the obstacle and come back is t*2 = 3 units. Since dist_per_samp = 0.1 units, the actual time delay is 3/0.1 = 30. This is the given x coordinate.

2. The maximum obstacle x and y coordinate that we can use for image reconstruction are the coordinates for which total distance travelled from source to obstacle to microphone is within 2000 units.
This is because we have valid data only for given 200 time samples so if my delay exceeds that it will not be considered as specified in the code here.

```
# Ensure delay is within the valid range of indices
if 0 <= delay < 200:
    total_signal += mic_outputs[mic_index, delay]
```

3. For different values of C, it is observed that the image becomes sharper if C is decreased. This is because decreasing C decreases the distance per sample decreases which leads to higher number of steps/more precision.



4. The 9 heatmaps for this question have been attached in the code python notebook. It is observed in general that the images become sharper with higher number of microphones and samples.