Sound Localization

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Objective

1. Construct an array of microphones and simulate a sonar pulse signal by creating the output of the microphones due to an object (perfect point scatterer).
2. Reconstruct an image using the Delay-and-Sum algorithm to find the position of an obstacle given a file of the microphone outputs.

Note: The files 'rx2.txt' and 'rx3.txt' will need to be present in the same folder as 'soundLocalization.ipynb'

Procedure

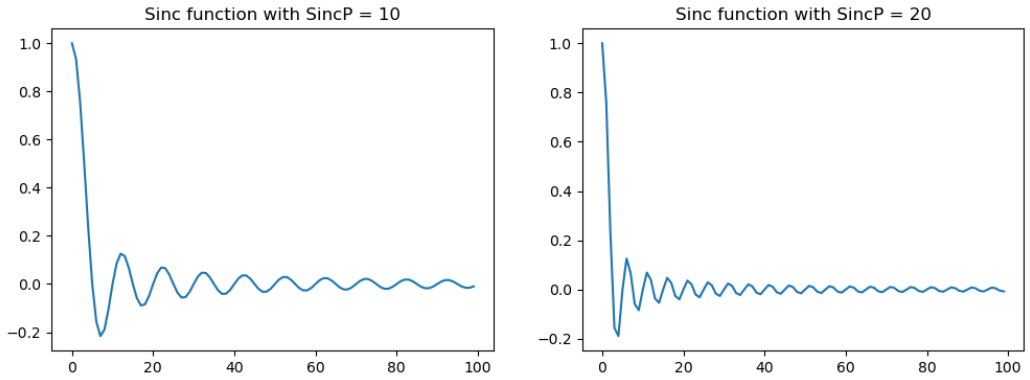
I first created the functions and plotted the sinc function. I then followed the method of shifting back the initial output sinc pulse to obtain a plot for the output of each microphone as a function of time.

Taking this data, I then followed the DAS algorithm to reconstruct an image of the objects present, creating a Heatmap for it.
I then took in the 2 datasets provided and performed the same reconstruction process.
Finally, I varied parameters such:
1. Speed
2. Nmic and Nsamp

to observe their effects of the reconstructed images.

Results and Answers

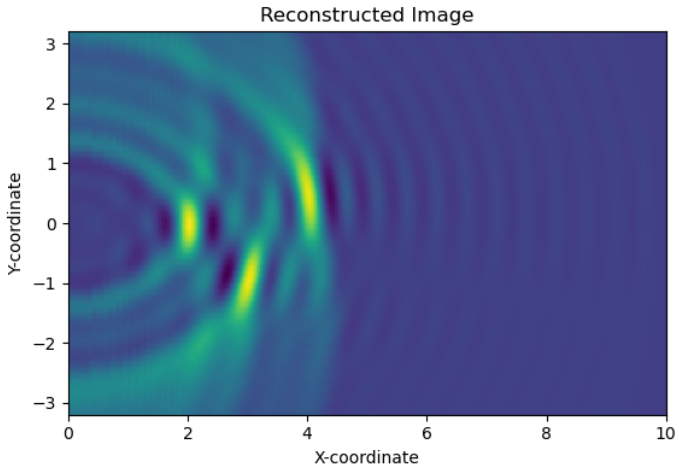
Sinc Function Parameters:



It can be seen that varying 'SincP' varies both the frequency as well as the Decay rate of the sinc function.
Varying 'C' also performs the same function, except it is inversely proportional.

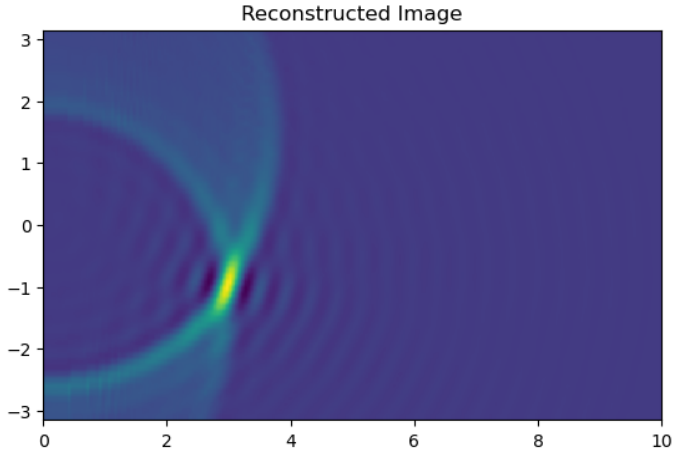
No. of Samples Required to Reconstruct:

In the code I have used, I only considered the first 100 samples (200 were given). We can reconstruct an image with data upto the time of the last microphone's sinc pulse (with some buffer). Here it comes out to be within the first 100 time samples.



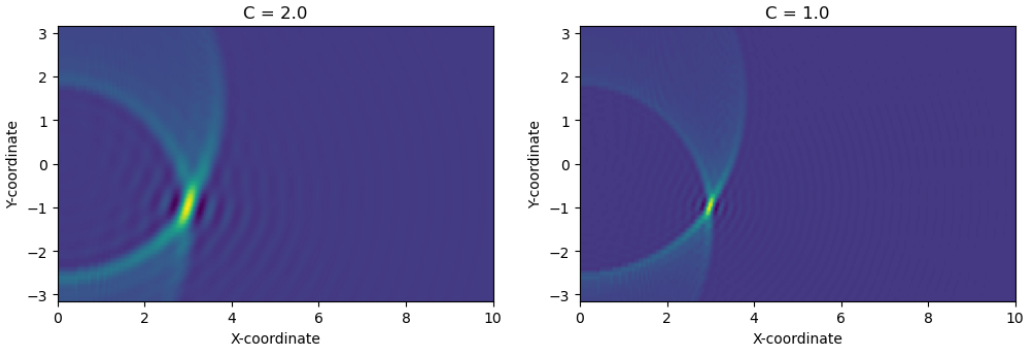
The above is the image from 'rx3.txt'. It can be seen that there are 3 objects at (2,0), (3,-1) and (4,0.5) respectively.

Interpreting co-ordinates of Maxima



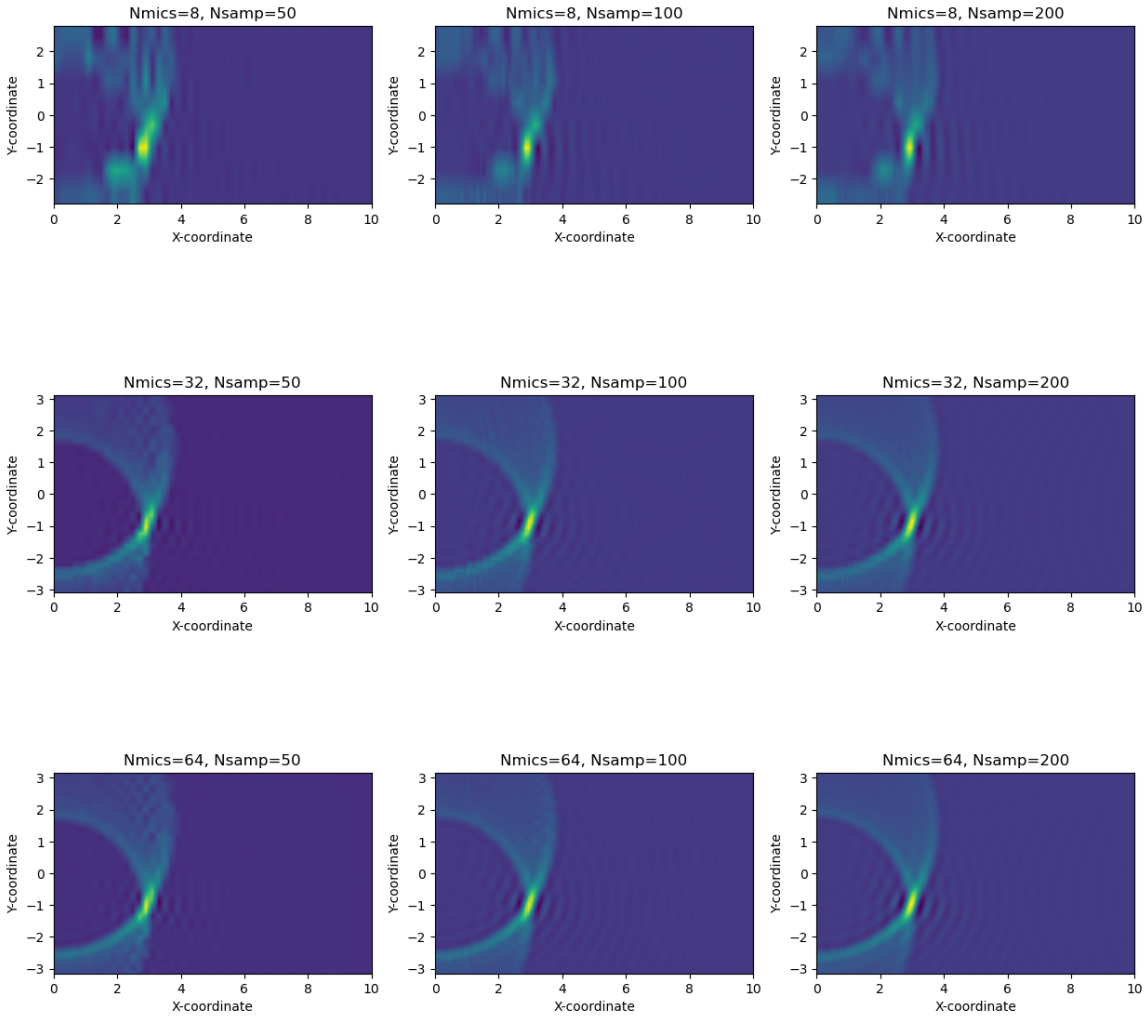
Here, it can be seen that the Maxima is at (3,-1) which was the first part of the assignment. In the Heatmap in the handout, the position was (30, 22). The reason for this is that: 1. The y-axis represented the index of the microphone and the 22nd microphone was placed at a y-coordinate of -1. 2. The x-axis represented the heatmap plot index. Here there were 200 samples and 'dist_per_samp = 0.1' so the 30th sample corresponds to a x-coordinate of

Varying 'C':



It can be seen that decreasing C is causing a sharper image. This is due to the fact that the sinc function becomes sharper and decays faster at smaller C values.

Varying Nmics and Nsamp:



It can be seen that as we increase the number of mics or the sampling rate, we can construct better and better images.
However, after Nmics=32 and Nsamp=100 in our case, the image quality is nearly the same. The slight blurryness observed is a consequence of the characteristic nature of the sinc pulse.