AMATH 582 Winter Quarter 2021

Homework 1: A submarine problem

DUE: Wednesday, Jan. 27, 2021

You are hunting for a submarine in the Puget Sound using noisy acoustic data. It is a new submarine technology that emits an unknown acoustic frequency that you need to detect. Using a broad spectrum recording of acoustics, data is obtained over a 24-hour period in half-hour increments. Unfortunately, the submarine is moving, so its location and path need to be determined.

Try to locate the submarine and find its trajectory using the acoustic signature. Also identify the acoustic admissions of this new class of submarine. Go to the class webpage and download: **subdata.mat** or **subdata.csv** . This containes 49 columns of data for measurements over a 24-hour span at half-hour increments in time.

1. Through averaging of the spectrum, determine the frequency signature (center frequency) generated by the submarine.
2. Filter the data around the center frequency determined above in order to denoise the data and determine the path of the submarine. (use plot3 to plot the path once you have it)
3. Where should you send your P-8 Orion sub-tracking aircraft (the x and y coordinates to follow the submarine.

Good luck, and I hope you track that submarine.

The following code will help you get started in analyzing the data. It also tells you the spatial and spectral resolution of your acoustic equipment. (NOTE: the reason for the **close all** command before **isosurface** is that **isosurface** doesn't seem to clear the previous imagine before plotting a new one)

```
% Clean workspace
clear all; close all; clc

load subdata.mat % Imports the data as the 262144x49 (space by time) matrix called subdata

L = 10; % spatial domain
n = 64; % Fourier modes
x2 = linspace(-L,L,n+1); x = x2(1:n); y =x; z = x;
k = (2*pi/(2*L))*[0:(n/2 - 1) -n/2:-1]; ks = fftshift(k);

[X,Y,Z]=meshgrid(x,y,z);
[Kx,Ky,Kz]=meshgrid(ks,ks,ks);

for j=1:49
    Un(:,:,:)=reshape(subdata(:,j),n,n,n);
    M = max(abs(Un),[],'all');
    close all, isosurface(X,Y,Z,abs(Un)/M,0.7)
    axis([-20 20 -20 20 -20 20]), grid on, drawnow
    pause(1)
end
```