AMATH 582 Winter Quarter 2020

Homework 1: An ultrasound problem
DUE: Friday, Jan. 24, 2020

You dog fluffy swallowed a marble. The vet suspects that it has now worked its way into the intestines. Using ultrasound, data is obtained concerning the spatial variations in a small area of the intestines where the marble is suspected to be. Unfortunately, fluffy keeps moving and the internal fluid movement through the intestines generates highly noisy data.

Do you want your dog to live? In order to save your dog's life you must located and compute the trajectory of the marble. Go to the class webpage and download: **Testdata.mat**. This containes 20 rows of data for 20 different measurements that were taken in time.

1. Through averaging of the spectrum, determine the frequency signature (center frequency) generated by the marble.

2. Filter the data around the center frequency determined above in order to denoise the data and determine the path of the marble. (use plot3 to plot the path once you have it)

3. Where should an intense acoustic wave be focused to breakup the marble at the 20th data measurement.

Good luck, and I hope your dog doesn't die.

The following code will help you get started in analyzing the data. It also tells you the spatial and spectral resolution of your ultrasound 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)

```
clear all; close all; clc;
load Testdata

L=15; % 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=1:20
    Un(:,:,:)=reshape(Undata(j,:),n,n,n);
    close all, isosurface(X,Y,Z,abs(Un),0.4)
    axis([-20 20 -20 20 -20 20]), grid on, drawnow
    pause(1)
end
```