**Homework Project # 7 (10 points)** **Due Date: 03/28/2019**

In this project, you will implement frequency domain filtering to minimize the effects of image noise. The image file, Data 7X.tif, is a digitized, noise-corrupted thoracic radiograph. Two types of noise are present, Gaussian noise and fixed pattern noise (FPN). You are to minimize/eliminate the FPN, which appears as parallel streaks at a fixed periodicity. In the Fourier domain, this noise is represented by distinct peaks at a particular angle. Figure 1 shows the Fourier transform of one of the noisy lung images with DC and low frequency information suppressed. Note the peaks that correspond to the FPN in this case.

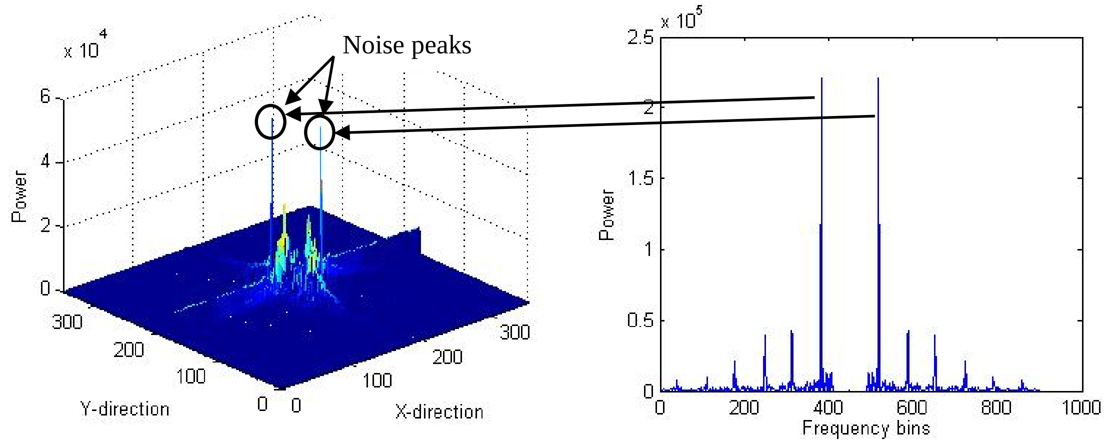


**Figure 1.** A 2-D FFT of the lung image showing dominant noise peaks caused by the periodic noise pattern. Sampling the FFT space at right angles to the noise direction provides a 1-D profile of the noise.

Each student will process two images with unique FPN noise orientations. Your images are:

Data_File_7__.tif and
Data_File_7__.tif.

The two objectives for this project are:

1. Determine the direction (in units of degrees) of the FPN in your lung image by identifying the noise peaks in the Fourier domain. One strategy is to implement a “peak detector” that will radially scan the Fourier space in search of noise peaks that provide a signature as shown in Figure 1. As a first step, suppress DC/low frequency content by multiplying the Fourier-transformed image with a binary mask. For this step, the following code is provided to you:

```
f = fftshift(fft2(double(Image),pts,pts));  % Obtain Image FFT
[f1,f2] = freqspace([pts pts],'meshgrid');  % Define regular 2D array
Hw=ones(pts,pts);                            % Generate Filter Mask
r = sqrt(f1.^2+f2.^2);                       % Define filter Radius
Hw(r<cutoff) = 0;                            % Design Low-Pass Filter
f = f.*Hw;                                   % Suppress Low Frequencies
```

Here `pts` is the number of FFT points and `cutoff` represents the bound on the lower frequency suppression. The number of points used will impact your results; this number should be equal for both the x- and y-directions; you are also to determine the `cutoff` frequency value (recommended value: between 0.05 – 0.15).

2. Determine the appropriate peak detector threshold to detect the dominant noise peaks. While scanning for the peaks, be careful to avoid the prevalent Fourier components exhibited at 0 and 90 degrees that are a result of finite image borders and are independent of the noise.

3. Once the location of the noise peaks (orientation and frequency) is determined, suppress these peaks in the Fourier space. The quality of your results will be impacted by the means you choose to eliminate the peaks. Finally, reconstruct the noise-suppressed image using the inverse Fourier transform.

Report your findings with a brief ***Introduction*** to the Fourier Transform. Explain why the Fourier filtering approach will work in this situation. Describe your implementation of the Fourier domain filter in the ***Methods*** section. Summarize your ***Results***, noting the letters of your specific input images and stating the values you determined for noise orientation for each assigned image. Under ***Discussion***, discuss your success with FPN removal. List the advantages and disadvantages of Fourier techniques for image processing. Can you identify situations in which periodic noise exists, but frequency domain techniques are <u>not</u> advisable?

Electronically submit your .m files, output image and report files to Pilot, using the following naming conventions:

Code: “BME7112_HW7_YLN_yourFilename.m”

Output Images “BME7112_HW6_YLN_7X.tif”
Replace X with the letter of your assigned images

Report: “BME7112_HW7_YLN.docx” (or .pdf)