Assignment 3, Deadline Thursday 03rd Oct: 4PM

Q1,2 are theory
Q3,4 are coding

If you discuss the answers with any of your friends, clearly mention this all the names on written and coding assignments. OR, if your code is inspired from any other source, you must refer the source. In the absence of such references if assignments of more than one student is significantly similar, it may be fall under plagiarism.

Naming convention for both will be informed.

Q1. Find MxN 2D DFT of $\delta(x+1,y)+\delta(x-1,y)$. Show that this is a low pass filter. Investigate values at k,l = 0 and k=N/2, l=M/2, you should observe that DC values pass through whereas highest frequencies at k=N/2, l=M/2 are blocked.
Note: DFT take summation only in (0,0) to (M-1,N-1), whereas $\delta(x+1,y)$ lies at (-1,0). For any elements on negative X or Y axes, you need to take modulo operation. If you define N columns and M rows, and X as horizontal and Y as vertical, then,
-1 modulo N, 0 modulo M ie x will be N-1 and y will be 0.

Effectively, you have to take DFT of $\delta(x-(N-1),y)+\delta(x-1,y)$. [2]

Q2. An image has strong periodic horizontal lines, which filter will you use to eliminate these lines? Draw the rough spectrum of the filter in frequency domain. [2]

Q3. Write a program to compute 2-D convolution between f and w using DFT.

$$f=\begin{bmatrix}1 & 3 & 4\\ 2 & 5 & 3\\ 6 & 8 & 9\end{bmatrix} \quad w=\begin{bmatrix}-1 & -2 & -3\\ -4 & 0 & 1\\ -6 & -5 & -1\end{bmatrix}$$

Assume origin of image to be top left. Assume origin for w to be at center. You first need to arrange elements of w, such that all are in (0,0) to (4,4), since the resultant size would be 5x5. Print the obtained result and w. [3]

Q4. Perform unsharp masking via DFT. [3]

- Define the filter 3x3 box filter. Assume top left corner to be at origin
- Use Chandrayaan 2' image of assignment 2. From top left crop size of 512x512.
- Zero pad both to size of 514x514
- Perform FFT2 on both
- Take Hadamard product
- Subtract the product from FFT2 of zero padded image, this is mask
- Add the resultant to FFT2 of zero padded image
- Take IFFT2 of the resultant, followed by *real* operation
- Crop 512x512 from top left.
- Display unsharp masked image

- In case you are getting dark or white image, check of you operation are in unsigned integer or float/double.
- Is this image similar to the one that you obtained via spatial filtering in assignment 2?

Ungraded

Q1. Consider a 3x3 spatial mask which takes an average using four nearest neighbors of a point (x,y) but excludes the point itself from the average.

a. Find equivalent filter H(k,l) n frequency domain.
b. Show that the filter is low pass.

Remember for points in negative axes, you need to compute modulo.