Assignment 5

Instructions: Q1.b and Q3 are programming. Q1.a and Q2 are theory.
Deadline for theory: 1st Dec: 4:00 PM
Deadline for programming: 5th Dec: 4:00 PM

Q1. a. Find W. Consider L to be the FFT of Laplacian. G is the observed image, $F$is the true image. All other variables have their standard meanings.

$$\sum_k \sum_l |W(k,l)G(k,l) - F(k,l)|^2 + \gamma \sum_k \sum_l |L(k,l)W(k,l)G(k,l)|^2$$

Show that $W = \frac{H^*}{|H|^2 + \frac{|N|^2}{|F|^2} + \gamma \frac{|LG|^2}{|F|^2}}$

b. Use the above filter to denoise a corrupted image.
- Take Barbara image and add AWGN of mean 0 and variance of the order of 100. Note you can use any inbuilt function for this. Sometimes they may scale the values and may be expecting values of variance in the order of 0.01 or even smaller. In whatever way you give noise variance, make sure that noise is visible to human eye.
- Since F, N are unknown, replace them with a constant, say K. Using a grid search, check for what value of constant K and γ the denoised image gives best PSNR. For G, consider using $|G|^2 = |HF|^2 + |N|^2$
- Show the original image, noisy image, denoised image with best PSNR
- Compare the results with Wiener filter, that is, $\gamma = 0$

Q2. a. Consider 3x3 image pixels f(x,y). Find magnitude and direction of gradient for red font pixels. Use Sobel operator for horizontal and vertical directions. You can use correlation compute the responses. Recall that for magnitude, one can add the absolute values of horizontal and vertical gradients.

f(x,y) =

1	1	1	1
0	**10**	10	1
0	2	3	1
0	5	15	8

b. Perform non-max suppression (NMS) for pixels with values 10. For NMS, you would need to compare the magnitude of gradient at pixel with neighbors in the direction of gradient. The direction can be obtained using part (a). Further check whether the direction is along horizontal, vertical or diagonal direction and then compare.

Q3. Write a code for the following steps of Canny edge detection using 4x4 pixel matrix of Q2.

i. Compute gradient and direction for f and display.
ii. Compute non-max suppression. For border pixels, you can assume the output after NMS to be zero.

iii. Perform hysteresis thresholding using two thresholds – high and low. You can take high threshold to be in the range of 90% of the maximum magnitude response and low to be 30% of the maximum magnitude response.