E9 241: Digital Image Processing (2020)
Assignment 4
Due Date: 7th Jan, 2021 (Late submissions will be penalized)

Note: Write your own functions. Also, you are expected to experiment with different choices of parameters, wherever necessary, to get reasonably good results.

Total marks: 110 (100 for questions + 10 for viva)

1. Image Deblurring: Deblur the images Blurred-LowNoise.png (Noise Standard Deviation (σ)=1), **Blurred-MedNoise.png** (σ=5) and **Blurred-HighNoise.png** (σ=10) which have been blurred by the kernel BlurKernel.mat using

a. Inverse filtering.

b. Wiener filter. (Consider $S_w = \sigma^2$, where the terms convey the same meaning as taught in class)

c. Constrained least squares filtering. **(20)**

2. Image Denoising:

a. Denoise the image **noisy-book1.png** corrupted by the impulsive noise by a spatial domain Gaussian filter and the Median filter and compare the results.

b. Use the bilateral filter and the non-local means filtering to denoise the image **noisy-book2.png** which has been corrupted by the Gaussian noise with zero mean and standard deviation of 5. Compare the results with the Gaussian smoothing. **(20)**

3. Filtering in frequency domain:

- Decimate the image **barbara.tif** by a factor of 2. What artefacts do you notice?
- Now first filter the image with Gaussian Low Pass Filter given as

$$H(u,v) = \exp\left(-\frac{D^2(u,v)}{2D_0^2}\right)$$

and then downsample it by a factor of 2 in both directions. Do you notice mitigation of the artefacts? Compare your result with the built in MATLAB function imresize (or the corresponding python function). **(20)**

4. Edge Detection:

In this problem, you are going to implement an edge detector for grayscale images(choose 3-4 images of your choice).

a) First, smooth the input image using a Gaussian filter (say 5x5).
b) Use the Sobel/Prewitt operator to compute the image gradients, and then compute the gradient magnitude.
c) Use thresholding to get the edges.

Experiment with different Gaussians (sigma) and magnitude threshold to understand the effect of each parameter choice. **(20)**

5. Quality Assessment **(20)**

You have the option of solving one among the following two questions:

A. **Option A:** Take part in a subjective study on Image Quality Assessment of Low Light Restored Images. This will involve taking part in two half hour sessions spaced 24 hrs apart. Make sure you give ratings according to your considered opinion. If you are clearly recognized as an outlier after every one has submitted their scores, you will not get complete credit! Each of you will receive a separate set of images. The study will give you an understanding of how subjective quality assessment studies are carried out and about challenges in low light photography.

   You need to contact Vignesh Kannan (vigneshkanna@iisc.ac.in) to receive instructions on how to take part in the study.

B. **Option B:** . In this problem, you will compare mean squared error (MSE) and structural similarity index (SSIM) with respect to their performance in terms of correlation with human perception. You can use the default functions in python libraries or MATLAB.

   Performance measurement: Download the database available at http://ece.iisc.ac.in/~rajivs/courses/aip2016/hw5.rar

   The database comes with the following:

   1. distorted images in the "gblur" folder
   2. reference images in the "refimgs" folder
   3. reference image name for every distorted image in the "gblur" folder in "refnames blur"
   4. human opinion scores in "blur dmos"
   5. indicator of whether the image in the "gblur" folder is an original image in "blur orgs"

   Compute the Spearman rank order correlation coefficient (SROCC) between the dmos scores in "blur dmos" and MSE/SSIM after having removed the scores that correspond to the original images in the "gblur" folder (as mentioned earlier, this information is contained in blur orgs).

   Compare the SROCC of MSE and SSIM. Also compare the performance of SSIM if the luminance similarity term in removed and only the contrast and structure terms are retained.