Advanced Image Processing: Assignment 5 (Due Apr 13, 2017)

Note: Please provide detailed comments for code that may be written to solve the following problems. The assignment will be evaluated not just based on the final results but also how you obtained them. Late submissions will be penalized.

Problem 1: Variations of structural similarity index (SSIM) and mean squared error (MSE) to measure perceptual image quality
In this problem, you will design variations of MSE and SSIM and analyze their performance in terms of correlation with human perception.

A. Algorithm variations: Let $x(i,j)$ denote the pixel value at location (i,j) in an image. Evaluate the following quality indices after converting the images to grey scale:

1. Mean squared error in pixel domain
2. Single scale structural similarity index (you can use code available online at `https://ece.uwaterloo.ca/~z70wang/research/ssim/` or in MATLAB)
3. Only using the contrast and structure terms (denoted by CS) in the SSIM index with constants $C_3 = C_2/2$, where C_2 and C_3 are stability constants corresponding to the contrast and structure terms. Use the default value of C_2. In effect, the luminance term is not used here.
4. A modified version of MSE defined as follows, where the MSE at each pixel location is given as:

$$MSE_{mod}(i,j) = \frac{\sum_{l=-M}^{M}\sum_{k=-M}^{M} w(k,l)(x(i+k,j+l) - \mu_X(i,j) - y(i+k,j+l) + \mu_Y(i,j))^2}{\sigma_X^2(i,j) + \sigma_Y^2(i,j) + C_2}, \tag{1}$$

where $w(k,l)$ refers to the same filter coefficients in a window that are used to determine $\mu_X(i,j)$, $\sigma_X(i,j)$, $\mu_Y(i,j)$ and $\sigma_Y(i,j)$ in the definition of the SSIM index.

B. Performance measurement: Download the database available at
`www.ece.iisc.ernet.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"

C. Questions - Answer the following in a report

1. Compute the Spearman rank order correlation coefficient between the dmos scores in "blur_dmos" and each objective algorithm you designed in A 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).

2. Comment on the relative performances of all the indices

3. Compute a mathematical relation between indices 3 and 4 (i.e. CS and MSE_{mod}) and comment on whether the SROCC needs to be the same in magnitude for both these indices.