Homework 3: Image Restoration

Due date: 2pm May 17, 2017
Submission files:
1) Source code: the code should work well with no modification. Provide 'readme.txt' and an interface for easily setting input images and parameters used in the code.
2) Technical report including all results and analysis
Programming tools: C (C++) or MATLAB depending on your preference

Input clean images: 'Cameraman.tif' and 'Lena.tif' http://www.eecs.qmul.ac.uk/~phao/CIP/Images/

1. Periodic Noise Removal

1-1. Add a periodic noise to a clean image so that the periodic noise is formed as in p41 of the lecture note 'AIP-04-Restoration-v2.pdf'. Show how the corrupted image looks as in p43. Note that the FFT function provided by MATLAB can be used.

1-2. Remove the periodic noise from images of 1-1 and two images ('im1' and 'im2', uploaded on the course website) by making use of 1) Butterworth bandreject filter and 2) Notch bandreject filter, and then compare the quality (PSNR) of the two filters.

Note: PSNR can be measured between the ground truth (clean) image and the restored image.
https://en.wikipedia.org/wiki/Peak_signal-to-noise_ratio

2. Simple Image Denoising

2-1. Add AWGN (Additive White Gaussian Noise) with varying SNRs to a clean image. Refer to the following link. (http://kr.mathworks.com/help/comm/ref/awgn.html) (Choose 3 SNRs: visually small, median, and severe noise)

2-2. Apply the Wiener filter as in p36-37 of the lecture note 'AIP-04-Restoration-v2.pdf'. In order to achieve the best PSNR, adjust the window size properly according to the AWGN added.

2-3. Apply the bilateral filter (BF) as explained in http://people.csail.mit.edu/sparis/bf_course/. In order to achieve the best PSNR, adjust the window size and two parameters (sigma_s and sigma_r) used in BF.

2-4. Apply the non-local mean filter (NLM). In order to achieve the best PSNR, adjust the window size, patch size, and sigma_r used in NLM.

For more details of NLM, refer to the following paper. (Section 3 of the paper)
A non-local algorithm for image denoising, CVPR 2005
http://isites.harvard.edu/fs/docs/icb.topic1386881.files/Imaging%20and%20Inverse%20Problems/2005_Buades.pdf

3. Simple Image Restoration

3-1. Generate the Gaussian blur kernel: 11x11 window, $G(x,y) = exp(-((x-5)^2 + (y-5)^2)/2\sigma^2)$, $\sigma = 4.0$. Please make sure that the Gaussian blur kernel is normalized so that sum is 1. Apply the Gaussian blur kernel to a clean image and then add the AWGN with varying SNRs. (Choose 3 SNRs: visually small, median, and severe noise)

3-2. Restore the above corrupted image using 1) Wiener filtering in p71 and 2) Constrained Least Squares (CLS) filtering in p80. In the CLS filtering, γ should be adjusted accordingly. Compare the results from Wiener filtering and CLS filtering subjectively and objectively. For the objective evaluation, use PSNR.

*** Note**

In technical report, you should include the following three things.

1) Description of your algorithm
2) The reason of the parameter setting you chose in your source code.
3) Show the results of your algorithm using various images which you want to use.