RE50900 - DIPCV - Assignment II

Histogram and Image Filtering

- **Requirements**: The requirements of each assignment of this course at least include a) full document in PDF/Word format with implementation details and difficulties you met, 2) source code and the compiled file (in exe/dmg/sh) and its readme to indicate how to launch it, and 3) key comments in your source code. If your code was referred from an existing source on the Internet, please cite it accordingly. Note that the packages CAN NOT be used in this assignment except the visualization functions.

- **Problem set (110pt):**

    Dataset: Flower.raw (task 1), Lena.raw/Baboon.raw/F16.raw (task 1,2,3,6,7), Noisy.raw (task 4,5,6,7)

    1. **(15pt) Histogram equalization**: Give three test images with RAW format, please use the gamma correction you have developed in the last assignment to decrease/increase the brightness of the images. Based on these degraded images, please:

        i.   Use global histogram equalization to these three degraded images to check their results. Please also draw the histogram before/after equalization.

        ii.   Use the local histogram equalization to enhance these three images and find the most suitable local window size. Please plot the best result you have tried.

        iii. Histogram matching: Please read the reference image "flower.raw" and extract the histogram as the reference. Please map the three test images to the reference histogram. In this task, please deveriate the inverse transform of HE (if necessary) and show the results after histogram matching.

    2. **(10pt) Convolution**: Give three test images with RAW format, please adopt the following filters to check the visualized results:

        i.   Gaussian Filter with kernel sizes 3,5,7,33

        ii.   Averaging Filter with kernel sizes 3, 5,7, 33

        iii. Unsharp mask filter with Kernel sizes 3,5,7

        iv.   Laplacian Filter with Kernel sizes 3,5,7

        v.   Sobel Filter with kernel sizes 3,5,7

    Note that the image size is 512x512, where the filtered (output) image should be 512x512 as well.

3. **(10pt) Convolution-2**: Give two special kernels below, please discuss the properties and the potential problems (if any). Also, please show the visualized results in the report.

    i.   *Kernel-1:*

-1	0	-1
0	6	0
-1	0	-1

    ii.   *Kernel-2:*

1/25 *	1	2	1
	0	5	0
	4	2	4

4. **(15pt) Image denoising**: The "Noisy.raw" is adopted in the following denoising tasks. Please select one of the "statistic-order filters" to filter the noisy image and show the visualized results.

5. **(20pt) Bilateral filter**: It is well-known that the Bilateral filter can preserve the edge after smoothing operation due to the context filter. Please implement a Bilateral filter with/without Gaussian Smoothing Kernel to verify the visualization effect. Also, please find the best parameters (sigma_c, sigma_s, kernel size) for the "Noisy.raw".

6. **(20pt) NonLocal Means (NLM) filter**: Please implement the naive NLM to denoise the Noisy.raw with kernel sizes of 5x5, 7x7. Also, please apply your NLM on the three test images (lena, baboon, F16) to check the filtered results and make discussion about when the NLM will work well.

7. **(20pt) Performance and efficiency improvement:** Please try to accelerate the NLM filter in any way (Hint: find the papers that cited the NLM original paper). Please report the computational complexity, run-time, memory usage before/after improvement.