HOMEWORK ASSIGNMENT #1
Image Enhancement and Noise Removal

Due Date: **11:59am on 03/25/2020**

Please read the **submission guideline** carefully before getting started. All images in this homework can be downloaded from our NTU COOL website. Only one image is in the raw file format. The rest images are in the JPEG format. Details of all files offered are listed in the appendix.

You are **NOT** allowed to use other functions except I/O, plotting and basic functions.

Problem 0: WARM-UP

(a) A RAW image is an image type that save pixel values with unsigned char type row by row. For example, **a grayscale image saved with RAW type has unsigned char data (h*w*channel=1)**. However, RAW images can't be displayed directly in most of the time. Thus, we need to compress and save it as **.jpg**. In this problem, you need to read image data from the RAW file named **sample1.raw**, reshape the image data to (h, w, channel=1) and save the data to a JPEG image named **result1.jpg**. **You can use functions to write out jpg image directly** and don't need to implement header and compression of jpg format.

   HINT: You can use numpy.fromfile() instead of f.read() in Python as your I/O function.

(b) Color and gray-level images are both common in our life. Thus, understanding how to convert a color image to a grayscale one is a good warm-up for digital image processing. In this problem, you need to convert the color image named **sample2.jpg** to a grayscale image named **result2.jpg**. Do not use functions such as rgb2gray() in MATLAB to get the grayscale result directly in this problem.

(c) First, rotate **result2.jpg** by 90 degrees counterclockwise and save the result as **result3.jpg**. Second, diagonally flip **result2.jpg** and save the result as **result4.jpg**.

sample1.raw
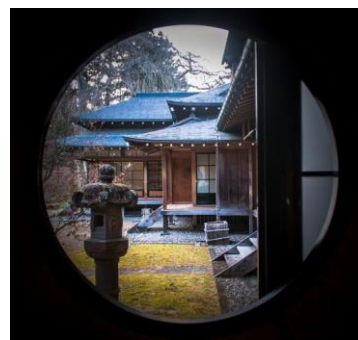
sample2.jpg

Problem 1: IMAGE ENHANCEMENT

(a) Please plot the histograms of **result1.jpg** and **sample3.jpg**. Discuss their difference. Also, what can you do to make **sample3.jpg** look like **result1.jpg**?

(b) Perform global histogram equalization on **sample3.jpg** to output the result as **result5.jpg** and plot its histogram.

(c) Perform local histogram equalization on **sample3.jpg** to output the result as **result6.jpg** and plot its histogram. You may try different window sizes and discuss their effects.

(d) Compare and discuss the results of global and local histogram equalization.

(e) Perform the log transform, inverse log transform and power-law transform to enhance **sample3.jpg** and save the results as **result7.jpg, result8.jpg and result9.jpg**, respectively. Adjust the parameters as best as you can. Show the parameters, output images and corresponding histograms. Provide some discussions on the results as well.

sample3.jpg

Problem 2: NOISE REMOVAL

In this problem, you are given a grayscale image **sample4.jpg** and asked to implement basic noise generation and noise removal.

(a) Please add Gaussian noise on **sample4.jpg** with two different parameters to generate two noisy images. The results should be named with **resultG1.jpg** and **resultG2.jpg**. Please discuss the difference of these two results.

(b) Please add salt-and-pepper noise on **sample4.jpg** with two different parameters to generate two noisy images. The results should be named with **resultS1.jpg** and **resultS2.jpg**. Please discuss the difference of these two results.

(c) Please design an algorithm to remove the noise in both **resultG1.jpg** and **resultG2.jpg** and generate clean images as **resultR1.jpg** and **resultR2.jpg**. Please write down details of your noise removal process in your report, including the method you choose, the reason why you use the method, and parameters you use.

(d) Please design an algorithm to remove the noise in both **resultS1.jpg** and **resultS2.jpg** and generate clean images as **resultR3.jpg** and **resultR4.jpg**. Please write down details of your noise removal process in your report, including the method you choose, the reason why you use the method, and parameters you use.

(e) Please compute PSNR values of **resultR1.jpg**, **resultR2.jpg**, **resultR3.jpg** and **resultR4.jpg**, respectively and provide some discussions about their values.

[BONUS] The most common noise in nature is rain. In this problem, given a rainy image **sample5.jpg**, you are asked to design a method to remove rain in the background as good as you can. Please describe your method and display your result in the report, and also offer some discussions about your result.

sample4.jpg

sample5.jpg

Appendix

Image Files:
1. sample1.raw: 400×600
2. sample2.jpg: 512×512
3. sample3.jpg: 400×600
4. sample4.jpg: 400×600
5. sample5.jpg: 400×600