HOMEWORK ASSIGNMENT 1

Image Enhancement and Noise Removal

Due Date: 11:59 p.m. on Mar. 14, 2023
Please read the **submission guideline** carefully before getting started. All images in this homework are in PNG format and can be downloaded from our `NTU COOL` website. 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

The goal of this problem is to get familiar with fundamental operations for image processing.

sample1.png

(a) (`5 pt`) Color to grayscale image transformation is a basic operation in digital image processing and computer vision. Please convert **sample1.png** to a gray-scaled image named **result1.png**.

(b) (`5 pt`) Perform vertical flipping on **result1.png** and output the result as **result2.png**.

Note that the built-in functions such as `cv2.cvtColor()` to directly perform transformation are NOT allowed.

Problem 1: IMAGE ENHANCEMENT

Given a gray-level image as shown in **sample2.png**, please follow the instructions below to create several new images.

(a) (`10 pt`) Decrease the brightness of **sample2.png** by dividing the intensity values by 3 and output the result as **result3.png**.

(b) (`10 pt`) Increase the brightness of **result3.png** by multiplying the intensity values by 3 and output the result as **result4.png**.

(c) (`10 pt`) Plot the histograms of **sample2.png**, **result3.png** and **result4.png**. What can you observe from these three histograms?

(d) (`10 pt`) Perform global histogram equalization on **sample2.png**, **result3.png** and **result4.png**, and output the results as **result5.png**, **result6.png** and **result7.png**, respectively. Please compare these three resultant images and plot their histograms.

(e) (`10 pt`) Perform local histogram equalization on **sample2.png**, **result3.png** and **result4.png**, and output the results as **result8.png**, **result9.png** and **result10.png**, respectively. Please compare these three resultant images and plot their histograms.

(f) (`10 pt`) Design a transfer function to enhance **sample2.png** and output the result as **result11.png**. Try your best to obtain the most appealing result by adjusting the parameters. Show the parameters, the best resultant image and its corresponding histogram. Provide some discussions on the result as well.

sample2.png

Problem 2: NOISE REMOVAL

Given an original image named **sample3.png** and two images corrupted by noise as shown in **sample4.png** and **sample5.png**, please follow the instructions below.

(a) (`20 pt`) Design proper filters to remove the noise in **sample4.png** and **sample5.png**. Output the clean images as **result12.png** and **result13.png**, respectively. Write down details of your noise removal process in the report, including the filters and parameters you use. Please also provide some discussions about the reason why those filters and parameters are chosen.

(b) (`10 pt`) In noise removal problems, PSNR is a widely used metric to present the quality of your recovered image. Please compute PSNR values of **result12.png** and **result13.png**, respectively, and provide some discussions.

$$PSNR = 10 \times \log_{10}(\frac{255^2}{MSE}), MSE = \frac{1}{w \times h} \sum_j \sum_k [F(j,k) - F'(j,k)]^2$$

(a) sample3.png

Figure 1: Original image.

(b) sample4.png

(c) sample5.png

Figure 2: Noisy images.

Appendix

Problem 0: WARM-UP

sample1.png:	800×600	color

Problem 1: IMAGE ENHANCEMENT

sample2.png:	600×800	gray-scale

Problem 2: NOISE REMOVAL

sample3.png:	313×320	gray-scale
sample4.png:	313×320	gray-scale
sample5.png:	313×320	gray-scale