Digital Image Processing (03/28/2018)

HOMEWORK ASSIGNMENT #1

Image Enhancement and Noise Removal

Due Date: 11:59am on 03/28/2018

Please read the submission guideline (posted on the class website) carefully before getting started.

All images in this homework can be downloaded from our class website: https://ceiba.ntu.edu.tw/1062DIP. Images are in the raw file format. The size of each image is listed in the appendix.

For MATLAB users, you are **NOT** allowed to use the MATLAB Image Processing toolbox except the imshow() and image() functions.

WARM-UP: SIMPLE MANIPULATIONS

Please convert the given color image I_1 as shown in Fig.1 to a gray-level one. Please also perform diagonal flipping on it and output the result as B.

Fig.1: sample1.raw

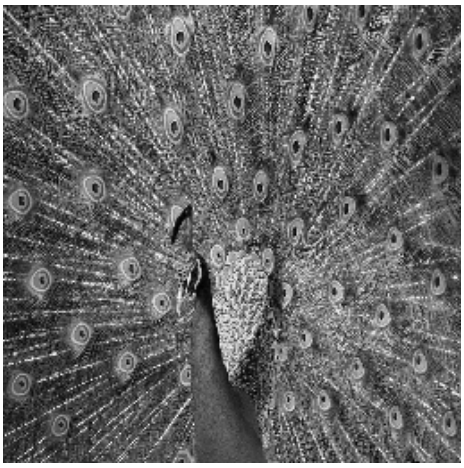

Fig. 2: sample2.raw

PROBLEM 1: IMAGE ENHANCEMENT

Given an image I_2 as shown in Fig. 2. Please follow the instructions below to create several new images.

(a) Decrease the brightness of I_2 by dividing the intensity values by 3 and output the image as D.

(b) Plot the histograms of I_2 and D. What can you observe from these two histograms?

(c) Perform histogram equalization on D and output the result as H.

(d) Perform local histogram equalization on image D and output the result as L.

(e) Plot the histograms of H and L. What's the main difference between local and global histogram equalization?

(f) Perform the log transform, inverse log transform and power-law transform to enhance image D. Please adjust the parameters to obtain the results as best as you can. Show the parameters, resultant images and corresponding histograms. Provide some discussions on the results as well.

PROBLEM 2: NOISE REMOVAL

(I) Given an image I_3 as shown in Fig. 3(a), please follow the instructions below to create some new images.

(a) Please generate two noisy images G_1, and G_2 by adding Gaussian noise to I_3 with different parameters. What's the main difference between these two images?

(b) Please generate two noisy images S_1, and S_2 by adding salt-and-pepper noise to I_3 with different parameters. What's the main difference between these two images?

(c) Design proper filters to remove noise from G_1 and S_1, and denote the resultant images as R_G and R_S, respectively. Please detail the steps of the denoising process and specify corresponding parameters. Provide some discussions about the reason why those filters and parameters are chosen.

(d) Compute the PSNR values of R_G and R_S and provide some discussions.

(II) Design your own method to remove the wrinkles on the face of a given image I_4 as shown in Fig. 3(b) and make it as pretty as you can. Please describe the steps of your process in detail and provide some discussions as well.

Fig.3(a): sample3.raw

Fig.3(b): sample4.raw

Appendix:

Salt-and-pepper noise generator:

$$\begin{cases} I(nim,i,j) = 0, & if\ uniform(0,1) < threshold \\ I(nim,i,j) = 255, & if\ uniform(0,1) > 1 - threshold \\ I(nim,i,j) = I(im,i,j), & otherwise \end{cases}$$

where im represents the input image, and nim is the output image. $I(im,i,j)$ and $I(nim,i,j)$ denote the intensity value of the input and output images at (i,j), respectively. $uniform(0,1)$ generates a random variable which is uniformly distributed in [0,1], and $threshold$ is the parameter you can determine on your own.

Image files:

Warn-up: SIMPLE MANIPULATIONS

sample1.raw	Fig.1	256 x 256 image	color

Problem1: IMAGE ENHANCEMENT

sample2.raw	Fig.2	256 x 256 image	gray-scale

Problem2: NOISE REMOVAL

Sample3.raw	Fig.3(a)	256 x 256 image	gray-scale
Sample4.raw	Fig.3(b)	256 x 256 image	gray-scale