EE6310 Image and Video Processing, Spring 2023

Indian Institute of Technology Hyderabad
Homework 2, Assigned 07.02.2023, Due **11:59 pm on 16.02.2023**

Have no fear of perfection; you'll never reach it. – Marie Curie

Instructions:

- You can work with grayscale images used for the previous HW.
- To better illustrate the effects of non-linear point operations (on gray scale images), use only copyright-free images from NASA's site: `http://apod.nasa.gov/apod/archivepix.html`. Convert color images to gray scale using any tool you like.
- Please turn in Python Notebooks with the following notation for the file name: `your-roll-number-hw2.ipynb`.
- Do not turn in images. Please use the same names for images in your code as in the database (and as mentioned in the problem statement below). For NASA images, please mention the link in your code comments.

1 Gray Scale Point Operations (10)

Write a program/function to do the following:

1. Perform simple linear point operations for the following cases:
   (a) **J = P.I**. (1)
   (b) **J = I** + **L**. (1)
   (c) **J = P.I + L**. (1)

   In each case, verify that the histogram of **J** is related to the histogram of **I** according to the relation discussed in class.
2. Full scale contrast stretch (FSCS). Verify your result by printing the min and max pixel values before and after applying FSCS. Also, plot the histogram of the image before and after applying FSCS. (2)
3. Log magnitude compression (always followed by FSCS). Plot the histogram of the image before and after applying log magnitude compression. (1)
4. Gamma correction: $\mathbf{J} = \mathbf{I}^{\gamma}$ with $\gamma = 1.4$. Clip pixel values greater than 255 to 255. Plot the histogram of the image before and after applying gamma correction. (1)
5. Histogram flattening. Plot the histogram of the image before and after applying histogram flattening. (3)

Now test your implementation using copyright-free images from NASA's site. Compare the original image with the output of each of the three operations above. Comment on the quality of the original images based on the output of these operations. Make sure your image display function doesn't do any further contrast stretching.

2 Image Zooming (10)

Write a program to zoom an image by 1.5 times along each axis using the following techniques discussed in class:

1. Nearest neighbor. (5)

2. Bilinear interpolation. (5)

Test your program using three of your favorite images from the above set. Comment on the quality of the two techniques and compare their computational complexity.

3 2D-DFT (15)

Recall the definition of the 2D-DFT from class. Use square gray-scale images whose side is a power of two (e.g., the USC SIPI images). Write a program that implements the DFT/IDFT pair using the following techniques.

1. From first principles i.e., as a summation over two dimensions. (5)
2. Matrix multiplication using the complex exponential matrix. (5)

Now do the following using three of your favorite images from the above set:

1. Display the image, its DFT magnitude, phase, DFT magnitude subject to the logarithmic transformation. (1)
2. Generate the centered DFT using $(-1)^{i+j}$I and display its magnitude. (1)
3. Verify that IDFT[DFT[I]] = I. (1)
4. Show the importance of phase by transposing the phase matrix and then synthesizing the image. Repeat by a) setting the phase to 0, and b) by adding noise. (2)