EE6310 Image and Video Processing, Fall 2021

Indian Institute of Technology Hyderabad
Homework 2, Assigned 25.09.2021, Due **11:59 pm on 02.10.2021**

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.
- Do not use built-in functions for the binary image processing question. Use *matplotlib* to read and plot images - `https://matplotlib.org/tutorials/introductory/images.html`.
- 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 Binary Morphology (10)

1. Implement the following filters that accept a binary image I and window B as inputs: DILATE, ERODE, MEDIAN. Filter the above binary image using the following windows B = CROSS(5), B = SQUARE(3) (meaning the side of the square window is 3 pixels). Use the binary images generated in the previous assignment as input to this function. (3)
2. Verify that DILATE and ERODE operators are duals of each other with respect to complementation. Also verify that the MEDIAN operator is its own dual with respect to complementation. Show that the difference between the images from the direct and complement paths is indeed zero. (2)
3. Implement the compound operators OPEN and CLOSE using the basic filters implemented above. Use the same windows as in the previous problem. (2)
4. Finally, implement OPEN-CLOS and CLOS-OPEN. Filter the binary image using the same windows as above. (2)
5. For the *APC* image, count the number of pixels in the object of interest - i.e., the military vehicle. Use the blob counting code from your previous homework. (1)

2 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.

3 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.