E9 241 Digital Image Processing

Assignment 02

Due Date: September 22, 2023 - 11:59 pm **Total Marks:** 70

Instructions:

For all the questions, write your own functions. Use library functions for comparison only.

- Your function should take the specified parameters as inputs and output the specified results.
- Also provide the wrapper/demo code to run your functions. Your code should be self-contained, i.e., one should be able to run your code as is without any modifications.
- For Python, if you use any libraries other than numpy, scipy, scikit-image, opencv, pillow, matplotlib, pandas, and default modules, please specify the library that needs to be installed.
- Along with your code, also submit a PDF with all the **results** (images or numbers) and **inferences** (very important: you may not be explicitly asked to give inferences in each question. You should always include your inferences from what you have observed). Include answers to subjective questions, if any.
- Put all your files (code files and a report PDF) into a single zip file and submit the zip file. Name the zip file with your name.
- **Note:** The functions mentioned after each question are not to be explicitly replicated. Feel free to define them your own way.

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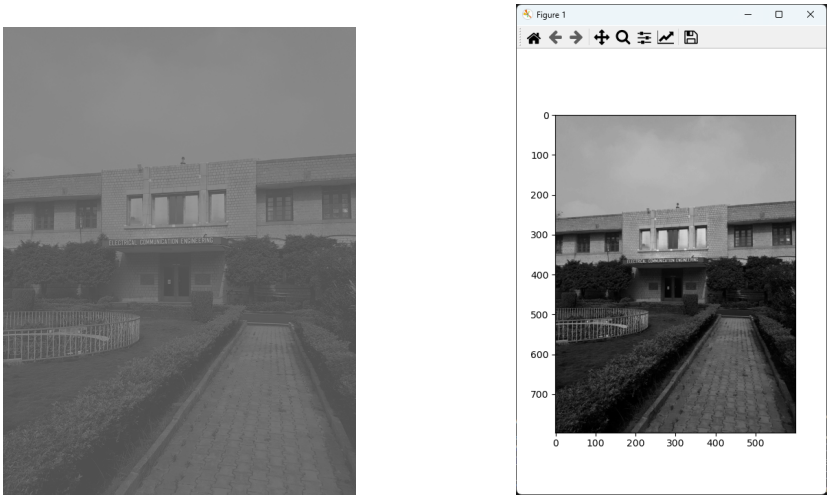
1. **Image Display:** When the image `'ECE.png'` (Figure 1a) is displayed with the following code:

```
import matplotlib.pyplot as plt
from scipy.io import imread
im = imread('ECE.png', cmap='gray')
plt.imshow(im)
plt.show(),
```

we get a result shown in Figure 1b. Explain why there is a difference between the actual image and the displayed image. Find out a way to prevent this from happening.

Note: This question has to be compulsorily solved in Python.

(5 Marks)



(a) Input image (b) Displayed image

Figure 1

2. **Contrast Stretching:**

   (a) Write functions to apply histogram equalization and power-law (gamma) transforms on a greyscale image.

   (b) Apply histogram equalization on `'haze.png'`.

   (c) Power-law (gamma) transformation: $J(i,j) = I(i,j)^{\gamma}$. Find the optimal parameter $\gamma \in (0, 5]$ that minimizes the mean squared error between the histogram equalized image from (b) and the gamma transformed image. Use this γ to transform and display the input image.

   Visualize the histogram before and after each operation and comment on how they relate to the resulting images.

Function	Gamma transform	**Function**	Histogram equalization
Input	Image, transform parameters	Input	Image
Output	Enhanced image	Output	Enhanced image

(20 Marks)

3. **Image rotation:** Write a function to rotate the image `'box.png'` in the clockwise direction by 5° and counter-clockwise by 30° using both nearest neighbor or bilinear interpolation. Make sure the rotated image is completely visible and not cropped. Observe the edges of the first image after rotation and comment on the difference between each interpolation method.

Function	Rotate image
Input	Image, degree of rotation, interpolation method
Output	Rotated image

(30 Marks)

4. **Spatial Filtering:** Apply high-boost filtering on the image `'study.png'` to sharpen it. Use square averaging of size 5 to perform unsharp masking. Choose the scaling constant for the high pass component as $k = 2.5$. Comment on what you observe. Now, blur the input image with a square average filter of size 3 and perform high boost filtering again. Comment on the difference in output compared to the previous case.

Function	High-boost filter
Input	Image, scaling constant
Output	Sharpened image

(15 Marks)