Digital Image Processing
Spring 2025
Lab:4 Intensity Transformation I

Name	
Student ID	
Date	

Objectives

- Apply power law transformation (nth power and root) to enhance images.
- Implement contrast stretching to improve image contrast.
- Understand how these techniques can be used to enhance image details and visibility.

Note: This lab is slightly challenging as you will be required to explore how to create a function in python.

Prerequisites

Make sure you have the following Python libraries installed:

- `opencv-python` (OpenCV)
- `matplotlib`
- `numpy`

You can install them using following command in command prompt or bash:

pip install opencv-python matplotlib numpy

A part from the packages, you also need to know how to create a value returning function in python

You are required to download test image from the link Gamma correction test images

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Part 1: Power law transformation (gamma correction)

The generalized formula for power law is as follows

$$T(r) = cr^{\gamma}$$

Where r is the input intensity, $T(r)$ is transformed intensity, γ is either nth root or nth power whereas c is intensity scaling factor (Different from image scaling factor that we covered in geometric transformation).

You are required to create a function named gamma_correction that

i. Takes the values of c, γ and input image as input
ii. Normalize the input image using the following syntax
I_norm = I_in.astype('float32')/255
iii. Apply the power of γ (nth root or nth power depending on the provided value of γ).
To apply cube to the image, the following syntax is used in python
image_cube = image_input**3
iv. The function then is supposed to return the image after applying power law transformation (gamma correction) to the image.

Task 1:

1. Apply the correct value of γ to each image in the shared folder, copy the screenshot of the output as well as the source code.
2. Write the reason of how you chose the value of γ for each input image.
3. Try saving the normalized image using cv2.imwrite. Observe the problem and try solving it within 5 minutes. If problem is not solved after 5 minutes, do call me, however, don't spend more than 5 minutes solving it as your time is precious.

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Part 2: Contrast Stretching

Contrast stretching is a linear technique used to enhance the contrast of an image by stretching the range of intensity values. It is especially useful for improving images that appear washed out or have limited contrast due to improper lighting conditions.

The general formula for contrast stretching is:

$$s = \left(\frac{s_{max} - s_{min}}{r_{max} - r_{min}}\right)(r - r_{min}) + s_{min}$$

Where $\boldsymbol{s_{max} = L - 1}$ and $\boldsymbol{s_{min} = 0}$. $\boldsymbol{r_{min}}$ and $\boldsymbol{r_{max}}$ are min and max intensity in the input image.

Create a function named contrast_stretching that

i. Takes input image(i_{in}), s_{max} and s_{min} as input
ii. Calculates r_{min} and r_{max}.
iii. Apply contrast stretching and return the output image.

Task 2:

1. Apply contrast stretching to all five provided images with $s_{max} = 0$ and $s_{min} = 255$ for non-normalized images.
2. Normalize the images and apply transformation with $s_{max} = 0$ and $s_{min} = 1$.
3. Does normalizing the image produce some positive/negative impact on the output?
4. For non-normalized, try various combination of s_{max} and s_{min} such as ($s_{max} = 0, s_{min} = 50$), ($s_{max} = 100, s_{min} = 160$) and write observation.

Submission

Submit the following:

1. Screenshots of the images after performing each transformation.
2. The code for each task.
3. A brief report explaining the purpose of gamma correction and contrast stretching.