LAB # 03: Transformation Operations

Lab Objective:

The objective of this lab is to implement thresholding on images to convert them to binary, perform different transformation operations on images.

Lab Description:

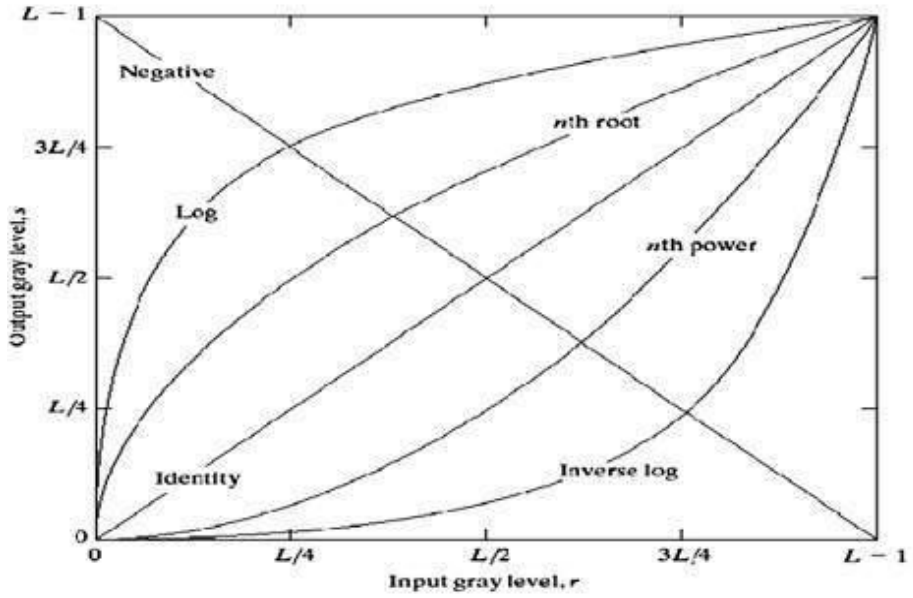
Transformation operations help enhance the quality of the image by applying operations like log, inverse log and power on the entire image. Different type of transformation yields different results.

Gray level transformation

There are three basic gray level transformations.

I. Linear
II. Logarithmic
III. Power – law

The overall graph of these transitions has been shown below.



Transformation curves

Power law transformations: It includes nth power and nth root transformation. These transformations can be given by the expression:

$$s = c * r^{\gamma}$$

This symbol γ is called gamma, due to which this transformation is also known as gamma transformation.

Variation in the value of γ varies the enhancement of the images. Different display devices / monitors have their own gamma correction, that's why they display their image at different intensity.

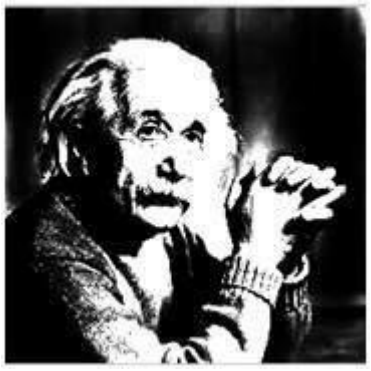
This type of transformation is used for enhancing images for different type of display devices. The gamma of different display devices is different. For example, Gamma of CRT lies in between 1.8 to 2.5, that means the image displayed on CRT is dark.

As mentioned before, gamma can be corrected as:

$$\boldsymbol{s = c * r^{\gamma}}$$

$$\boldsymbol{s = 255 * ((r/255)^{\gamma})}$$

The same image but with different gamma values has been shown here.



Gamma 8

Gamma 6

Gamma 10

Log transformations:

The log transformations can be defined by this formula:

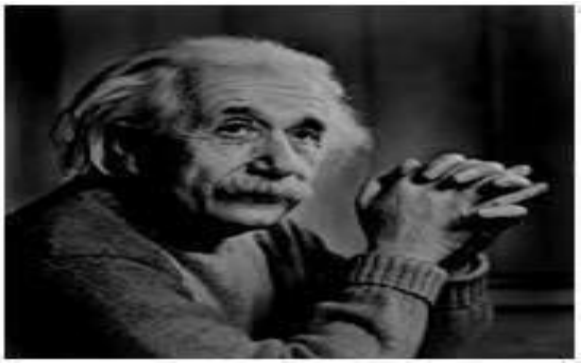
$$s = c\ log(r + 1)$$

$$c = 255/log(1 + max\ of\ image\ pixel)$$

$$s = c * log(r + 1)$$

Where *s* and *r* are the pixel values of the output and the input image and *c* is a constant. Value 1 is added to each of the pixel value of the input image because if there is a pixel intensity of 0 in the image, then *log (0)* is equal to *infinity*. So 1 is added, to make the minimum value at least 1.

During log transformation, the dark pixels in an image are expanded as compare to the higher pixel values. The higher pixel values are kind of compressed in log transformation.



Input image

Output of log Transformation

Negative Transformation

The second linear transformation is negative transformation, which is invert of identity transformation. In negative transformation, each value of the input image is subtracted from the L-1 and mapped onto the output image. This transformation is done by this formula

$$s = (L - 1) - r$$

So, each value is subtracted by 255, so the lighter pixels become dark and the darker picture becomes light. And it results in image negative.

Negative transformation

Thresholding is the operation through which an image can be converted into a binary image/black & white i.e. having only two distinct levels. Threshold value can be the mean or median etc. of the image.

Gray level Slicing is used to highlight a specific range of gray levels in an image

Some Useful Commands:

1. To calculate the mean of 2D array using NumPy: my_mean = **numpy.mean (my_array)**
2. To calculate min (or max) of an array: **my_min = numpy.amin(my_array)**
3. To calculate the power of an array using NumPy: array_power = **numpy.power (my_array, power)**
4. To obtain percentile value. **percentile_array = numpy.percentile(my_array, percentile)**

5. To change data type of array. **my_array = my_array.astype(numpy.uint16)**

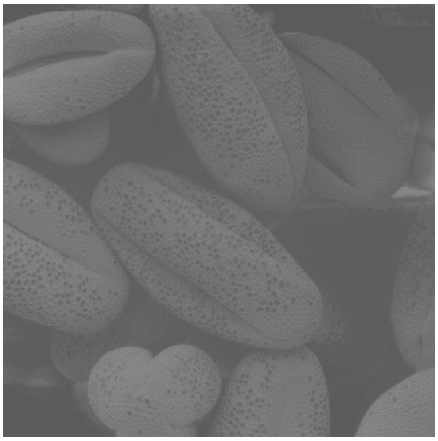
Lab Tasks:

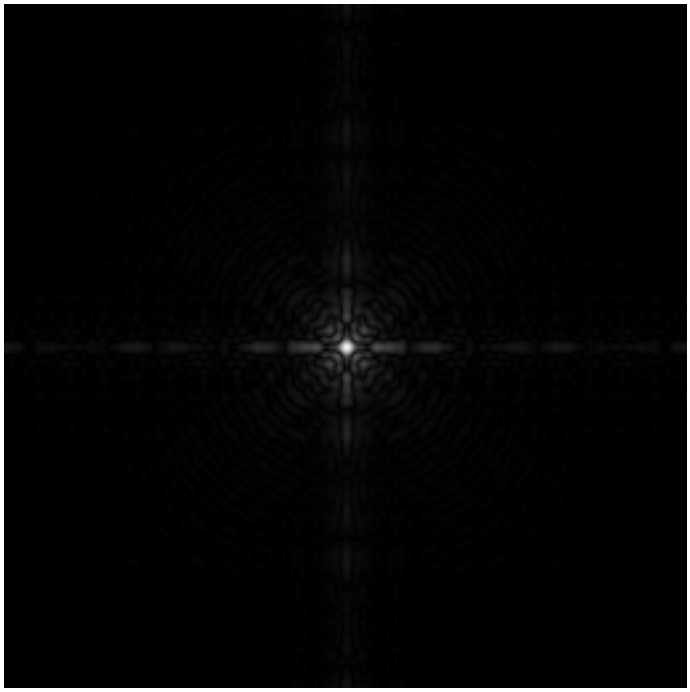
1: Read an image and convert it into black & white (binary image). Calculate threshold value by taking mean of whole image. Also, convert the same image into a negative image using the transformation: $s = (L-1) - r$ where L are the total grayscale levels of the image. Use the gradient image that we used in the last lab.

2: Apply the following transformation on an image. You can use any image but do check your results on the gradient image.

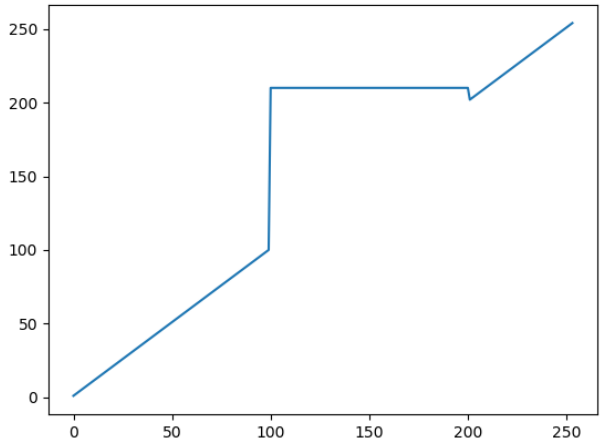
	Pixel values range	**Output pixel value**
a)	**Less than mean**	**0**
	Greater than mean	**255**
b)	**Less than mean**	**255**
	Greater than mean	**0**
c)	**±20 mean**	**0**
	Otherwise	**255**

3:Apply Power Law transformation for the following values of γ (0.2, 0.5, 1.2 and 1.8) . Make sure to adjust data types accordingly. Also apply log (log10) transformation on the images.





4:Apply Gray level slicing using lower limit 100 and upper limit 200. Set all these values to 210.



Home Task:

1. Read a scanned document image (it has to be a document) and convert it to binary using the mean thresholding method.
2. Apply power transformation law to improve the contrast.
3. Crop a portion of the enhanced image.

4. Using the Connect Component function from the last lab, separate the alphabet in your document. (Hint: You may need to figure out the background color as it may vary or you might need to convert it to some predefined value).