CSE 573

Programming Assignment 1

Problem (1) - 1D and 2D Convolution on Images
Problem (2) - Histogram Equalization

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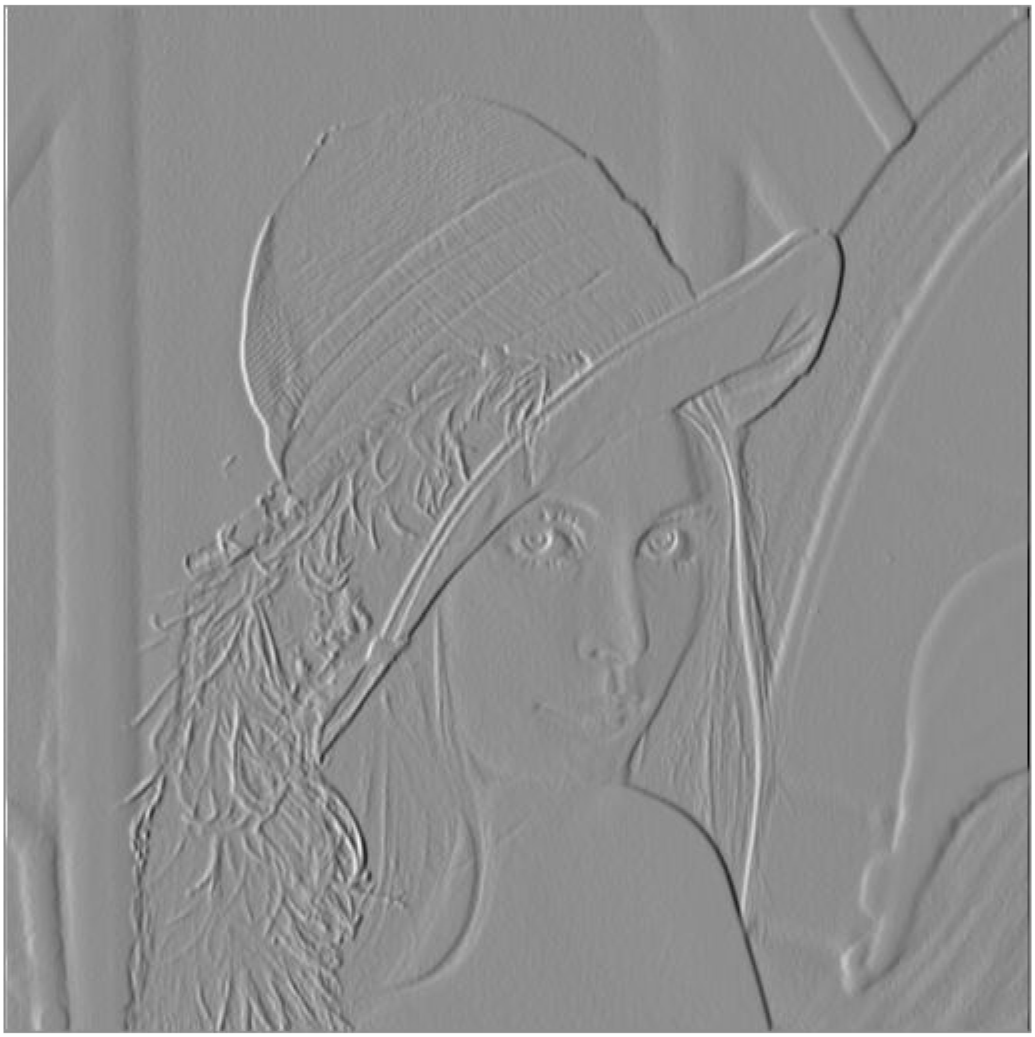
1D and 2D Convolution on Images

PART A -2D Convolution

- Gradient Image- Gx

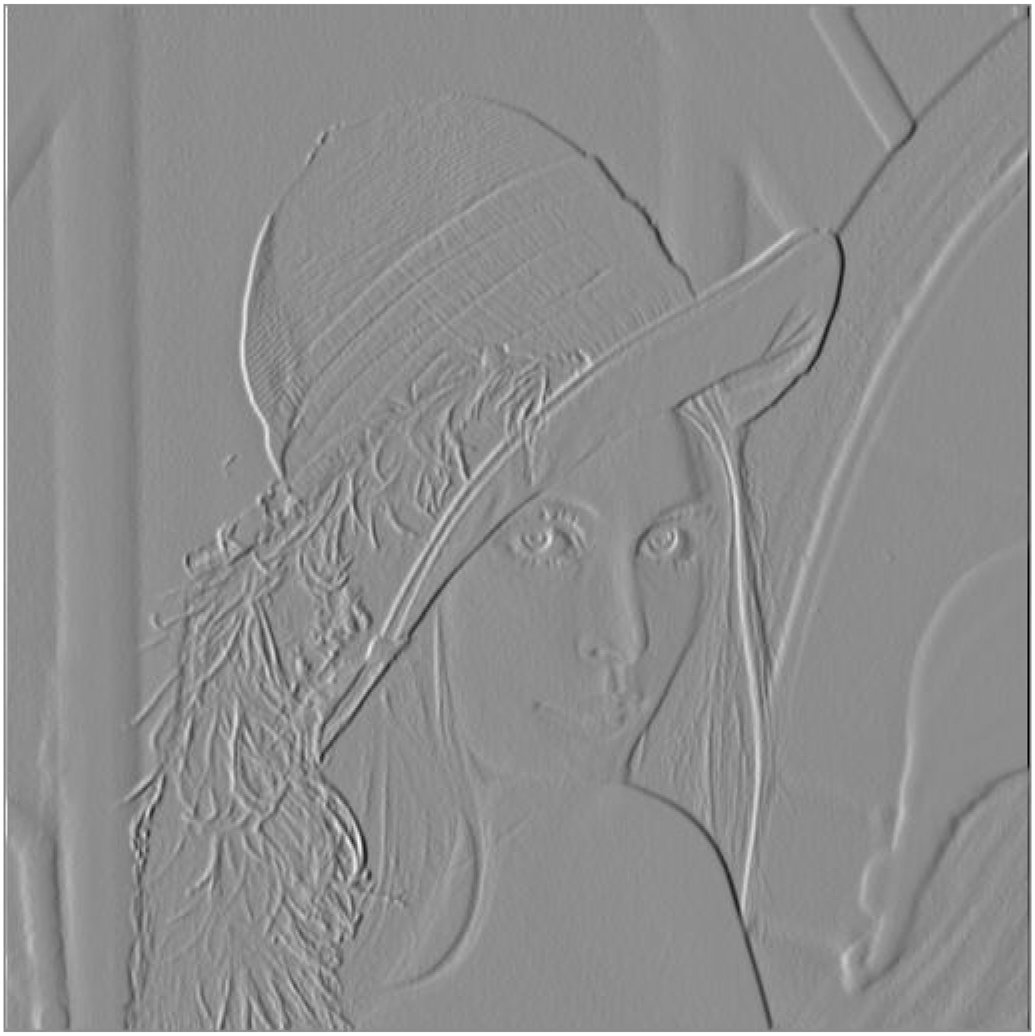


- Gradient Image- Gy

- Gradient Image- G (magnitude)

Part B- 1D Convolution

- Gradient Image- Gx



- Gradient Image- Gy

- Gradient Image- G(magnitude)

The result after 1D convolution is same as the one obtained from 2D convolution as seen in the images obtained above.

<u>PART</u> <u>C-</u> Given an MxN Image and a PxQ filter, compute and report the computational complexity of performing 2D convolution vs using separable filters with 1D convolution

In 2D convolution with P×Q kernel, the number of computations required on a M×N Image would be P×Q for each window(each sample from the image taken of size P×Q). Like for Sobel Filter whose size is 3×3, 9 multiplications and accumulations are necessary for each sample.

So the computational complexity for the lena_gray image of size 512×512 would be :

$$O(M \times N \times P \times Q)$$

2D convolution : 512×512×3×3 =2359296

For smaller kernel size it is still feasible but what if the kernel size is quite large then the P×Q computations are expensive to perform.

Nevertheless, 1D convolution which is performed twice instead of 2D convolution; convolve with the input and M×1 kernel in vertical direction, then convolve again horizontal direction with the result from the previous convolution and 1×N kernel. The first vertical 1D convolution requires M times of multiplications and the horizontal convolution needs N times of multiplications, altogether, M+N products.

So the computational complexity for the lena_gray image of size 512×512 would be :

$$O(M \times N \times (P+Q))$$

1D convolution : 512×512×(3+3) =1572864

Hence the computational complexity is higher for 2D convolution as compared to 1D.

Histogram Equalization

Performed Histogram Equalization for two different images :

IMAGE 1 :

Original Image

Contrast Enhanced Image

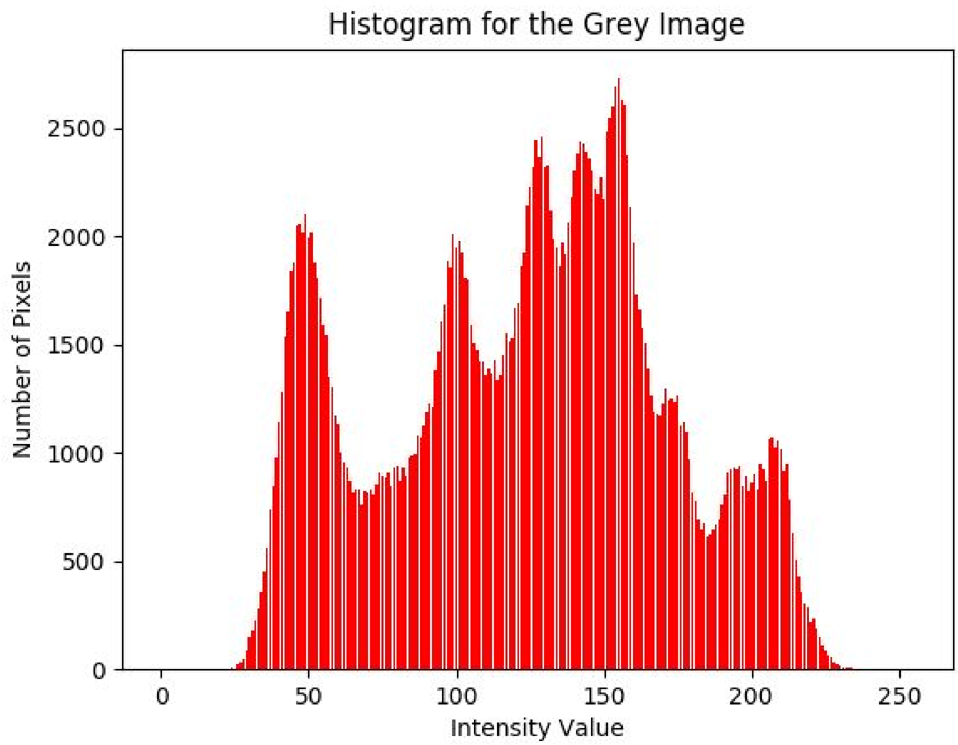
IMAGE 2:

Original Image

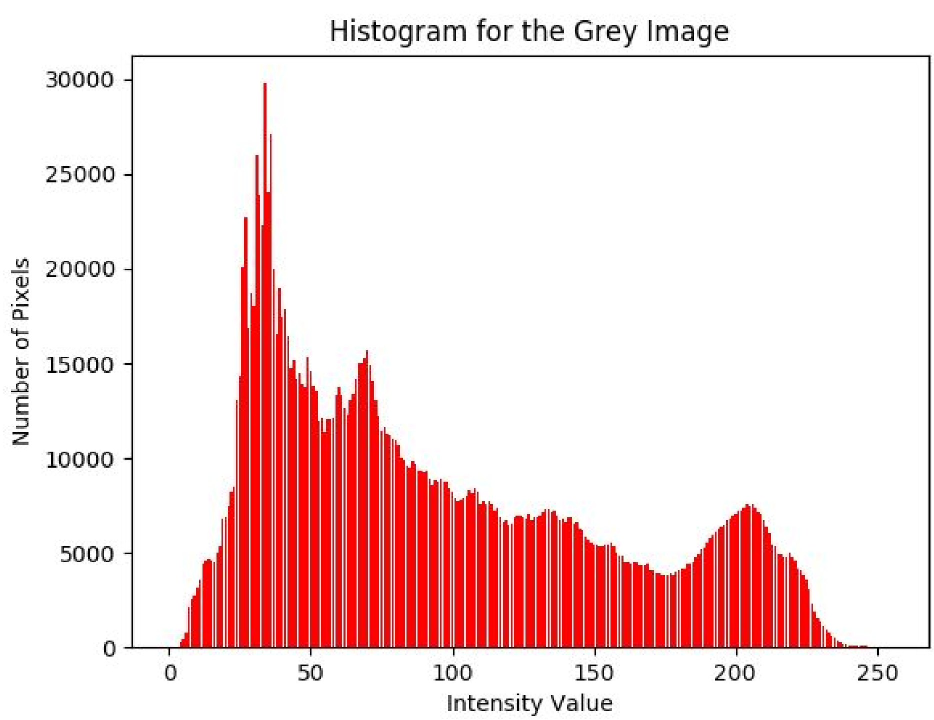
Contrast Enhanced Image

1. **Image Histogram :**

❖ **For Image 1**

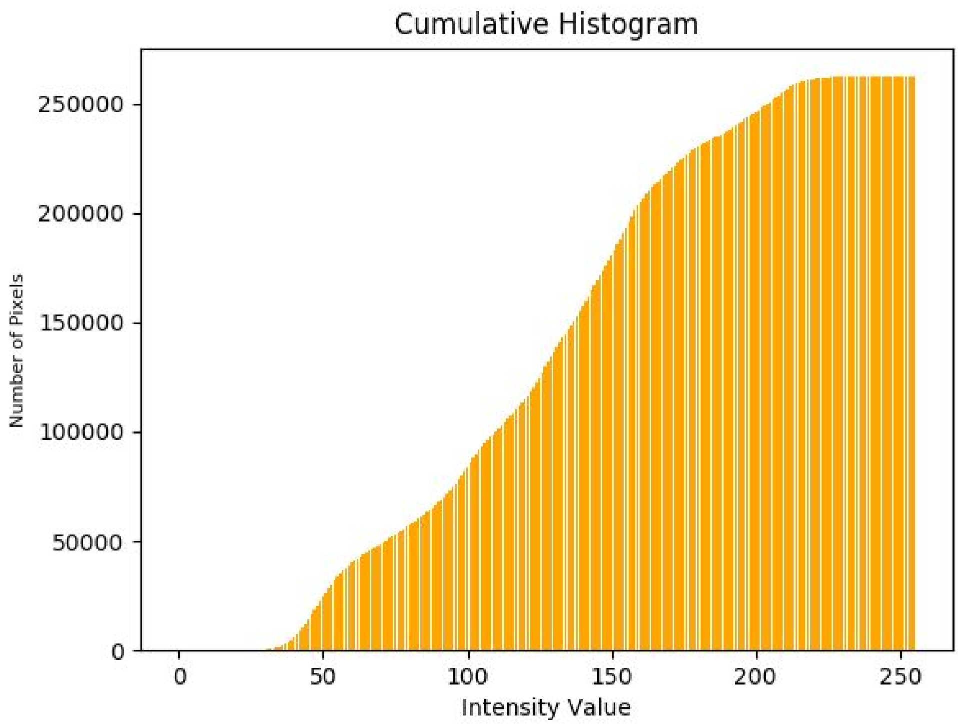


❖ **For Image 2**

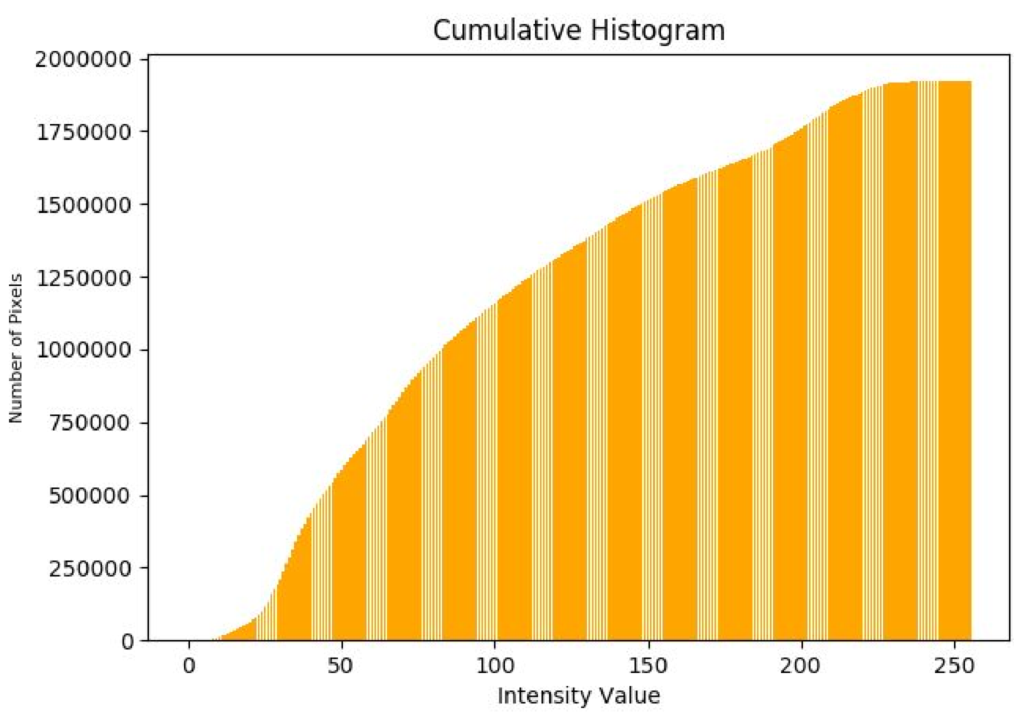


2. Cumulative Image Histogram:

- **For Image 1**

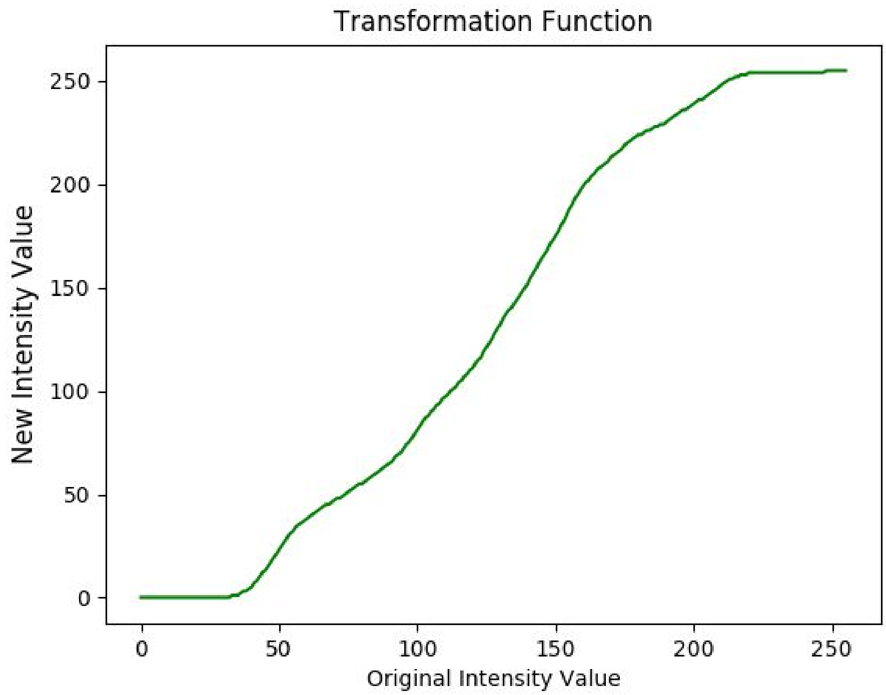


- **For Image 2**

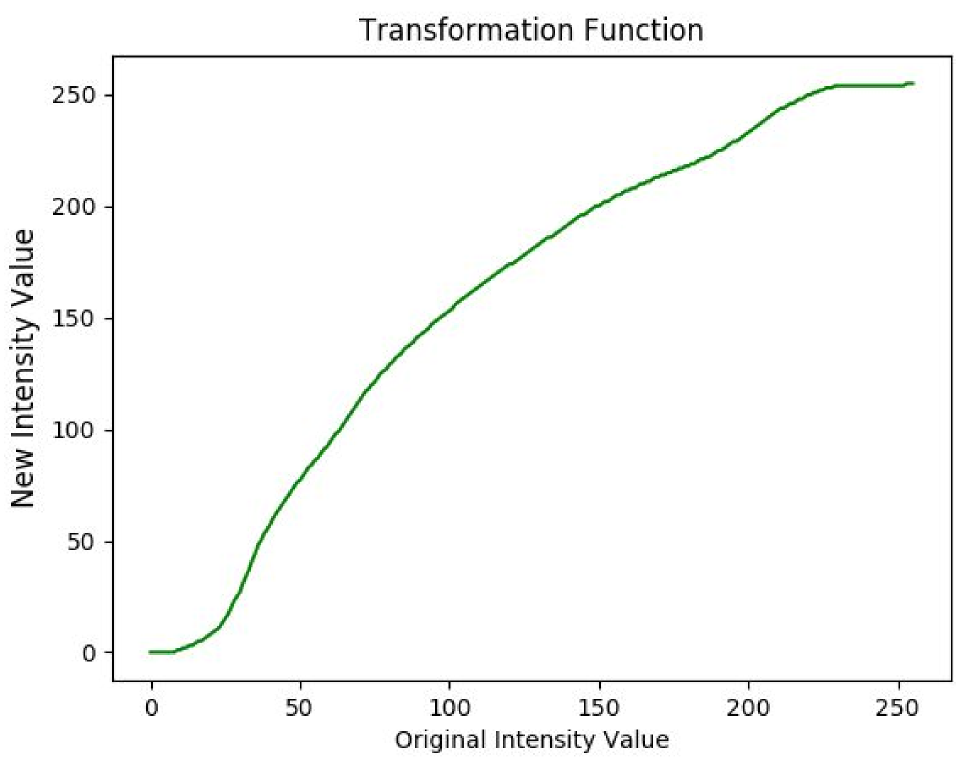


3. Transformation Function (Look Up table):

- **For Image 1**

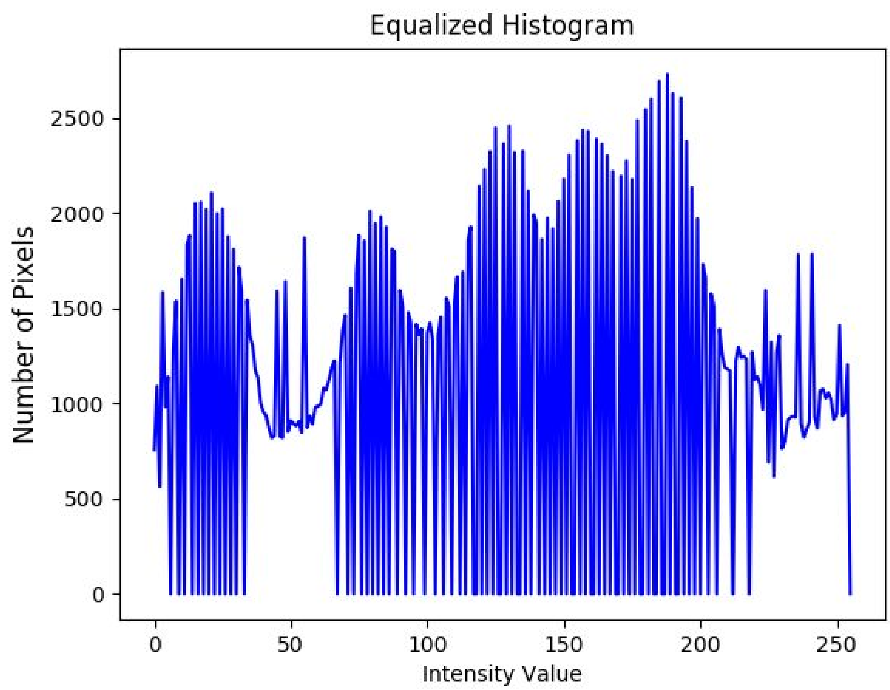


- **For Image 2**



4. Equalized Histogram of the Image :

❖ For Image 1



❖ For Image 2