State University of New York at Buffalo

CSE 473/573 Summer 2016

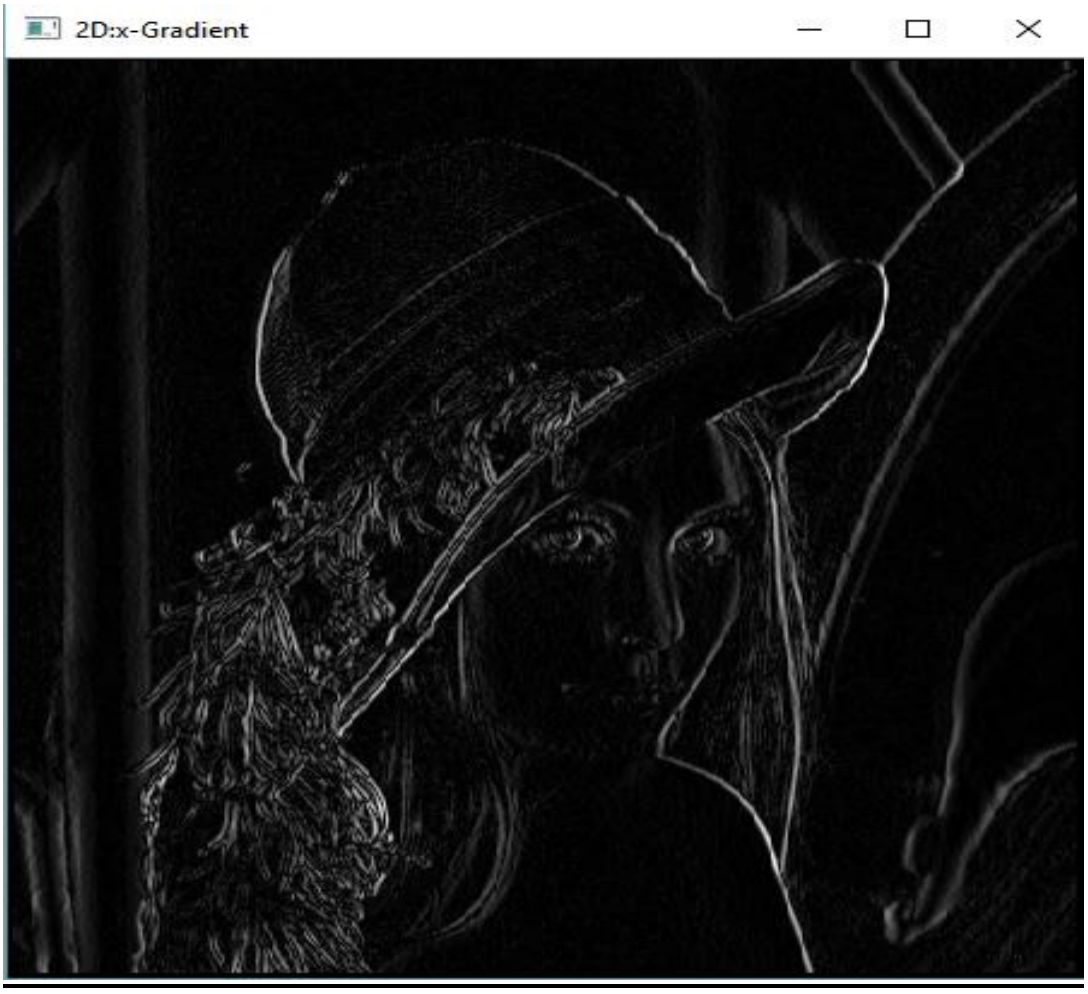
Programming Assignment #1

Problem1: 1D and 2D Convolution on Images

2D and 1D convolutions involve convolving both horizontal and vertical directions in 2 and 1 dimensional spatial domain of the image. They are frequently used for image processing, such as smoothing, sharpening, and edge detection of images.

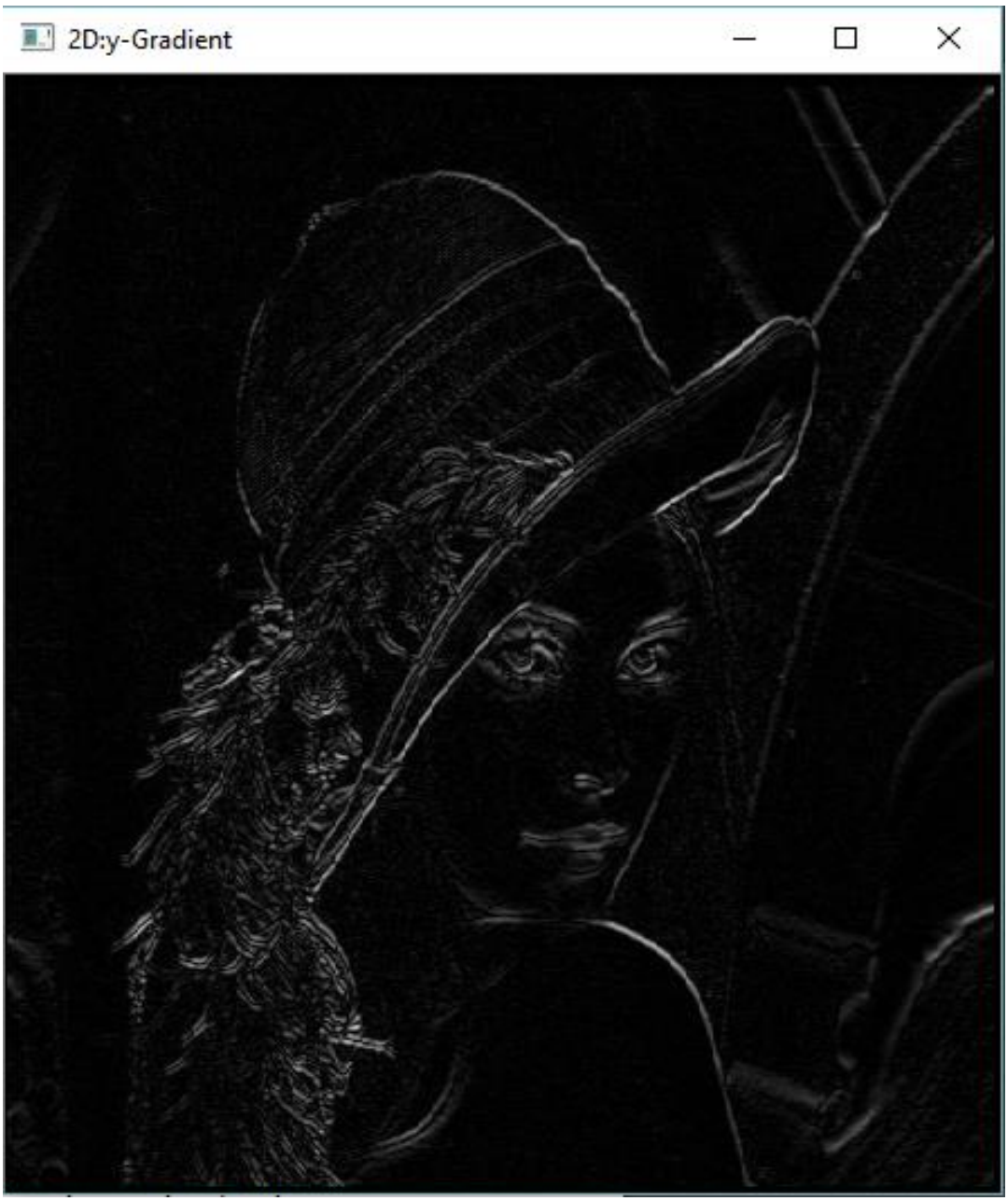
A] 2D Convolution

- **2D Convolution X- Gradient : G_x**



Applying X gradient of the Sobel filter, we get all the vertical edges of the image.

- **2D Convolution Y- Gradient : G_y**



Applying Y gradient of the Sobel filter, we get all the horizontal edges of the image.

- **2D Convolution Gradient Magnitude : G_{mag}**

B] 1D Convolution

- **1D Convolution X- Gradient : G_x**

- **1D Convolution Y- Gradient : G_y**

- **1D Convolution Gradient Magnitude : G_{mag}**

C] Given an MxN Image and a PxQ filter, compute the computational complexity of performing 2D convolution vs using separable filters with 1D convolution.

Computational complexity of 2D Convolution: O(M.N.P.Q)

This is because the P x Q filter has to be applied on each pixel in the M x N image matrix.

The Computational complexity of Separable filter with 1D convolution: O(MN(P+Q).

This shows that separable filter with 1D convolution has better complexity as compared to 2D convolution.

Example:

Image size: 256 x 512

Convolution filter: 3x3

M=256, N=512, P=3, Q=3

Computational complexity of 2D Convolution: O(256 x 512 x 3x3)= 1179648 operations

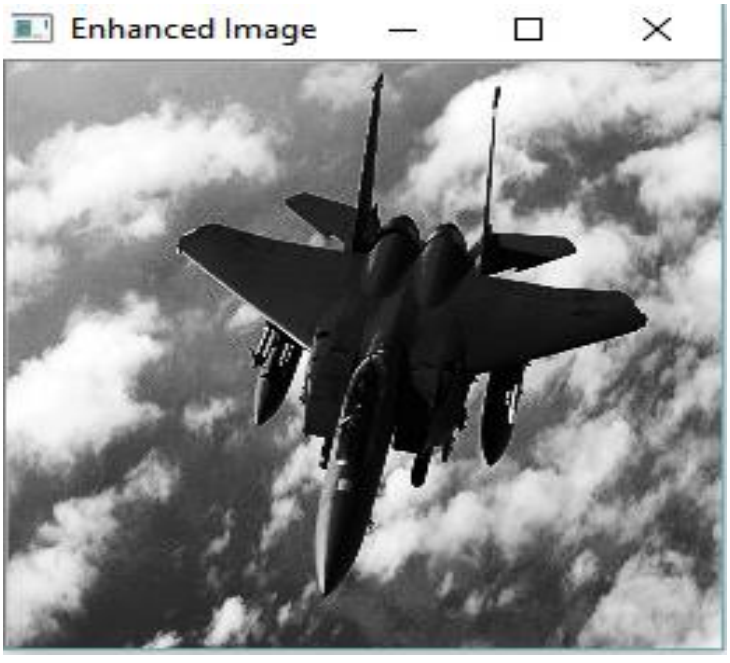
Computational complexity of Separable filter with 1D convolution: O(256x512(3+3))

=786432 operations

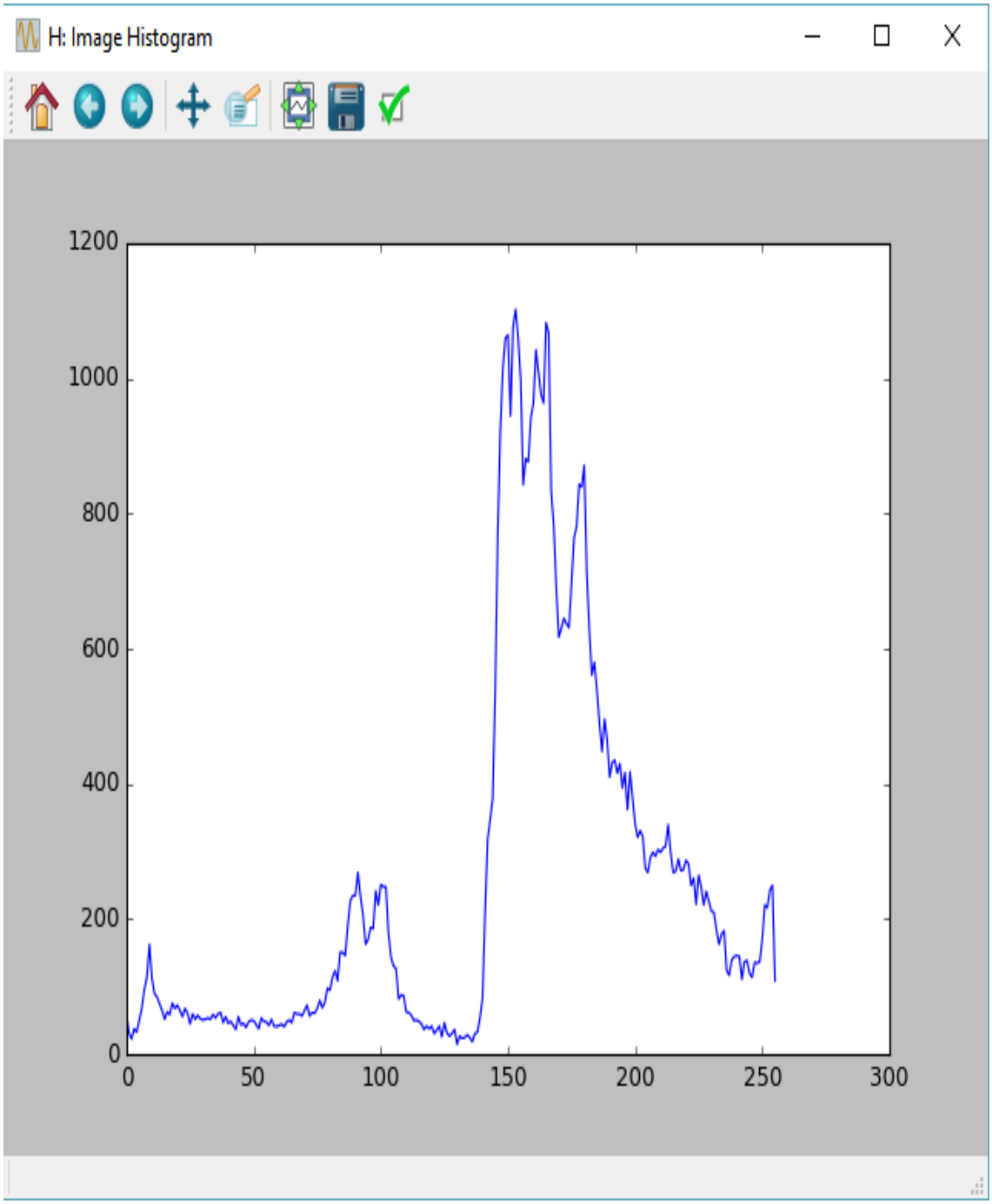
Problem 2: Histogram Equalization

Applying the Histogram Equalization algorithm given, the following were the images and histograms obtained.

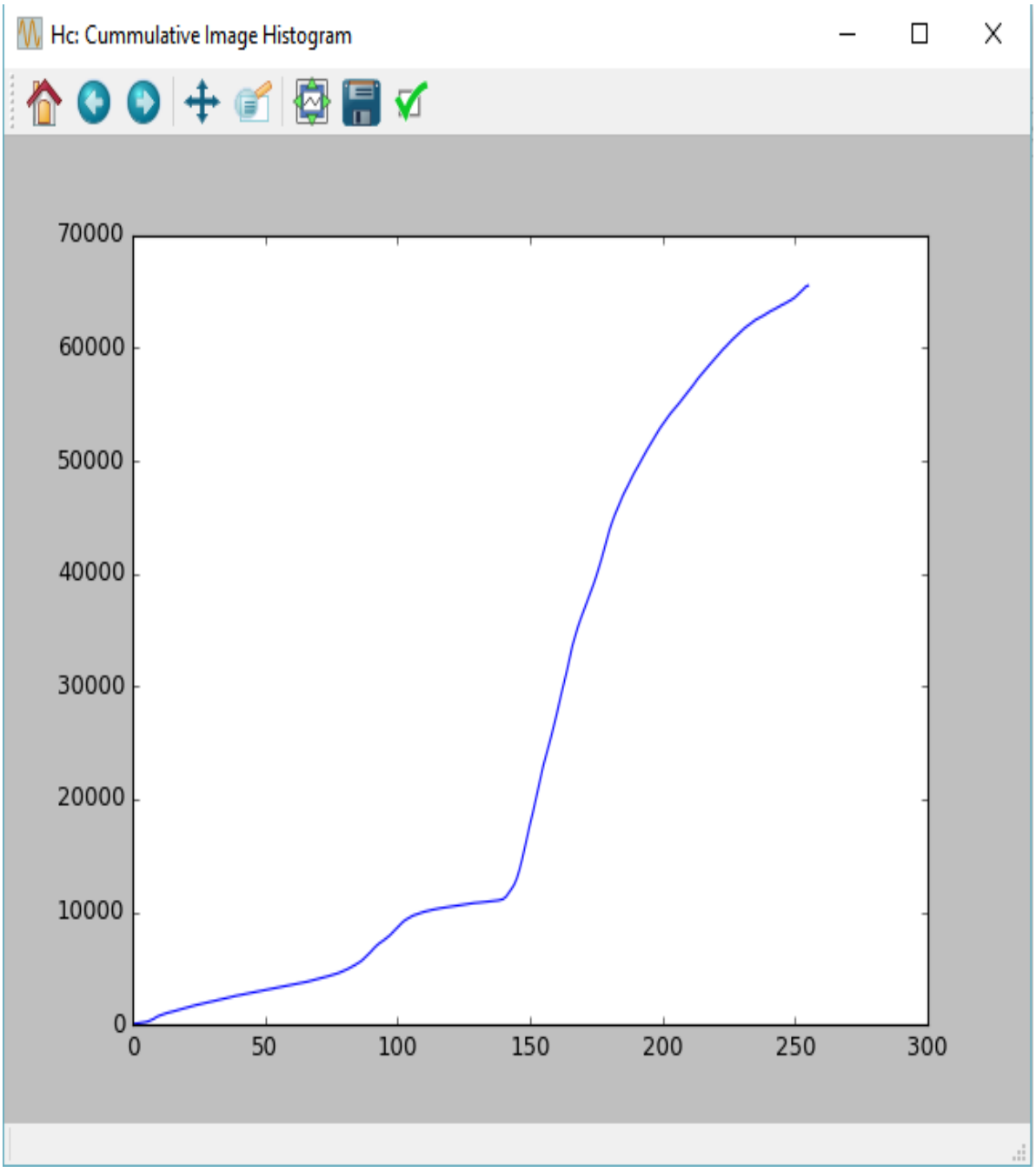
- Original Image and Enhanced Image



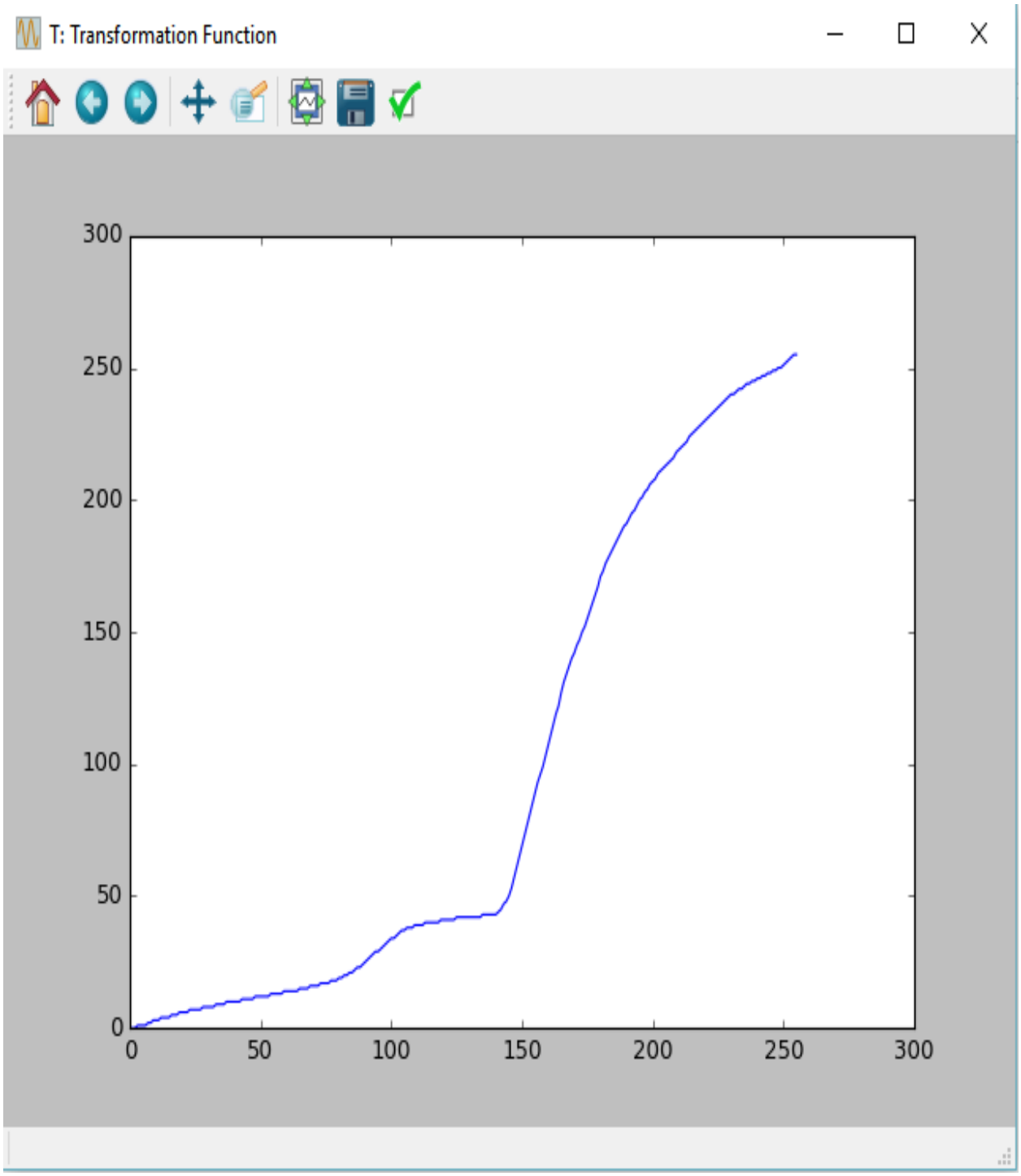
➢ Original Image Histogram



➢ Cumulative Histogram



➢ Transformation Function



➢ Enhanced Image Histogram