IMAGE PROCESSING

Mini Project

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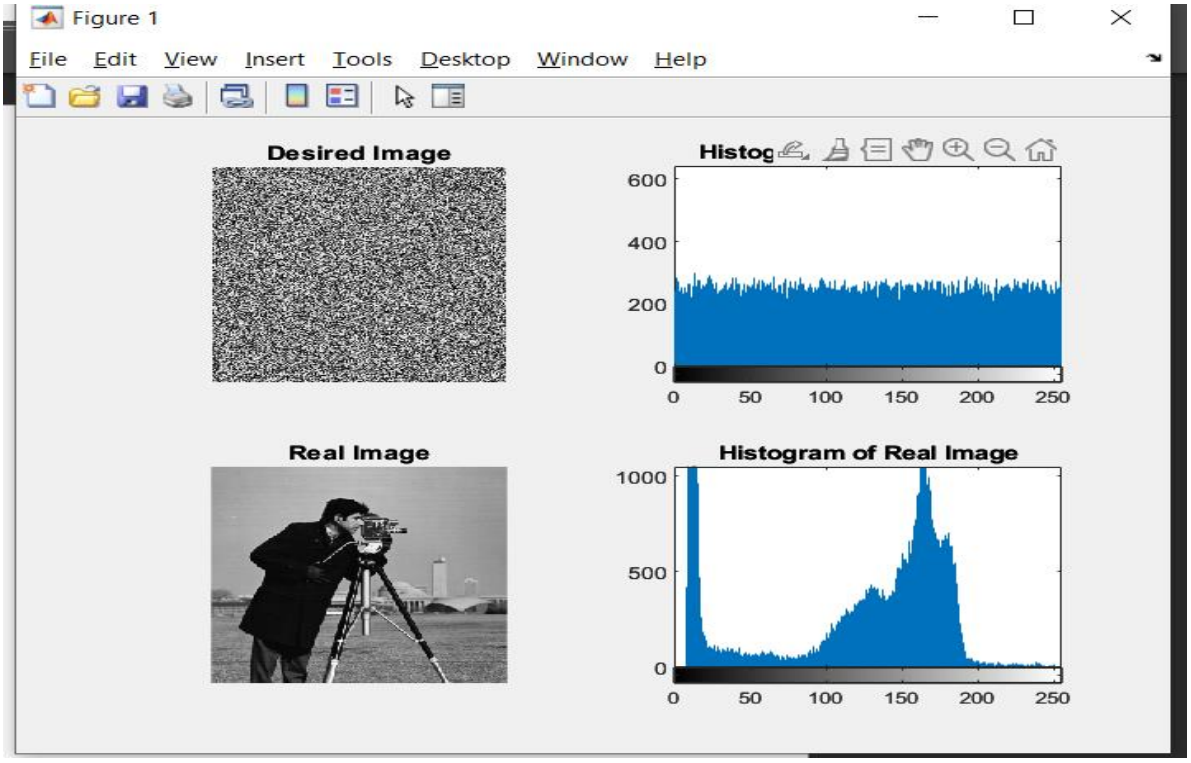
Introduction

Image processing is an important field of study in computer science and engineering. In this mini project, we explored some basic concepts of image processing using MATLAB and the Image Processing Toolbox.

Task (a)

We started by discussing the concept of image histograms, which represent the distribution of pixel intensity values in an image. For an 8-bit grayscale image, there are 256 different **intensity values (ranging from 0 to 255),** and the histogram shows the distribution of pixels among those values. By observing the histogram of an image, we can infer important information about the image, such as its brightness and contrast.

To gain some practical experience, we first **synthesized a desired image and loaded another image included in the Image Processing Toolbox**. We **displayed both images and their histograms** side by side using MATLAB's subplot function. We **observed** that the pixels in the images had relatively low **intensity** values and a small dynamic range.



- Do pixels have high or low intensity values?
    - The pixels of the real image is balanced with a slight shift towards the grey portion. The synthesized image has an equal distribution of intensities.
- What is the dynamic range of pixels?

- For an 8-bit grayscale image, the dynamic range is from 0 to 255, representing the range of possible intensity values from black to white.

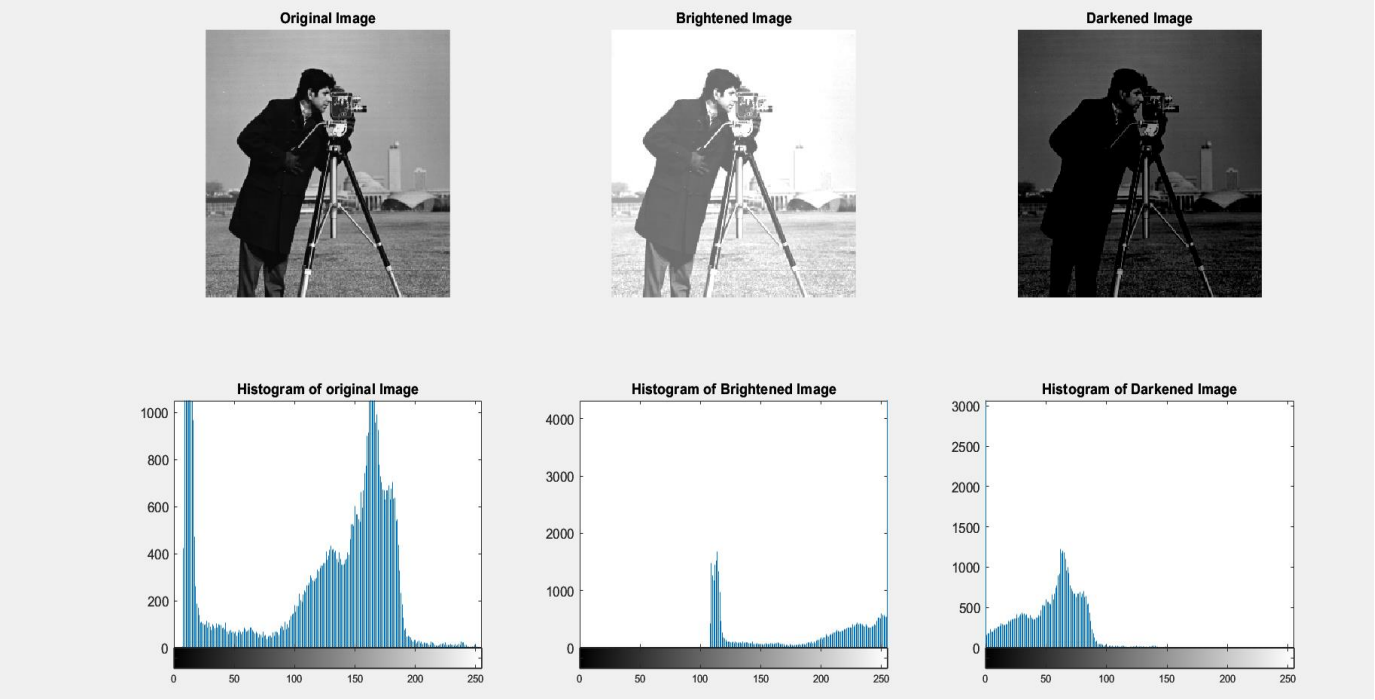
- Do pixels have a small or large dynamic range?
  - Pixels in both images have a small dynamic range. In the desired image the brightness level is the same across pixels. In the real image it's balanced but it tends to lower end a bit.

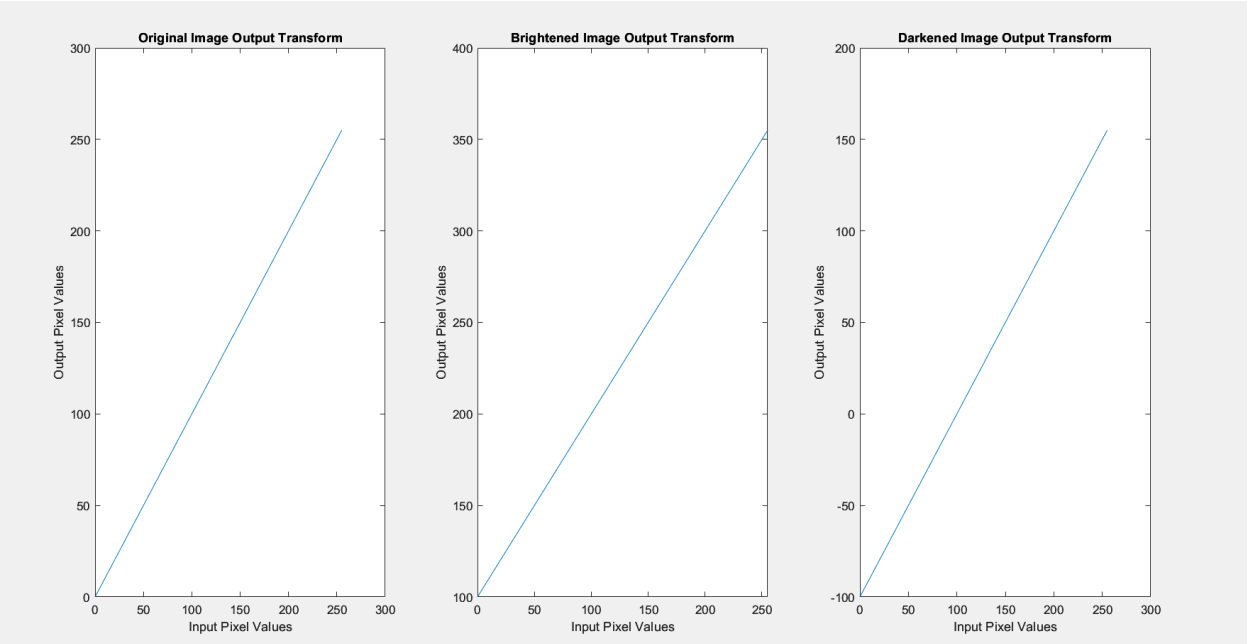
Task (b, c)

Next, **we adjusted the brightness** of the loaded image using the concepts of image transforms. To increase the brightness, we added a positive value to each pixel, and to decrease the brightness, we added a negative value. We stacked the original, brightened, and darkened images in one figure and displayed their histograms side by side. We also plotted the output transforms of the original, brightened, and darkened images to compare them. We observed that **increasing brightness shifted pixel values to the right, while decreasing brightness shifted pixel values to the left**. We also noticed that **increasing/decreasing brightness did not affect the dynamic range of pixels.**

- Does decreasing brightness shift pixel values to the left?
  - Yes, decreasing the brightness shifts the values to the left.

- Does increasing/decreasing brightness affect the dynamic range of pixels?
  - No, altering the brightness did not affect the dynamic range of pixels.





Task (d)

Finally, we performed **histogram equalization to enhance the contrast** of the loaded image. We used the "histeq" function provided by the Image Processing Toolbox to equalize the histogram. We stacked the original image and the enhanced image in one figure and displayed their histograms side by side. We observed that the **histogram of the enhanced image was flat and equalized**, indicating that all intensities of the image were distributed equally. Whereas the original image has a histogram that is not flat. We also noted that **the quality of the image improved after histogram equalization.** We plotted the output transform of the enhanced image obtained from histeq and compared it to that of the original image.

- Does equalization improve the quality of the image?
    - Yes, the quality of the image was improved after the equalization in case of the 2nd image.

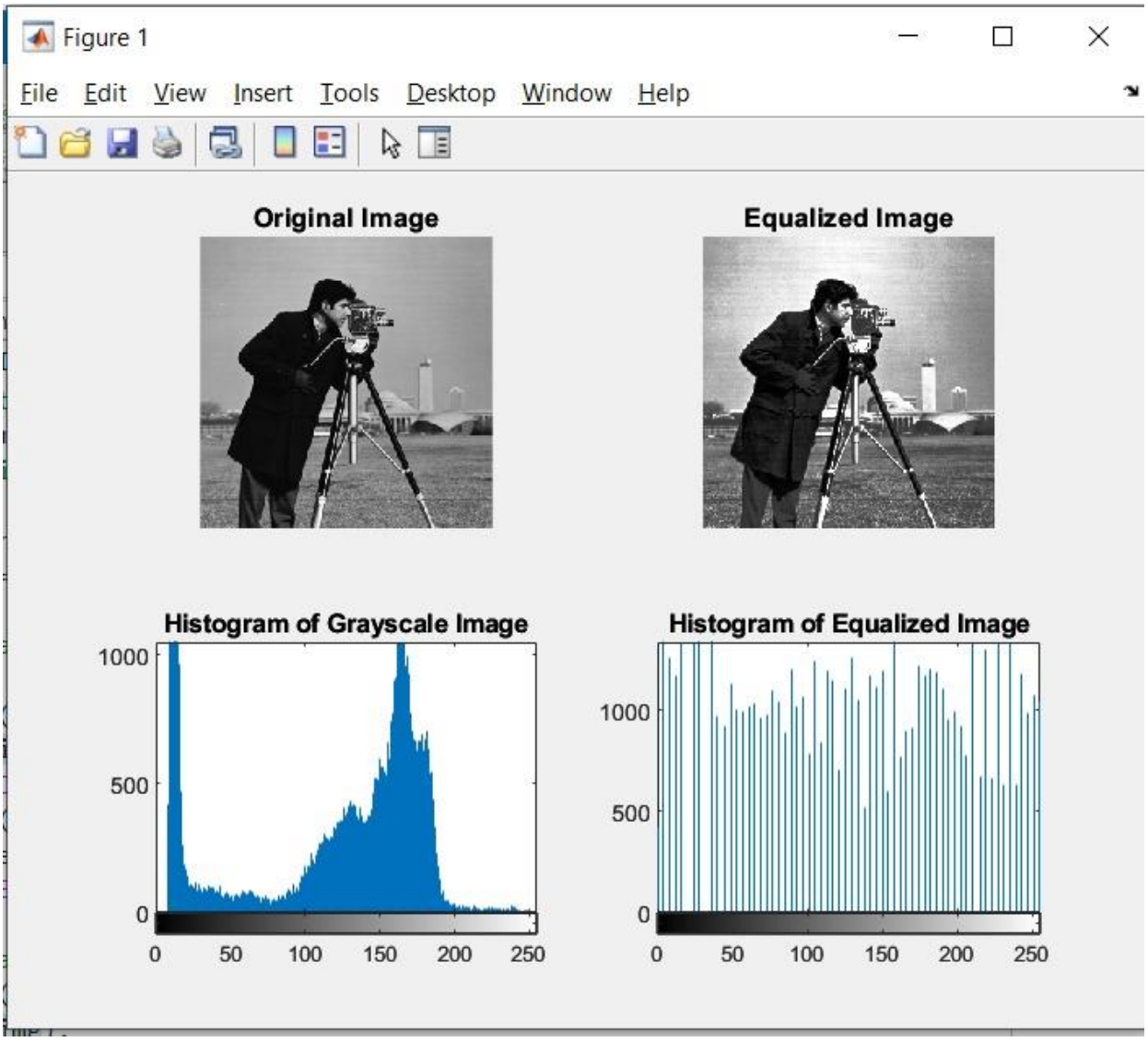


Figure 1
File Edit View Insert Tools Desktop Window Help
Original Image
Equalized Image
Histogram of Grayscale Image
Histogram of Equalized Image
1000
500
0
0 50 100 150 200 250
1000
500
0
0 50 100 150 200 250

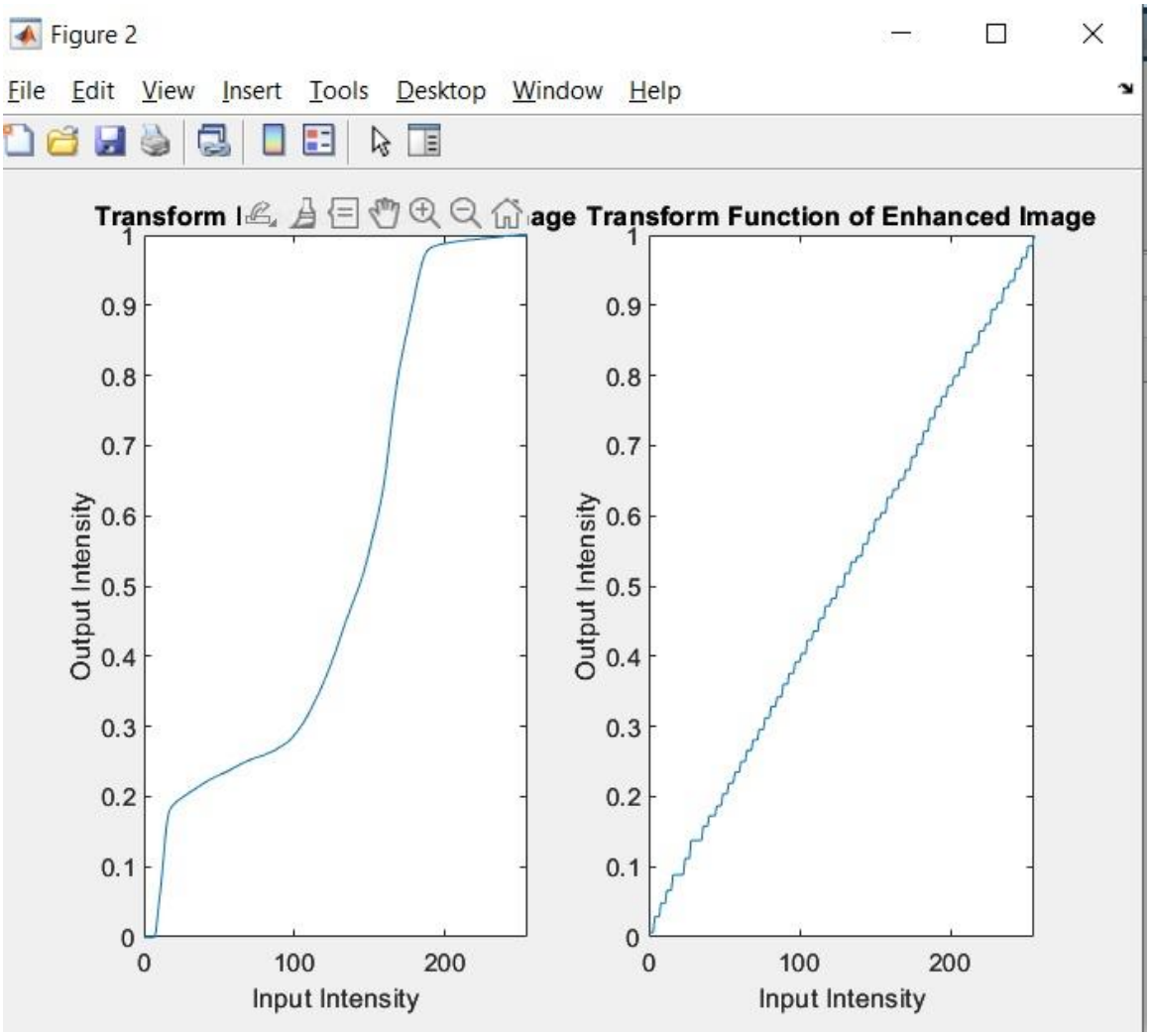


Figure 2
File Edit View Insert Tools Desktop Window Help
Transform I
age Transform Function of Enhanced Image
Output Intensity
Input Intensity
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
100
200

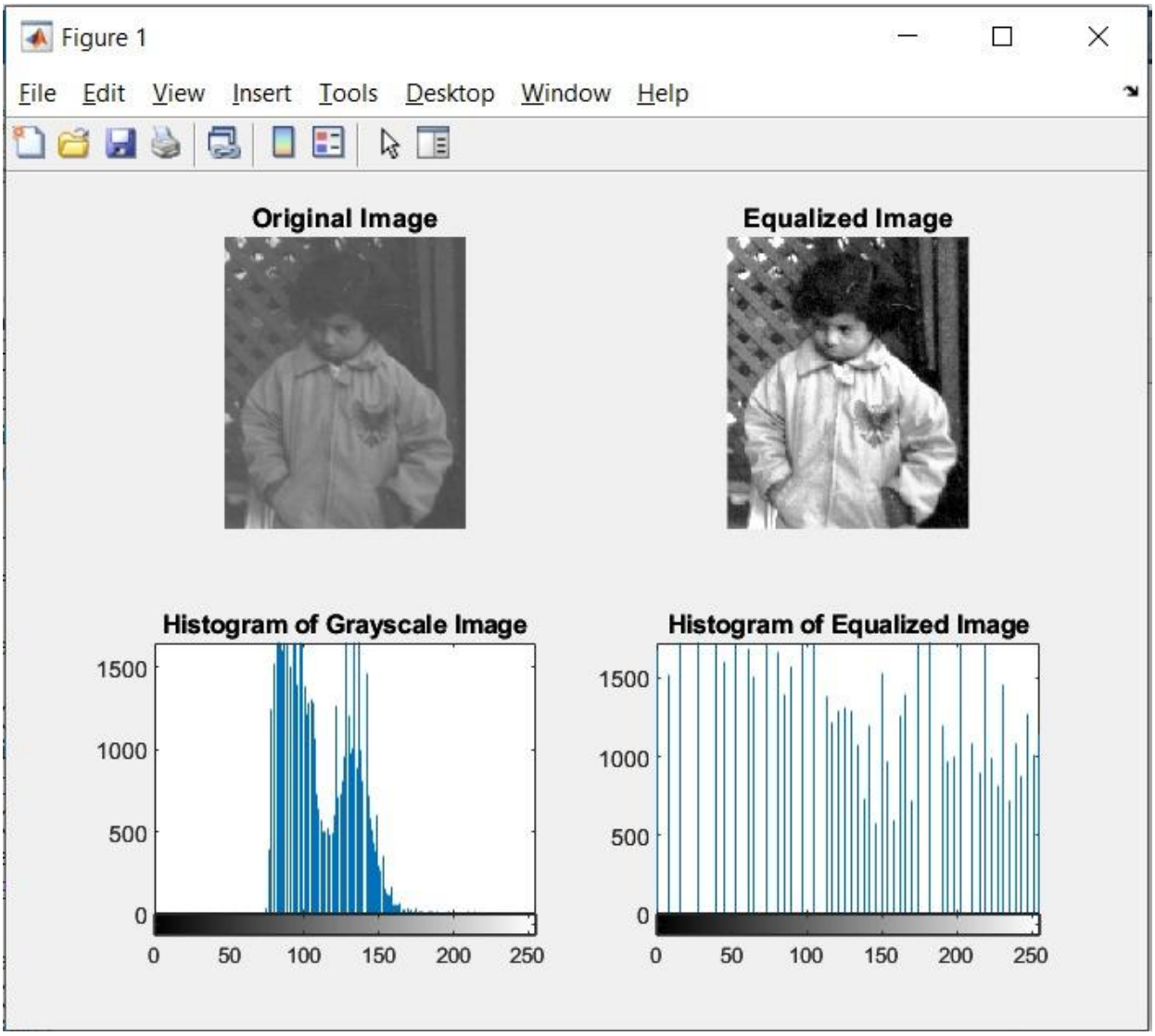
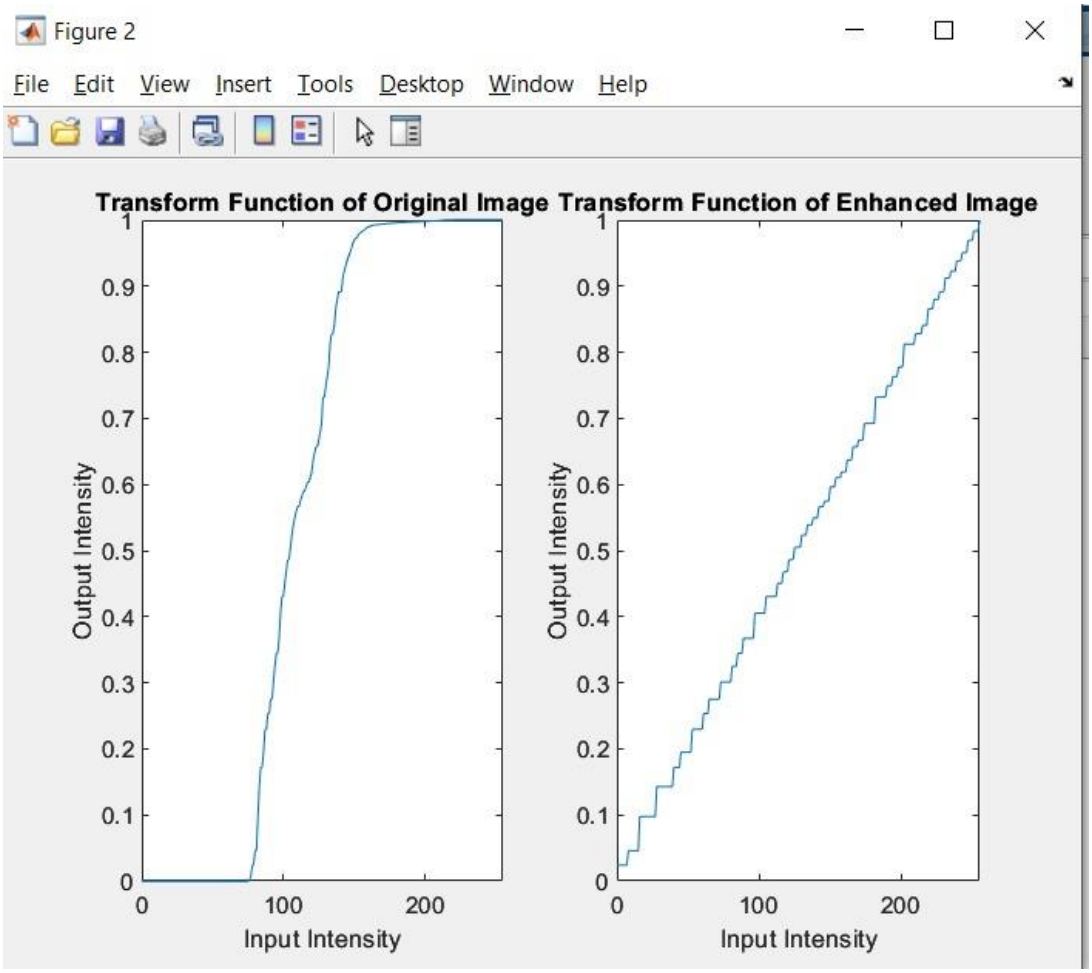


Figure 1
File Edit View Insert Tools Desktop Window Help
Original Image
Equalized Image
Histogram of Grayscale Image
Histogram of Equalized Image
1500
1000
500
0
0 50 100 150 200 250



Conclusion

In conclusion, this mini project provided a basic introduction to some important concepts of image processing, such as image histograms, brightness adjustment, and histogram equalization. By gaining a better understanding of these concepts, we can process and enhance images to improve their quality and extract useful information from them.