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CS825 – Assignment2

Problem 1. [*Image Intensity Transformation, Power-Law Transformation, Gamma Correction*] Power-law function for image intensity transformation is defined as $s=T(r)=(L-1)(rL-1)\gamma$ where *L* is the number of intensity levels and γ is a positive parameter. The following graph shows shape of s = T(r) for various parameter values.

The below images shows command line arguments to be given for both images. We have compile and run the program using
gcc ProgramName -o executable
./executable “Input image path” “Output image path” 256 256 γ – For first image
./executable “Input image path” “Output image path” 452 307 γ – For second image

```
PS C:\Users\Sushitha Rajeev\OneDrive\Documents> gcc A2Q1.c -o q1
PS C:\Users\Sushitha Rajeev\OneDrive\Documents> ./q1 "C:\Users\Sushitha Rajeev\OneDrive\Documents\assn2.raw" "C:\Users\Sushitha Rajeev\OneDrive\Documents\hist.raw" 452 307 1.0
... Load input image
138764...Save the output image
```

```
PS C:\Users\Sushitha Rajeev\OneDrive\Documents> ./q1 "C:\Users\Sushitha Rajeev\OneDrive\Documents\assn1.raw" "C:\Users\Sushitha Rajeev\OneDrive\Documents\hist.raw" 256 256 0.3
... Load input image
65536...Save the output image
```

1)Explain what are effects to an image if (a) γ < 1.0; (b) γ = 1.0; and (c) γ > 1.0, respectively, and why.

When γ < 1.0, Original dark region of the image will be brightened

When γ = 1.0, Original image would not be affected

When γ > 1.0, Original image will become darker

We can see the results below 6 figures in the part 2.

In Figure 1,2,3 – Image: 256 x 256 grayscale image with γ=0.3, 1.0, 1.8.

When γ=0.3, image is brighter, visible and clearer than original image.

When γ=1.0, we don’t see any changes compared to original image.

When γ=1.8, image has become more darker compared to original image.

In Figure 4,5,6- Image: 452 x 307 grayscale images with γ=0.3, 1.0, 1.8.

When γ=0.3, image is brighter, visible and clearer than original image.

When γ=1.0, we don’t see any changes compared to original image.

When γ=1.8, image has become more darker compared to original image.

2) Total 6 testing results:
Figure 1,2,3 – Images with 256 x 256 grayscale with γ =0.3(Figure 1), γ=1.0(Figure 2), γ=1.8(Figure 3)
Figure 4,5,6 – Images with 452 x 307 grayscale with γ =0.3(Figure 4), γ=1.0(Figure 5), γ=1.8(Figure 6)

Figure1 : γ = 0.3

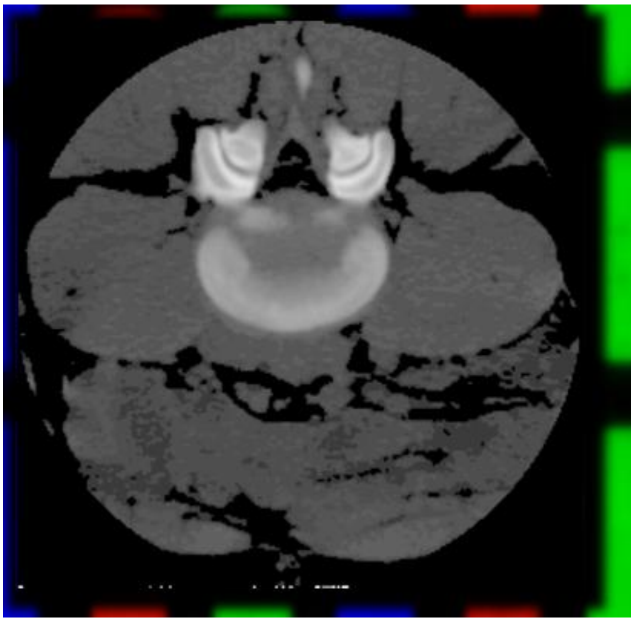


Figure2 : γ = 1.0

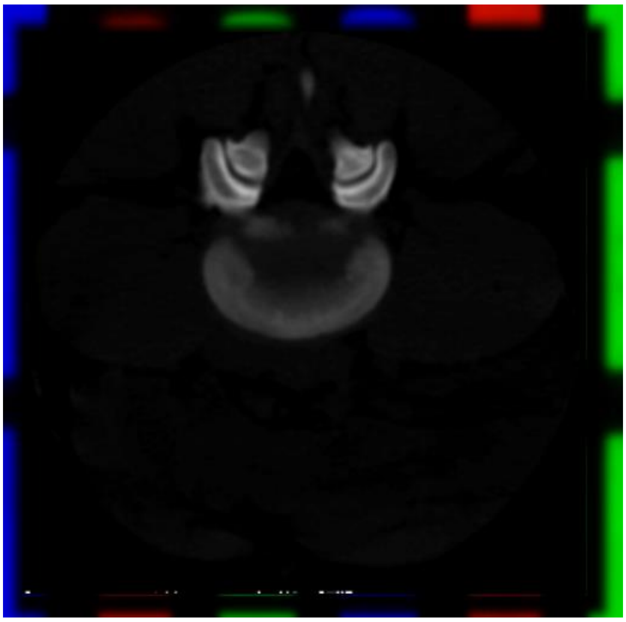


Figure3 : γ = 1.8

Figure1,2,3- Image:256 x 256 grayscale images with γ =0.3, 1, 1.8

Figure 4: γ =0.3

Figure5: γ =1.0

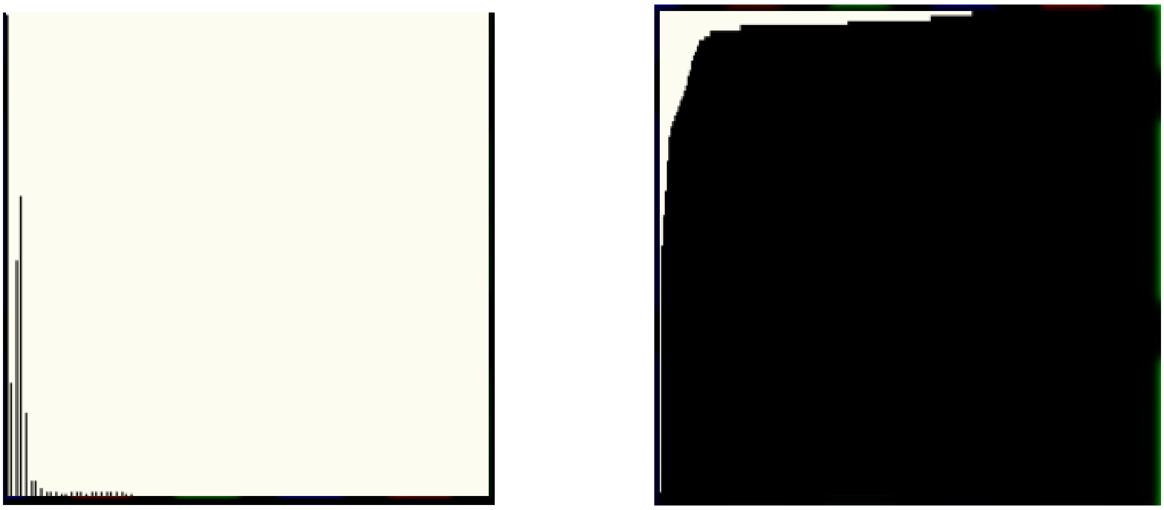
Figure6: γ =1.8

Figure4,5,6- Image: 452 x 307 grayscale images with γ =0.3, 1.0, 1.8

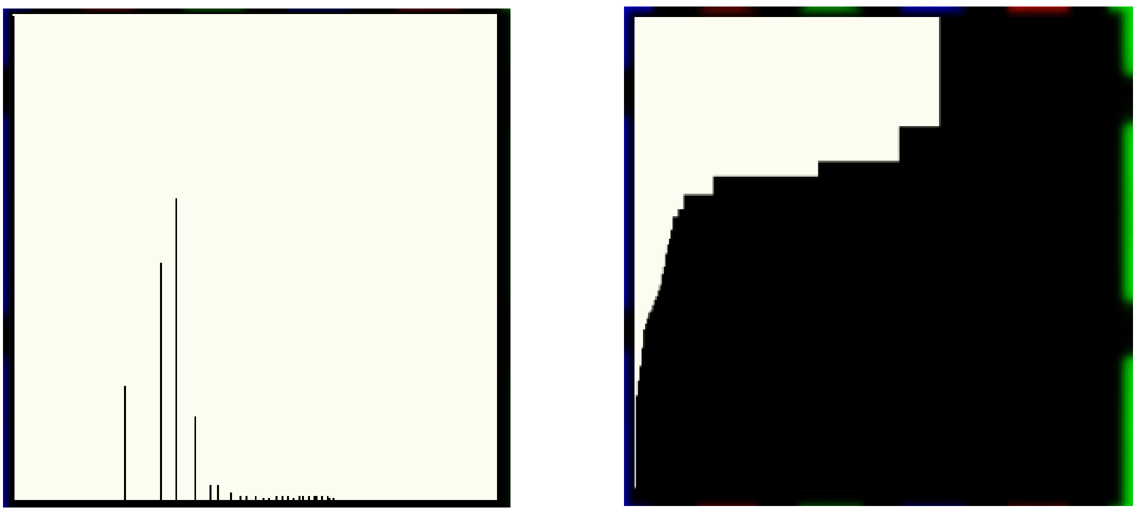
Problem 2. [*Histogram, Cumulative Histogram*]
Write a complete program that computes and displays the histogram and the cumulative histogram of an input image. Test your program with the two original testing images and the six transformed new images from Problem 1.

Below 4 plots are on image 256 x 256 for histogram with cumulative histogram. Plot 1 is for the original image. Plot 2, plot 3 and plot 4 are on images with γ=0.3,1.0 and 1.8 respectively.

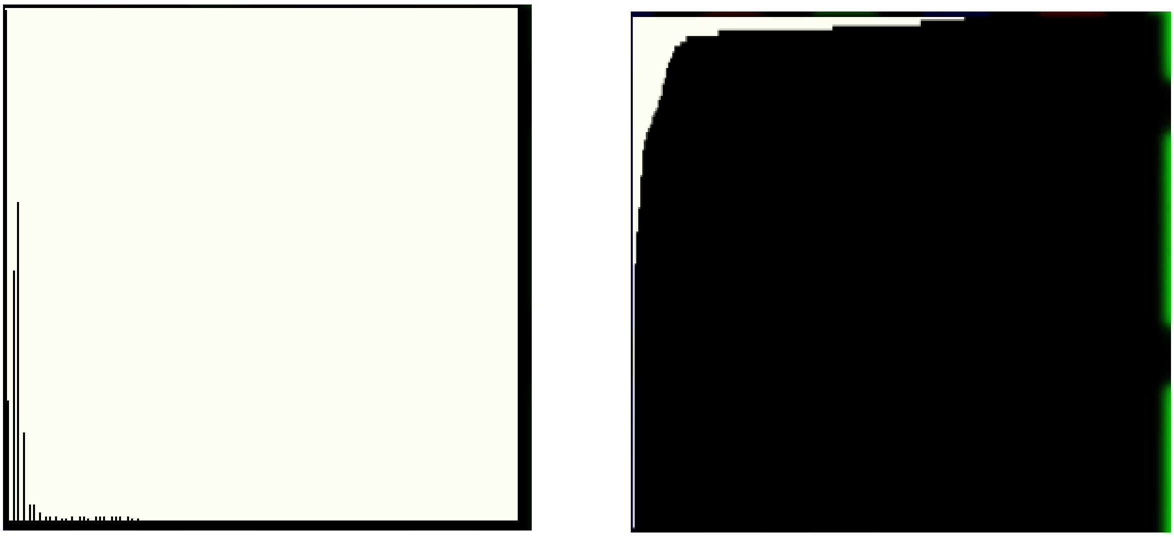
Plot1: Original image: 256 x 256 with histogram and cumulative histogram.



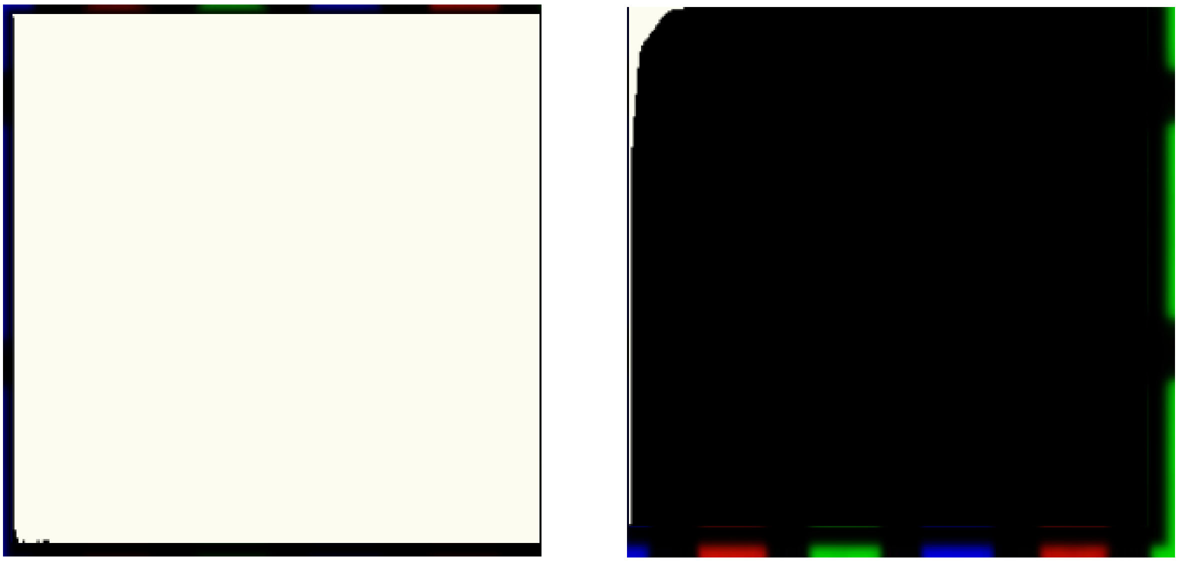
Plot2: Image 256x256 with histogram and cumulative histogram on γ=0.3



Plot3: Image 256x256 with histogram and cumulative histogram on γ=1.0

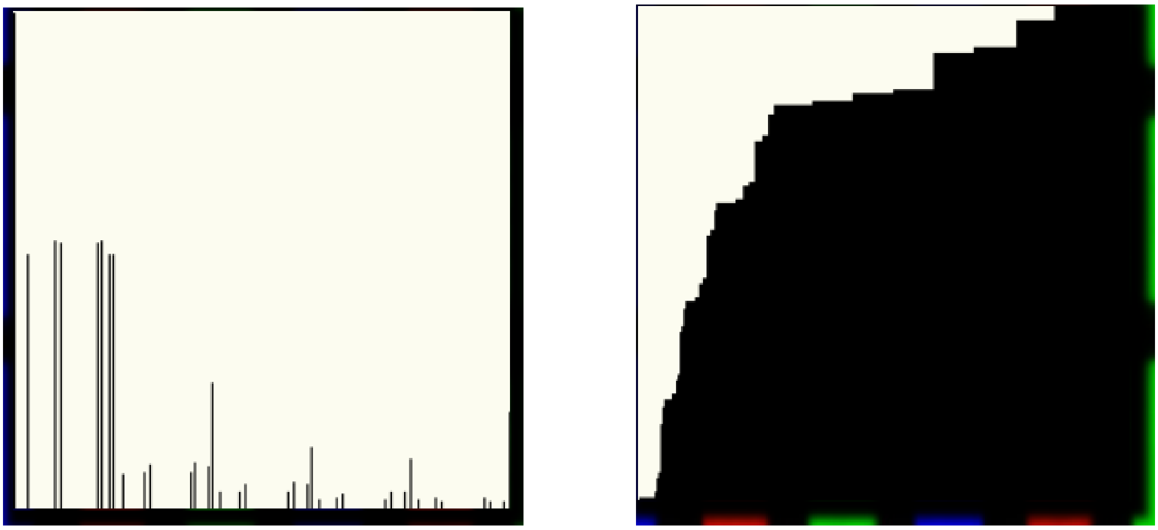


Plot4: Image 256x256 with histogram and cumulative histogram on γ=1.8

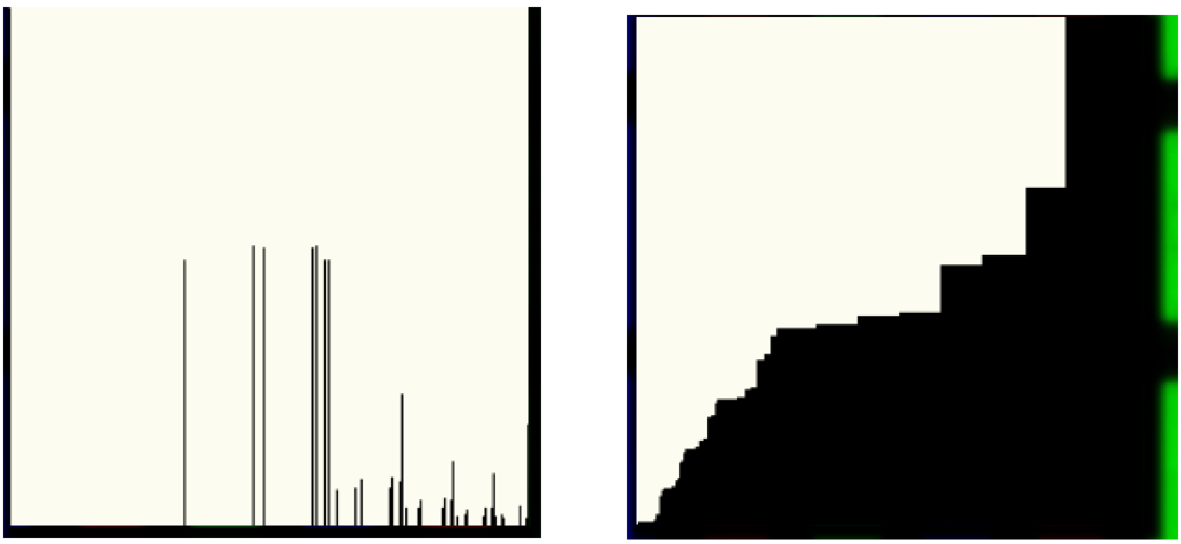


Below 4 plots are on image 452 x 307 for histogram with cumulative histogram. Plot 5 is for the original image. Plot 6, plot 7 and plot 8 are on images with γ=0.3,1.0 and 1.8 respectively.

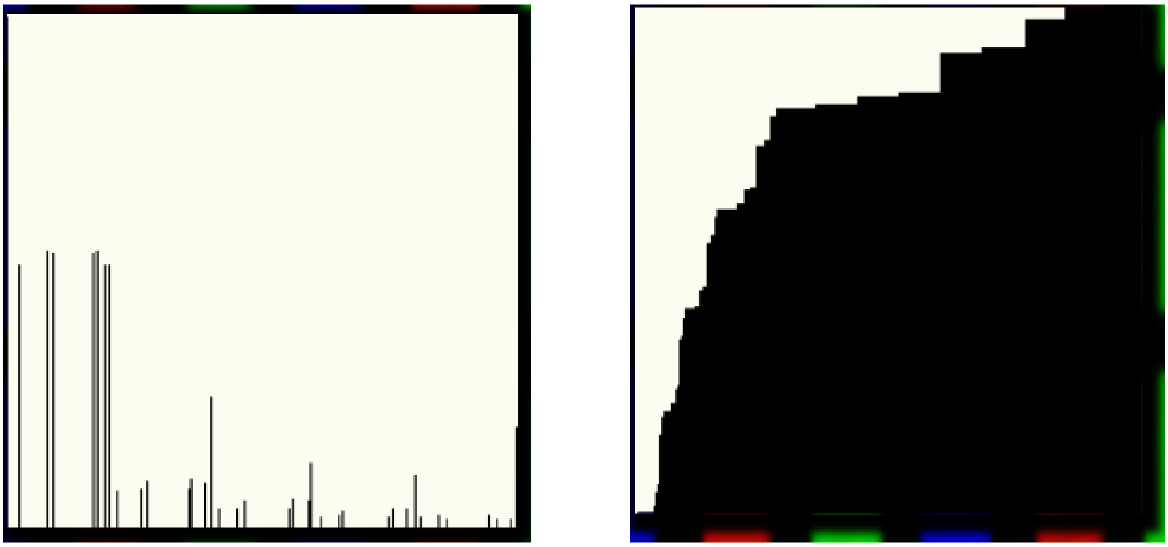
Plot5: Image 452 x 307 with histogram and cumulative histogram on original image



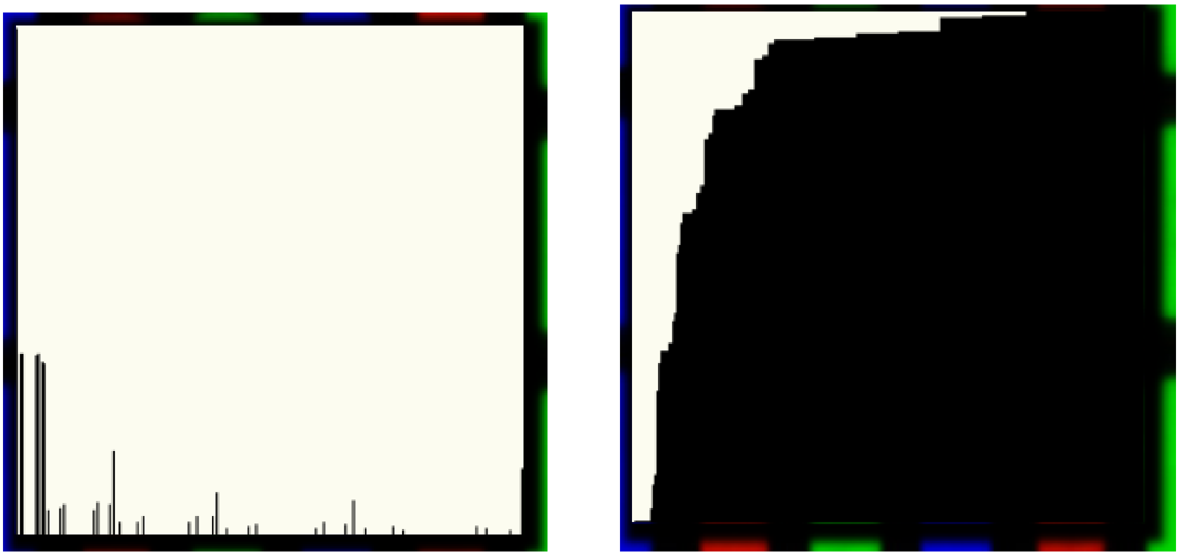
Plot6: Image 452 x 307 with histogram and cumulative histogram on γ=0.3



Plot7: Image 452 x 307 with histogram and cumulative histogram on γ=1.0



Plot8: Image 452 x 307 with histogram and cumulative histogram on γ=1.8

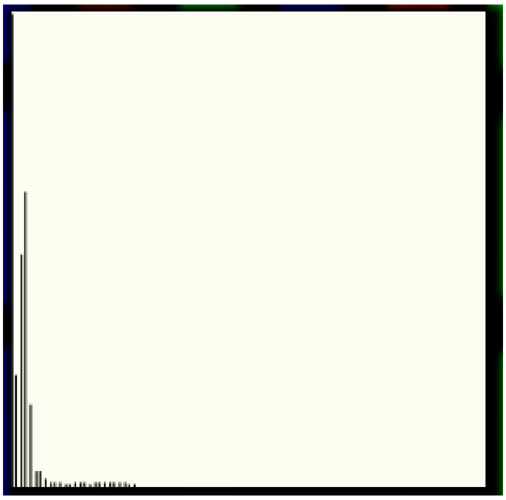


Problem 3. [*Histogram equalization*]

1) **Write a complete program that implements the traditional histogram equalization algorithm. That is, (a) compute the histogram of an input image (i.e. PDF); (b) compute its cumulative histogram (i.e. CDF); and (c) transform the input image using CDF as the transformation function. Test your program with the two images in Problem 1.**

   Image1: 256 x 256 grayscale original image.

Histogram of original Image



Cumulative histogram of Original Image

Transformed Image

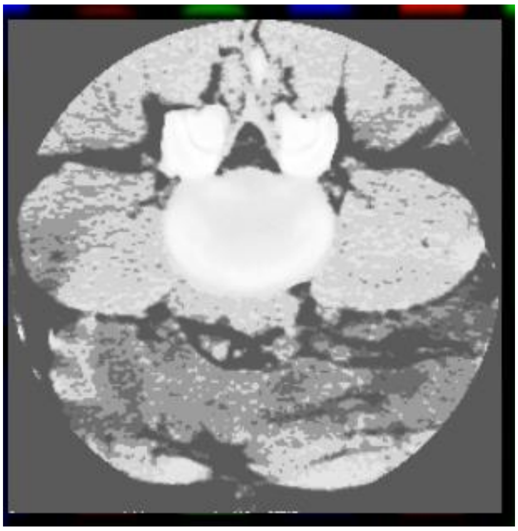
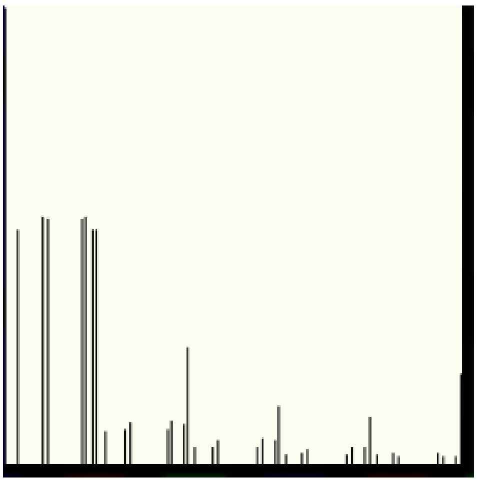
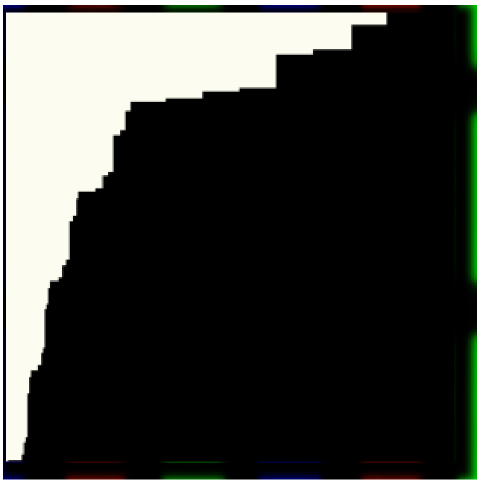


Image2: 452 x 307 grayscale original image

Histogram of original image



Cumulative histogram of original image

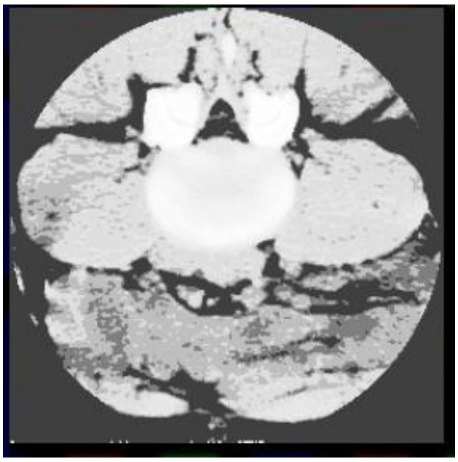


Transformed image

2) Write another complete program that implements my novel divide-and-conquer algorithm for histogram equalization.

Transformed Image of test image1 using novel divide-and-conquer algorithm for histogram equalization.

Figure: Transformed Image of test image1 using novel divide-and-conquer algorithm for histogram equalization.



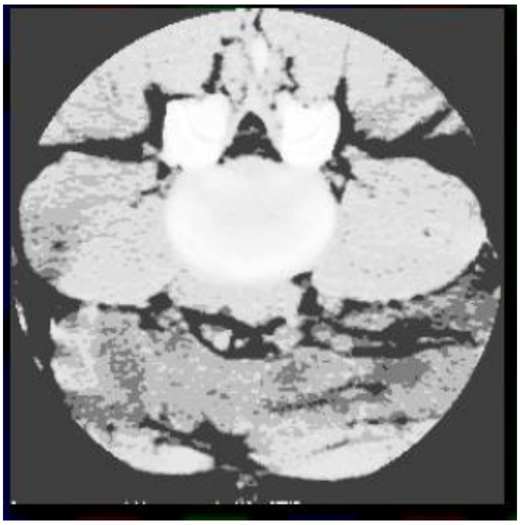
Transformed Image of test image2 using novel divide-and-conquer algorithm for histogram equalization.

Figure: Transformed Image of test image2 using novel divide-and-conquer algorithm for histogram equalization.

3) **Compare the histograms of the result images from 1) and 2) respectively. Briefly discuss your observations.**

Image1: 256 x 256 grayscale image

Novel algorithm



Traditional algorithm

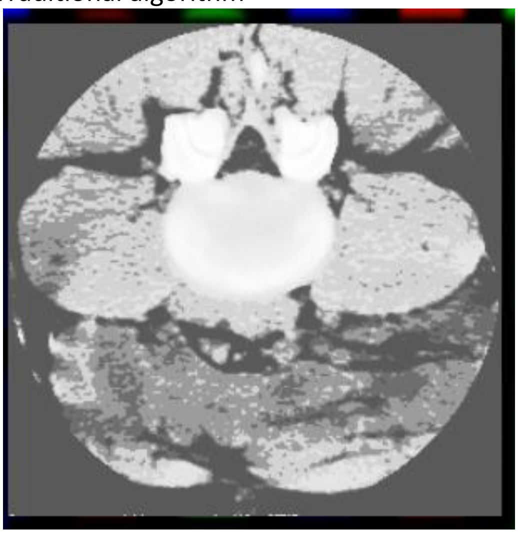


Image2: 452 x 307 grayscale image

Novel algorithm

Traditional algorithm

- While computing cdf in the 1st method, we need to scale. But, in case of novel algorithm model, no need to scale as it is almost close to scaled cdf.
- In novel method, only last elements was not filled and we filled it later using neighbour value
- Novel method took less time to compute compared to traditional algorithm method.
- This differences are same for both image 1 and image 2.
- Above images are comparison between novel and traditional method. In novel method, image seems to be brighter in some parts than traditional method image. Also, background is bit darker in novel compared to traditional method.

Problem4:

a. C1 = [150, 80, 120], estimate its hue with calculation details.

This can be decomposed into 2 parts.
[150,80,120] = [80,80,80] + [70,0,40]
[80,80,80]- White amount
[70,0,40]-Hue amount

Hue is calculated by liner interpolation
Red=70, Blue=40.
(360*70+240*40)/110 = 316.363636363636 degrees

b. Given another color, C2 = [75, 40, 60], estimate its hue.

This can be decomposed into 2 parts.
[75,40,60]=[40,40,40]+[35,0,20]

Hue is calculated by liner interpolation
Red=35, Blue=20
(360 * 35 + 240 * 20) / 55= 316.3636363636364 degrees

c. Are the two hue values approximately same or exactly same?

Yes, they are exactly same because color values C2 is exactly half of color values of C1.
i.e 2*C2=C1

d. Do C1 and C2 have approximately same or exactly same saturation?

C1 saturation= (70+0+40)/(150+80+120)=0.3142

C2 saturation = (35+0+20)/(75+40+60)=0.3142

Yes, C1 and C2 have same saturation, it is because color values of C2 is exactly half of color values of C1.

e. Are the intensities of C1 and C2 same or different? If they are different, estimate the ratio between the intensities of C1 and C2, and briefly explain your method.

C1 intensity = (150+80+120)/3 = 116.66

C2 intensity = (75+40+60)/3 = 58.33

C1 and C2 intensities are different
C2 intensity = (C1 intensity) / 2

Intensity is average of the intensities of R, G, and B. C2 intensity of R, G and B is exactly half of C1 intensity of R, G and B

f. Given another color, C3 = [150, 120, 80], estimate its hue.

Can be decomposed into 2 parts
[150,120,80]=[80,80,80]+[70,40,0]

Hue is calculated by liner interpolation
(360*70+120*40)/110=272.7272 degrees

g. Can you compare the intensities between C3 and C1? Briefly explain how

C1 intensity = (150+80+120)/3 = 116.66

C3 intensity = ((150+120+80)/3)=116.66

Yes, C1 and C3 have same intensities.

Intensity is average of the intensities of R, G, and B. The Average of C1 intensity of R, G and B is exactly same as the average of C3 intensity of R, G and B.

h. The concepts of saturation and intensity are often confused by some people. Briefly explain the difference between the two.

Saturation is the percentage of the hue amount over the total amount. A fully saturated color should have saturation=1.0 and a totally un-saturated color should have the saturation=0.0. The saturation gives the proportion of the hue amount and the white amount. Therefore, the proportion of R, G, and B can be determined.

The intensity refers to lightness or darkness of a color. The intensity provides a scaling factor to obtain the exact amount for R, G, and B. The simplest definition will the average of the intensities of R, G, and B.