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Assignment I

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Question 1

In the given intensity transformation, pixel values lie within the range 50 to 150 has been increased while other pixels remain same. Above pixel values of a gray scale image generally represent gray colour, hence we can observe that gray colour pixels have been transformed into near white in the output image. Figure 1 shows the original image, intensity transformation function and output image respectively.

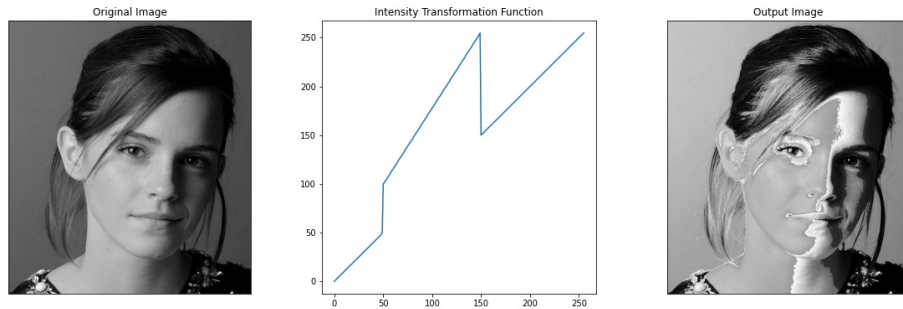


Figure 1: Question 1

Question 2

- (a) In this part the white matter of brain proton density image has been accentuated. Applied intensity transformation is shown in figure 2. Since both the white matter and gray matter [1] have closer pixel values it is very important to select the correct cut-off value. Here 175 was selected as cut-off value and range between 150 and 200 has transformed linearly while others are shifted to pure white or black.

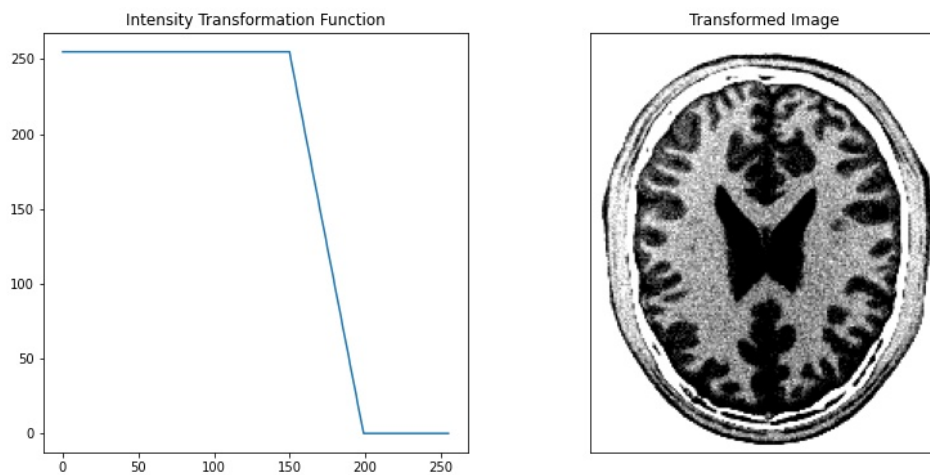


Figure 2: Question 2-a

(b)

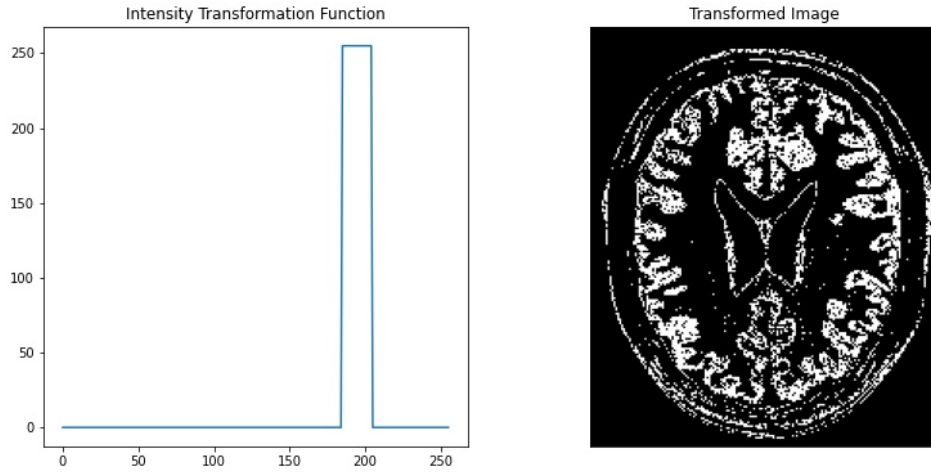


Figure 3: Question 2-b

Question 3

In this exercise a gamma correction ($\gamma = 0.8$) has been performed on the L place of the given image after converting it to the L*a*b colour space [2]. Results are shown in figure 4.



Figure 4: Question 3 input and gamma corrected images

In the L*a*b colour space L represents the lightness of the pixel. According to the equation 1 applying a gamma value less than 1 always produces a new L value which is greater than the previous. Therefore, after the gamma correction output image is lighter than before giving a nice appearance to dark places like rock hallows.

$$\text{new L value} = 255 \left(\frac{\text{current L value}}{255} \right)^{0.8} \quad (1)$$

This can also be represented using the histograms of the two versions of image. As you can observe in figure 5, after the gamma correction histogram has moved right slightly while storing more pixels in right most bins.

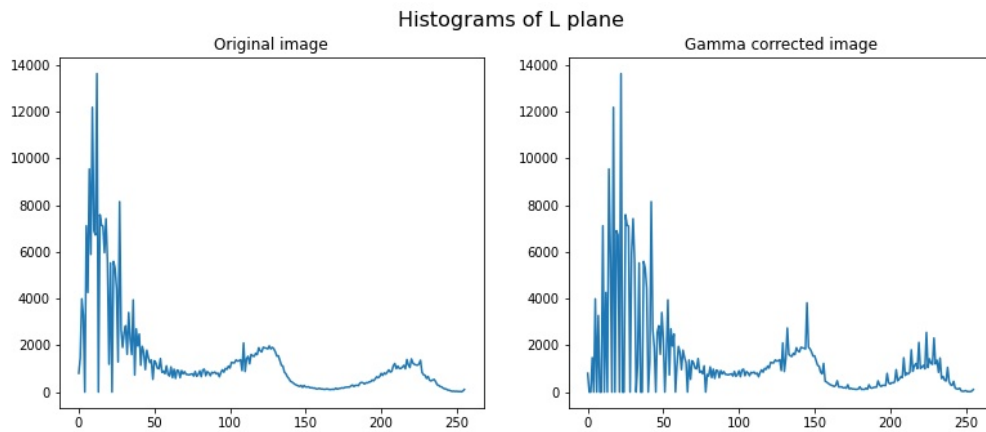


Figure 5: Question 3 histograms

Question 4

Images may have histograms confined into some region, but a histogram of a good image have the values in all regions. Therefore, we need to distribute the pixel values throughout the region. That is what histogram equalization does [3].

In this exercise a python function was written (figure 6) to carry out the histogram equalization on a given image. As the first step histogram of the given image was obtained using the numpy histogram function and the cumulative summation was calculated. Then the histogram equalization equation can be applied resulting a transformation function. Finally, it can be used as a look-up table to generate the equalized image. Resulting histograms are shown in figure 7 and the proper operation of the implemented function can be verified by comparing it with the output of openCV in-built histogram equalization function. Equalized image is shown in figure 8.

```
def equalizeHist(img):
    hist = np.histogram(img.flatten(),256,[0,256])[0]
    cdf = hist.cumsum()
    cdf = np.ma.masked_equal(cdf,0)
    cdf = (cdf - cdf.min())*255/(cdf.max()-cdf.min())
    cdf = np.ma.filled(cdf,0).astype('uint8')
    img_equatized = cv.LUT(img, cdf)

    return img_equatized
```

Figure 6: Histogram Equalization Function

References

- [1] S. Team, "Grey matter vs white matter in the brain," June 07, 2020. Accessed on: Feb. 14, 2022. [Online]. Available: <https://www.spinalcord.com/blog/gray-matter-vs-white-matter-in-the-brain>.
- [2] T. Mouw, "Lab color values / color spaces," Oct. 08, 2018. Accessed on: Feb. 14, 2022. [Online]. Available: <https://www.xrite.com/blog/lab-color-space>.

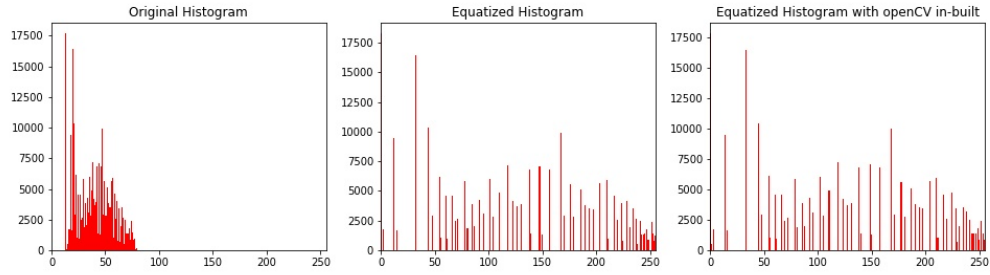


Figure 7: Histograms of shell image

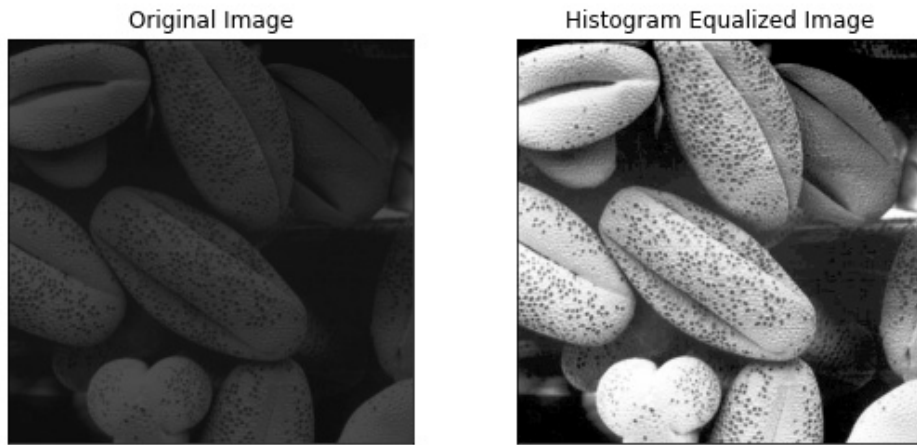


Figure 8: Equalized image

- [3] K. S. Htoon, "A tutorial to histogram equalization," Aug. 19, 2020. Accessed on: Feb. 20, 2022. [Online]. Available: <https://medium.com/@kyawsawhtoon/a-tutorial-to-histogram-equalization-497600f270e2>.