

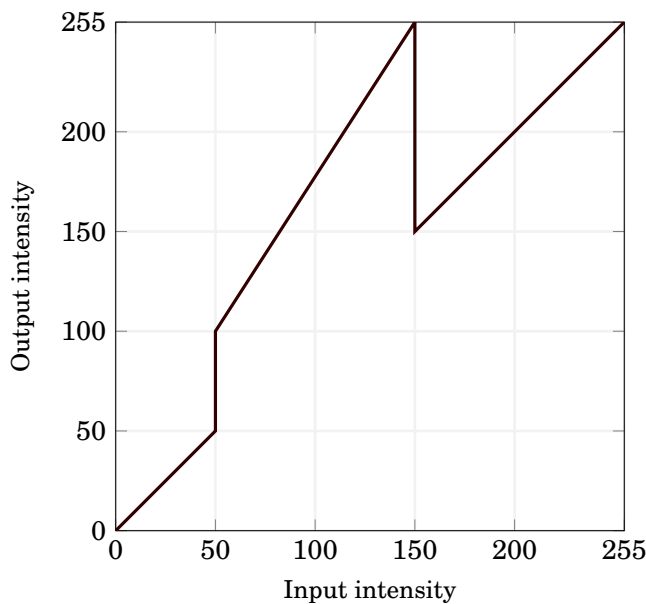
# EN3160 Assignment 1 on Intensity Transformations and Neighborhood Filtering

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1. Implement the intensity transformation depicted in Fig. 1a on the image shown in Fig. 1b.

[10]



(a) Intensity transformation.



(b) Image for intensity transformation.

2. Apply a similar operation as above (question 1) to accentuate

- (a) white matter
- (b) gray matter

in the brain proton density image shown in Fig. 2. Show the intensity transformations as a plots.

[10]

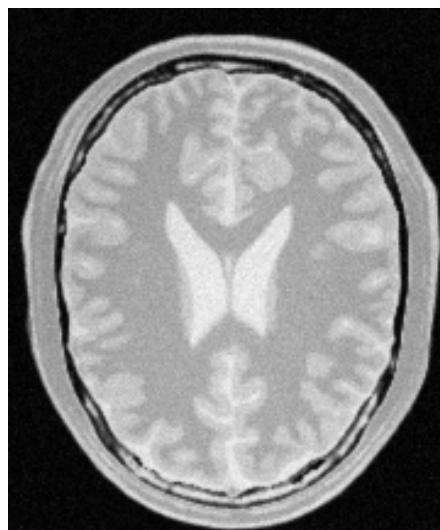


Figure 2: A brain proton density slice.

3. Consider the image shown in Fig. 3<sup>1</sup>. [10]

- (a) Apply gamma correction to the  $L$  plane in the  $L^*a^*b^*$  color space and state the  $\gamma$  value.
- (b) Show the histograms of the original and corrected images.



Figure 3: Image for gamma correction.

4. Increasing the vibrance of a photograph is probably achieved by applying an intensity transformation such as

$$f(x) = \min \left( x + \frac{a}{128} e^{-\frac{(x-128)^2}{2\sigma^2}}, 255 \right),$$

to the saturation plane, where  $x$  is the input intensity,  $a \in [0, 1]$  and  $\sigma = 70$ . [10]

- (a) Split the image shown in Fig. 4 into hue, saturation, and value planes.
- (b) Apply the aforementioned intensity transformation to the saturation plane.
- (c) Adjust  $a$  to get a visually pleasing output. Report the value of  $a$ .
- (d) Recombine the three planes.
- (e) Display the original image, vibrance-enhanced image, and the intensity transformation.



Figure 4: Image for enhancing the vibrance.

5. Write a function of your own to carry out histogram equalization on the image shown in Fig. 5. Show the histograms before and after equalization. [10]

6. In this question, we will apply histogram equalization only to the foreground of an image to produce an image with a histogram equalized foreground. [10]

- (a) Open the image in Fig. 6, split it into hue, saturation, and values and display these planes in grayscale.
- (b) Select the appropriate plane to threshold in extract the foreground mask. A mask is a binary image.
- (c) Now obtain the foreground only using `cv.bitwise_and` and compute the histogram.
- (d) Obtain the cumulative sum of the histogram using `np.cumsum`.
- (e) Use the formulas in slides to histogram-equalize the foreground.
- (f) Extract the background and add with the histogram equalized foreground.

Show the hue, saturation, and value plane, the mask, the original image, and the result with the histogram-equalized foreground.

7. Filtering with the Sobel operator can compute the gradient. Consider the image shown in Fig. 7 [10]

<sup>1</sup><https://www.adobe.com/creativecloud/photography/discover/highlights-and-shadows.html>

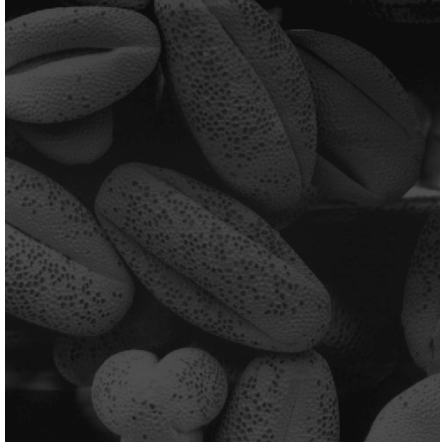


Figure 5: Image for histogram equalization.



Figure 6: Image for histogram equalizing the foreground.

- (a) Using the existing filter2D to Sobel filter the image.
- (b) Write your own code to Sobel filter the image.
- (c) Using the property

$$\begin{bmatrix} 1 & 0 & -1 \\ 2 & 0 & -2 \\ 1 & 0 & -1 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix} * \begin{bmatrix} 1 & 0 & -1 \end{bmatrix},$$

carry out Sobel filtering.

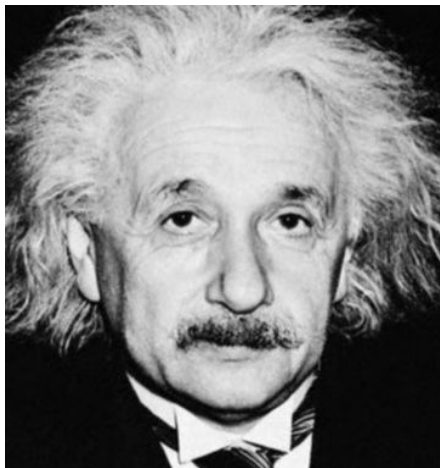


Figure 7: Image for Sobel filtering.

- 8. Write a program to zoom images by a given factor  $s \in (0, 10]$ . You must use a function to zoom the image, which can handle
  - (a) nearest-neighbor, and
  - (b) bilinear interpolation.

I have included four images, two large originals, and there zoomed-out versions. Test your algorithm by computing the normalized sum of squared difference (SSD) when you scale-up the given small images by a factor of 4 by comparing with the original images. [15]

9. Fig. 8<sup>2</sup> shows a flower image with both the foreground and background are in focus. [15]
- (a) Use grabCut to segment the image. Show the final segmentation mask, foreground image, and background image.
  - (b) Produce an enhanced image with a substantially blurred background. Display the original image alongside the enhanced image.
  - (c) Why is the background just beyond the edge of the flower quite dark in the enhanced image?



Figure 8: Image enhancing.

## GitHub Profile

You must include the link to your GitHub (or some other SVN) profile, so that I can see that you have worked on this assignment over a reasonable duration. Therefore, make commits regularly. However, I will use only the pdf for grading to save time.

## Submission

Upload a report (eight pages or less) named as `your_index_a01.pdf`. Include the index number and the name *within the pdf* as well. The report must include important parts of code, image results, and comparison of results. The interpretation of results and the discussion are important in the report. Extra-page penalty is 20 marks per page.

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<sup>2</sup><https://steemit.com/marguerite/ctrl-alt-nwo/marguerite-daisy>