**EN2550-Assignment 1**

**Intensity Transformations and Neighborhood Filtering**

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Github Repository:

A collage of a person

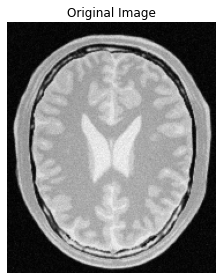
Description automatically generated with low confidence**Chart, line chart

Description automatically generatedQuestion 1 – Intensity Transformations**

* In the given intensity transformation, the intensity values in the region [50,150] of the original image are mapped to an increased intensity value.
* Therefore, the colors correspond to the values in the region [50,150] get closer to the intensity value of white color than before.
* So those colors in that region will be displayed more whitish than the original image after the transformation.

**Question 2 – White and Gray Matter**

* Now we have to identify white and gray matter from a brain proton density slice image, using the same type of intensity transformations. White and gray matter are two regions in the brain. They are identified as below in the figure.



* Identifying the regions to accentuate
  + A window with intensity transformation of value 255 with some fixed width was applied to the image. Other parts of the transformation were kept linear.
  + The range which the window exist was changed to identify the correct range to accentuate.
  + Then after identifying the rough range, some slight changes were done in the width of the window to get the desired output.

Gray matter

White matter

|  |  |
| --- | --- |
| Chart, line chart  Description automatically generated | A picture containing old, ceramic ware  Description automatically generated |
| Chart, line chart  Description automatically generated | A picture containing text  Description automatically generated |

* Since we have to accentuate white and gray matter, other regions are kept linear in the intensity transformation.
  + White matter – [150,180] range is transformed to an intensity value of 255
  + Gray matter – [180,210] range is transformed to an intensity value of 255

**Question 3 – Gemma Correction on L\* Plane**

* To apply gemma correction to the L plane in the L\*a\*b\* color space, we have to obtain the L, a, b planes of the image.
* cv2.cvtColor(img,cv.COLOR\_BGR2Lab) function will return the L\*a\*b\* color space array of the image(img).
  + L\* plane – Lightness value, black at 0 and white at 100
  + a\* plane – Represents the green to red opponent colors, with negative values toward green and positive values toward red
  + b\* plane – Represents the blue to yellow opponents, with negative numbers toward blue and positive toward yellow
* Then an intensity transformation is generated according to the gemma correction. The value of gemma is chosen to be 0.6 in this experiment. (**gemma = 0.6**)
* After applying the transformation to the L\* plane, the three planes are combined to generate the new image.

**Chart, histogram

Description automatically generatedA person wearing a white dress

Description automatically generated with low confidence**

* From the corrected image we can observe that the lightness of the image can be changed without affecting the colors of the image.

**Question 4 – Histogram Equalization**

* We have to generate a transformation to equalize the image.
* To obtain a transformation we need the histogram of the original image. After that, we can find a transformation according to the following equation.

Number of intensity levels (Since we are using gray scale images, L = 256)

kth value in the transformation array

jth value in the histogram of the original image

* Function to carry on histogram equalization



A picture containing indoor, different, sliced, arranged

Description automatically generated

**A picture containing chart

Description automatically generated**

**Question 5 – Zoom images**

* **Nearest-neighbor method** – Single-pixel value of the zoomed image is chosen by considering the nearest pixel value when the pixel indexes of the zoomed image are divided by the scale.
* **Bilinear Interpolation** – The pixel value is determined by using linear interpolation, considering the intensity values of the nearest four points in the original image.
* Calculated normalized SSD values between each zoomed image and original large image.

|  |  |  |
| --- | --- | --- |
|  | **Nearest-Neighbour** | **Bilinear Interpolation** |
| Image1 | 44.2050 | 39.2872 |
| Image2 | 19.0738 | 16.2412 |
| Image3 | 24.6596 | 21.3778 |



* The normalized sum of squared difference (SSD) gives us an idea about how similar two images are. Lesser the SSD value, the more similar the images. From the calculated SSD values we can see that the bilinear interpolation method gives a more similar image than the nearest-neighbor method. Rounding values and handling overflow might have caused the number of dissimilarities of the images.
* Zoomed images for Image2.

**A person with a scarf around the head

Description automatically generated with low confidence**

**A picture containing indoor, person, head covering, dark

Description automatically generatedA person with a towel over the head

Description automatically generated with low confidence**

**Question 6 - Filtering with the Sobel operator**

Sobel vertical kernel **-** Sobel horizontal kernel -

1. A close-up of a person's face

   Description automatically generated with medium confidenceUsing the above two matrices as the filter kernels, we can obtain the filtered images using the inbuilt function filter2D() in OpenCV python. Sobel vertical filterings give us the derivative of the image with respect to vertical direction while horizontal filtering gives us the derivative of the image with respect to the horizontal direction.
2. Instead of using the inbuilt filter2D() function, we can obtain the same results by using convolution. In normal convolution, the result will be rotated by 180 degrees. But the Sobel filter kernels are symmetric in this case. Therefore, we can use the convolution operation to obtain our result without flipping the image.



1. We can use the associative property to do the convolution in two steps to obtain the results.

**A close-up of a person's face

Description automatically generated with medium confidenceA close-up of a person's face

Description automatically generated with medium confidence**

* All three methods gave the same output. Therefore we can use any of the methods to filter with the sobel operator.

**Question 7 – Using grabCut**

**(a)**

**A picture containing flower, plant

Description automatically generated**A picture containing plant, flower, yellow, daisy

Description automatically generated

* Code where the grabCut() function is used to extract foreground and background images.

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**(b)**  First, the Gaussian blur effect was added to the extracted background image with a kernel size of (11,11) and sigma = 5. Then the extracted foreground image and blurred background image were combined to obtain the enhanced image.

A group of yellow flowers

Description automatically generated with medium confidence

**(c)**

* When we apply the gaussian blur to the extracted background, the part which contains the total black color will remain unchanged.
* But near the edges of that blacked area, the blur filter kernel will contain some parts of the background image.
* Therefore, the convolved value will not be zero for some places along the edge.
* So, when we combine the blurred background and the foreground image, some parts of the edges will give darker colours that we did not expect.

**References**

<https://en.wikipedia.org/wiki/CIELAB_color_space>

<https://pyimagesearch.com/2020/07/27/opencv-grabcut-foreground-segmentation-and-extraction/>

<https://docs.opencv.org/4.x/d8/d83/tutorial_py_grabcut.html>