Computer Vision Algorithms
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Programming Task

NOTE: You can use either MATLAB or Python for the programming questions. Some hints about the certain questions is given in the questions itself.

1. In this assignment, you will be provided with an image of the axial MRI of the brain. Write the code to correctly display the image in grayscale. [HINT: You can use image read function in either MATLAB or Scikit-image/OpenCV library for importing the image. If you are using Python, the image can be plotted using the matplotlib library]
2. Normalize the pixel values in the image between 0 to 1.[HINT: The pixel with maximum value in the image should have a value of 1 and the pixel with the lowest value in image should have the value of 0]
3. Save the normalized image as 'norm_image.png'.
4. Now, use the non-normalized image(the one you imported in Question 1) and perform a Sobel filtering on the image in x & y direction. Compute the gradient image after applying the filter in x & y direction and save it as 'sobel_grad.png'.

   [HINT: The shape of sobel filter in x and y direction are as follows:

$$\mathbf{G}_x = \begin{bmatrix} -1 & 0 & +1 \\ -2 & 0 & +2 \\ -1 & 0 & +1 \end{bmatrix} \qquad \mathbf{G}_y = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ +1 & +2 & +1 \end{bmatrix}$$

   To compute the gradient image:

$$\mathbf{G} = \sqrt{{\mathbf{G}_x}^2 + {\mathbf{G}_y}^2}$$

5. Implement the Fast Radial Symmetry transform algorithm on the non-normalized image(imported in Q1) with the following constraints:

5.1.) The RST output image must be generated for the negatively affected pixels. [Hint : p(-ive) formula].

5.2.) Run the algorithm for 4 different radii R = {1,2,3,4}. The matrix S must be computed according to the weighted mean of the RST outputs where weights are proportional to the magnitude of the radius.

5.3.) Take the dimensions of gaussian kernel as (3x3). You can use any value of mean and standard deviation for the kernel.

5.4.) Take the value of beta as 20% of the highest gradient magnitude in the image.

[HINTS :

$$\mathbf{p}_{-ve}(\mathbf{p}) = \mathbf{p} - \text{round}\left(\frac{\mathbf{g}(\mathbf{p})}{\|\mathbf{g}(\mathbf{p})\|}n\right)$$

$$O_n(\mathbf{p}_{-ve}(\mathbf{p})) = O_n(\mathbf{p}_{-ve}(\mathbf{p})) - 1$$

$$M_n(\mathbf{p}_{-ve}(\mathbf{p})) = M_n(\mathbf{p}_{-ve}(\mathbf{p})) - ||\mathbf{g}(\mathbf{p})||$$

The radial symmetry contribution at a range n is defined as the convolution

$$S_n = F_n * A_n \tag{1}$$

where

$$F_n(\mathbf{p}) = ||\tilde{O}_n(\mathbf{p})||^{(\alpha)}\tilde{M}_n(\mathbf{p}), \tag{2}$$