ASSIGNMENT 1 - EE6132

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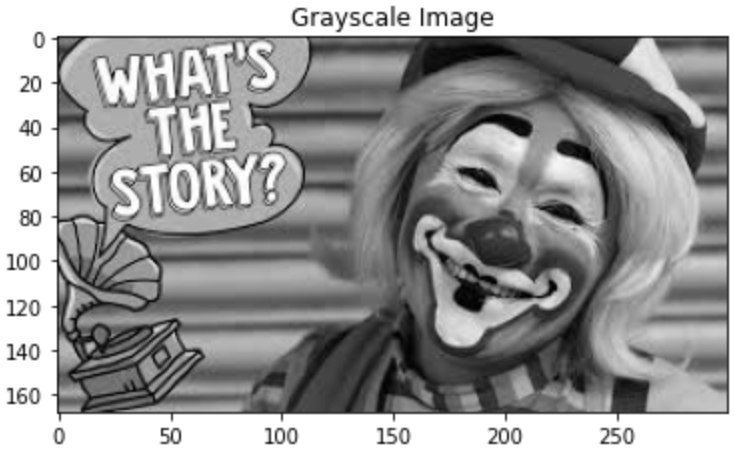
Libraries used : Matplotlib, OpenCV, Numpy

Question 1

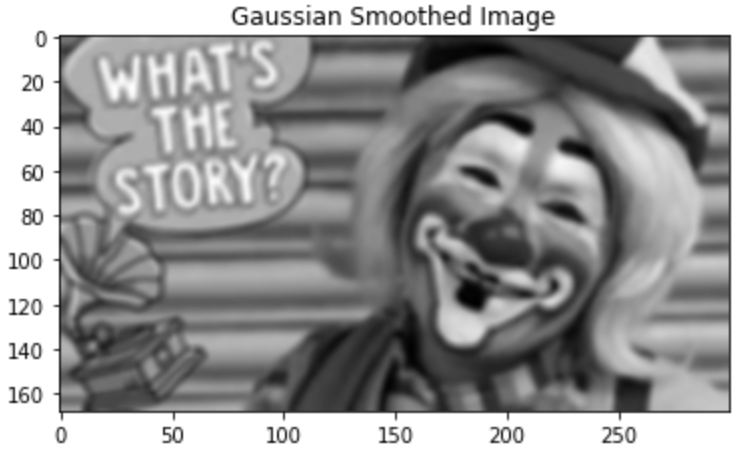
a) We can read the image using cv2.imread() function present in OpenCV. Then, we display the image using plt.imshow()

b) We can convert the image into grayscale using cv2.cvtColor. One point to note is that openCV reads the image in BGR form hence, we need to convert it into RGB first. Then, we display it. The grayscale converted image is as below :



c) We can then use the inbuilt GaussianBlur function. Here, we use sigma = 1.5 and kernel size = 5. As we can see in the picture below, the picture is smoothed resulting in slight burring of the image unlike the grayscale image above wherein

the image is sharp. However, this smoothing step is necessary in order to get rid of the noise present in the image.



d) Now, we apply the sobel filters using the cv2.Sobel function. Here, the sobel filters SobelX and SobelY are as given below :

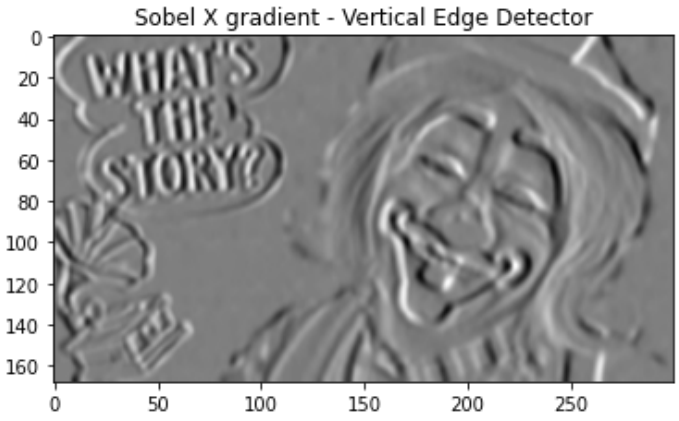
-1	0	+1
-2	0	+2
-1	0	+1

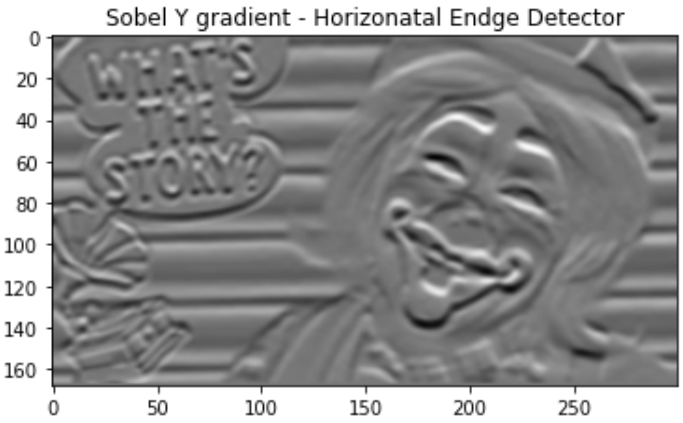
Gx

+1	+2	+1
0	0	0
-1	-2	-1

Gy

Here, the SobelX filter can be helpful in detecting vertical edges and SobelY filter can be helpful in detecting horizontal edges. As we can see in the images below :



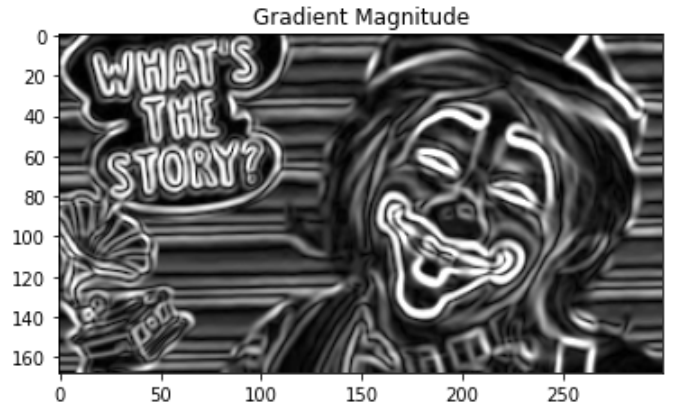


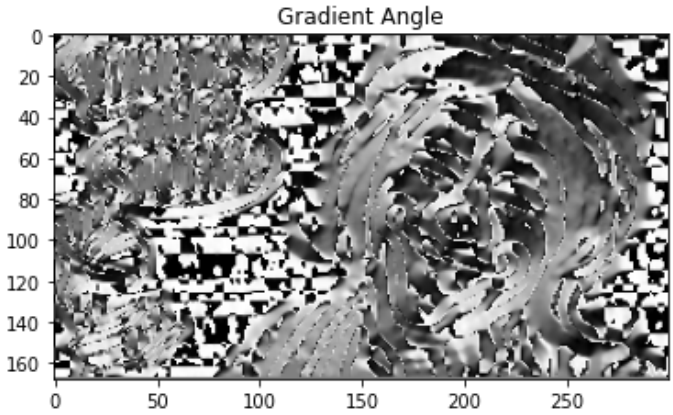
Now, we can find the gradient magnitude and gradient angle using the formulas as specified below :

$$|G| = |Gx^2| + |Gy^2|$$

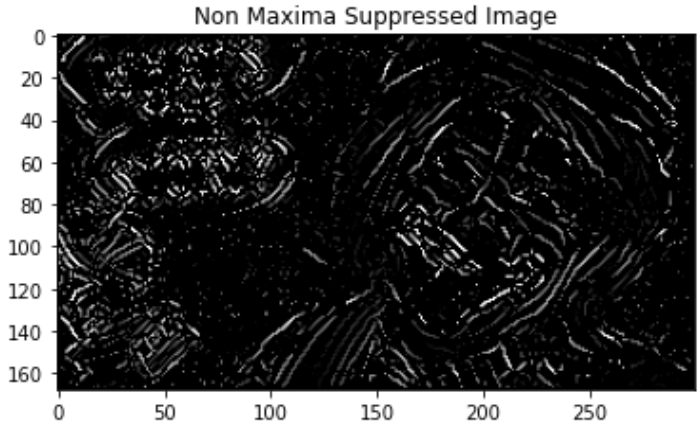
$$\arg(G) = \arctan\left(\frac{Gy}{Gx}\right)$$

We scale the obtained magnitude from above equation to [0,255] and the angle matrix obtained above into degrees. The images of gradient magnitude and gradient angle are as below :





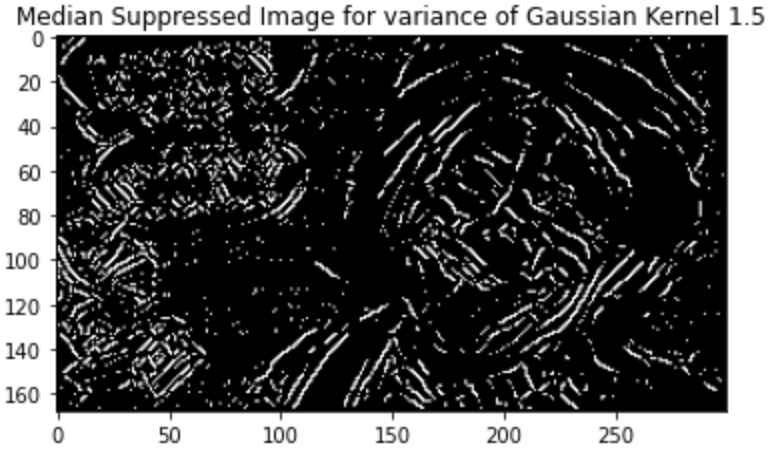
e) Now, we must apply non maxima suppression. In order to perform this, we do the following. Firstly, we must discretise the gradient angles of the points. We discretize them into [-90, -45, 0, 45, 90]. We can do by checking the closest angle to the current angle of the point. For example, if the current angle of the point is -48, then we can approximate it to -45 and so on. Doing this, we have a discretized angle matrix using which we can find if the magnitude of the point is grater than the magnitude of both the points along the gradient. Doing so, we get the following image.



f) We can find the median of the gradient magnitude function using the np.median() function. Then, we can apply the threshold by comparing the magnitude of each pixel individually and then setting them to zero if the magnitude is lesser than the threshold.

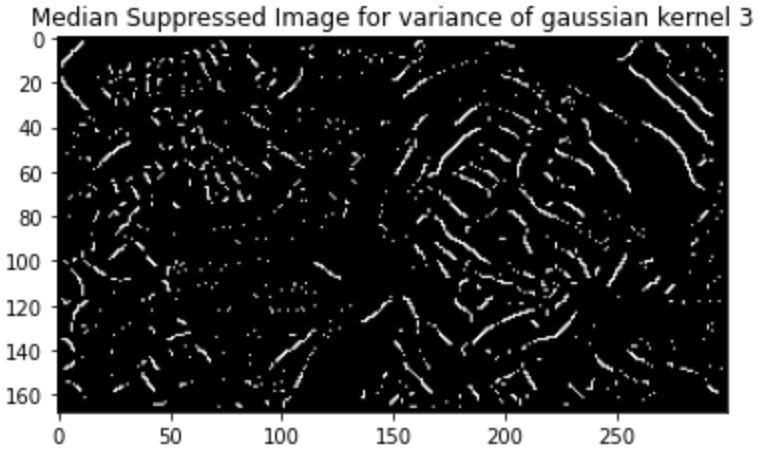
In the image below, we can see that the threshold suppresses some edges which are left after the non maxima suppression. Hence, the image below doesnt have as many edges as the previous image without threshold.

Moreover, here we set the pixel intensity to 255 for the pixels whose intensity is greater than that of the threshold.



Question 2

Now, we apply all the above steps with the changes in sigma for the gaussian smoothing. Here, we use the sigma for the gaussian smoothing to be 3 and we increase the kernel size to 19. The edges obtained from this are in the image as below :



- Also, we can observe that when using larger sigma for gaussian smoothing, there are fewer edges observed. This is owing to the fact that increase in the gaussian smoothing suppresses thinner edges and only the most dominant edges are visible.
- Hence, we can conclude that we should use the sigma value as according to out usecase. If we want finer edges as well, we are better off using smaller sigma. Whereas if we want only the high level edges, then we can use a higher value of sigma. Also, we should take into account the amount of noise in the image prior to choosing the value of sigma.
- The size of kernel in gaussian smoothing needs to be determined based on the value of sigma of gaussian. Since we would want to obtain the majority of the values which the filter would affect, it is safe to assume that 3*sigma or either side captures about 99%. Hence, for a given sigma about (6*sigma + 1) is a good value for kernel size for gaussian smoothing. In accordance to it, kernel size is 19 here.