German University in Cairo
Faculty of Media Engineering and Technology
Winter 2019

DMET 901 – Computer Vision

Problem Set #5

Problem 1

Apply the Sobel edge detector given by h_1 and h_2 to the image given below.

i) Compute the gradient magnitude for the pixels indicated with (*).

ii) Choose an appropriate threshold that should be used with the gradient magnitude image to produce a binary edge image.

$$h_1 = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}, h_2 = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$

0	0	0	10
100	100*	100*	100
100	110*	110*	110
100	110	110	130

Image

Upper left: $h_1 = -430,\ h_2 = 10,\ mag = \sqrt{{h_1}^2 + {h_2}^2} = 430.1$

Upper right: $h_1 = -430,\ h_2 = 10,\ mag = \sqrt{{h_1}^2 + {h_2}^2} = 430.1$

Lower left: $h_1 = -30,\ h_2 = 30,\ mag = \sqrt{{h_1}^2 + {h_2}^2} = 42.4$

Lower right: $h_1 = -60,\ h_2 = 20,\ mag = \sqrt{{h_1}^2 + {h_2}^2} = 63.2$

An appropriate threshold would be any value greater than 63.2 and less than 430.1.

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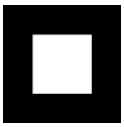
Problem 2

i- For the binary image given below, **sketch** the gradient magnitude image **showing values** if the Sobel edge detector is applied whose operators are given by:

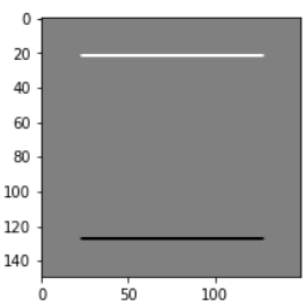
$$h_1 = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}, h_2 = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$

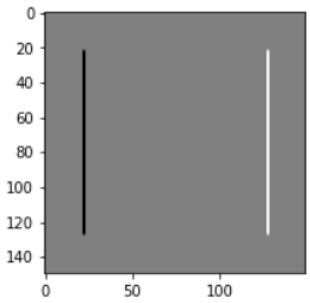


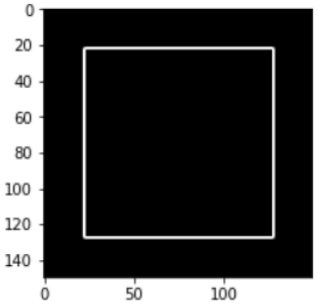
Image

ii- Assume the size of the white square is 100 x 100, **sketch** a histogram of the gradient directions computed using the Sobel operator for pixels with non-zero gradient magnitude.

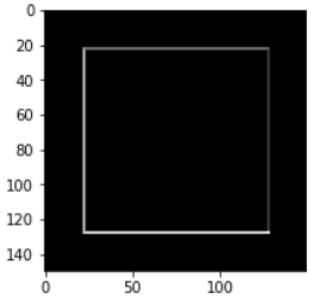
i) h1 h2 gradient magnitude

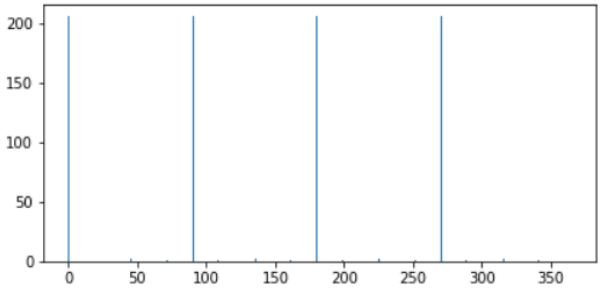






ii) gradient directions histogram





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Problem 3

Consider the image given below and the output of three different edge detectors. **Match** each of the edge images (Image 1, Image 2 and Image 3) to one of the edge detectors listed below and **state** the reasons for your choice. Note that all three edge detectors use the same detection threshold.

i – Prewitt edge detector

ii – Laplacian of Gaussian (LoG) with Gaussian standard deviation = 1

iii – Laplacian of Gaussian (LoG) with Gaussian standard deviation = 2

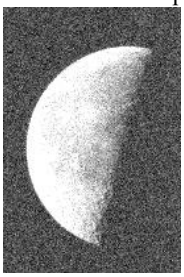
Original Image


Image 1

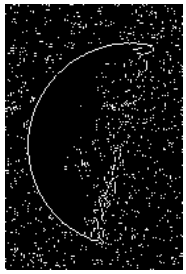
Image 2


Image 3

Image 1: Laplacian of Gaussian (LoG) with Gaussian standard deviation = 2; as most of the noise is eliminated as per using a Gaussian filter with a high standard deviation.
Image 2: Prewitt edge detector; as no filtering is applied resulting in a high sensitivity to noise.
Image 3: Laplacian of Gaussian (LoG) with Gaussian standard deviation = 1; as some of the noise is eliminated as per using a Gaussian filter with a low standard deviation.

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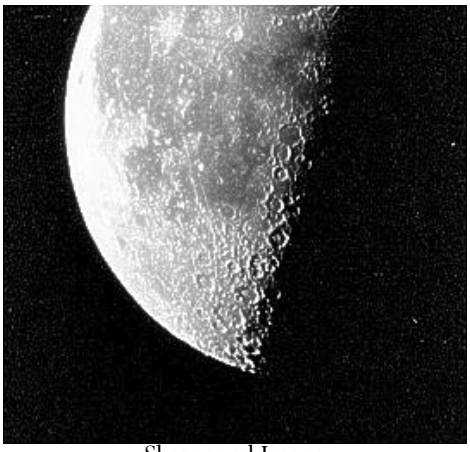
Problem 4

Consider the image given below that has been sharpened as shown in the right image. Using one or more of the algorithms you have learned in the course, **determine** how you can obtain a sharpened image of any gray-scale image.

Original Image



Sharpened Image

Image sharpening can be achieved by applying the following steps:

i) Apply edge detection on the original image. The gradient magnitude resulting from applying the edge detection should maintain its polarity, in order to keep the information about the transition being from bright to dark or the other way around.

ii) The gradient magnitude is to be multiplied by a factor, in order to rescale the values respecting the 0 to 255 range (most likely a smaller range, for example 0 to 50).

iii) Adding the scaled magnitudes to the original image.