University Kasdi Merbah - Ouargla

Department of Computer Science and Information Technology

Master Artificial Intelligence and Data Science

Module: Digital Image

TD N°2

Exercise 1

- Compute the number of colors in each of RGB, HSV and CMYK color spaces?
- What would happen if the coefficients of converting RGB to gray level are flipped?

Exercise 2

Perform erosion, dilation, opening and closing on the image below using the structuring elements under the image

0	0	0	0	1	1	1	0	0
1	1	1	1	1	1	1	1	1
1	0	1	1	0	1	1	1	0
1	0	1	1	1	1	1	0	0
0	0	1	1	0	1	0	0	1
0	0	0	0	1	1	0	0	0
1	0	0	0	1	0	1	1	1
0	0	1	0	0	1	1	1	1
0	1	1	0	0	0	1	1	1

1	1
1	1

	1
1	1

1
1

Exercise 3

- Given an image I, in which max value = 2 and min value = 1. We cannot improve the image contrast by adjusting the dynamic using the linear transformation defined by $f(x) = x + 2$. Why? Change one value in $f(x)$ to improve the image contrast? Justify?
- Define the linear transformation that transform any input image X to a uniform image having 100 as gray-level?
- An image is processed using Gamma correction such that $\gamma = 2.5$, how to restore the original values of the image?

Exercise 4

- Explain why histogram equalization algorithm does not produce, in general, a flat histogram?
- Demonstrate that a second pass of histogram equalization on the same image will yield the same result as the first pass?

Exercise 5

Suppose we are given the following image, denoted as I

2	11	8	9	3
7	0	2	2	4
6	5	4	9	0
1	2	2	8	5
0	1	0	7	3

1- Compute the gray-level histogram of I?
2- Compute the PMF and CDF?
3- Explain, in few words, why normalizing the PMF?
4- Quantize I by matching it to [5 8 11]?

Exercise 6

- Gray level histograms of two image look like a Gaussian curve, if you know that $\mu_1 \cong \mu_2$ and $\sigma_1 \gg \sigma_2$, we refer to max value of the first and second image by M_1 and M_2, respectively. What we can said about the relation between M_1 and M_2?
- Given two strictly identical images I and R, such that size of I = size of $R \times 2$. What would be the relation between the PMF of I and PMF of R?

Exercise 7

- Propose a recursive procedure to simplify the computation of 3x3 mean filter? (neglect the factor 1/9)
- Given an $M \times M$ image, compare the number of operations required by the two procedure i.e., ordinary and recursive?

Exercise 8

The contra-harmonic mean filter is given by

$$f(x, y) = \frac{\sum_{s,t \in S_{xy}} g(s,t)^{Q+1}}{\sum_{s,t \in S_{xy}} g(s,t)^{Q}}$$

- Explain why the filter will be effective in removing pepper noise when Q is positive?
- Explain why the filter will be effective in removing salt noise when Q is negative?

Exercise 9

- Demonstrate that removing noise using Gaussian and mean filter based on convolution and correlation produce the same result?
- Fill in the following matrix which represents a Gaussian kernel with $\sigma = 1$

			0.0130	0.0028
0.0214	0.0963			
			0.0583	

Exercise 10

Given the following image

0	1	3	4	3
0	15	2	20	6
4	9	11	0	2
1	25	0	4	0
0	3	1	1	1

- Calculate the contrast and brightness of this image
- Remove noise in this image using 3x3 mean and median filters, and 3x3 Gaussian filter with $\sigma = 1$?
- Generate a Gaussian kernel such that $\mu_x = \mu_y = 0, \sigma_x = 1,\ \sigma_y = 0.5$, could we use this kernel for removing noise?
- Explain why normalizing the Gaussian kernel?

Exercise 11

Given the following image

1	0	1	1	1	2	6
2	2	4	7	3	3	4
3	5	8	0	0	2	2
5	0	1	1	1	0	1
6	7	0	6	5	0	2
0	8	3	5	7	4	2
1	2	2	5	1	4	0

- Add random salt, pepper and salt and pepper noise to this image?
- Add to this image a Gaussian noise that is generated using a 1D zero-centered Gaussian distribution with $\sigma = 1$?
- Add to this image a Gaussian noise that is generated using a 1D Gaussian distribution with $\mu = 1, \sigma = 2$?

Exercise 12

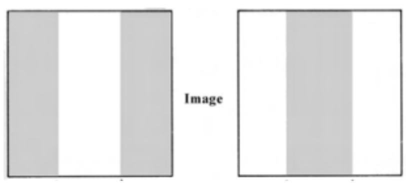
Verify that Laplacian of Gaussian can be written as $\Delta^2 G = \frac{1}{\sigma^2}\left(\frac{x^2+y^2}{\sigma^2}\right)G(x,y)$ such that $G(x,y) = \frac{1}{2\pi\sigma^2}e^{-\frac{x^2+y^2}{\sigma^2}}$

Exercise 13

A binary image contains straight lines that are oriented horizontally, vertically, at +45° and at -45°. Give a set of 3x3 masks that can be used to detect 1-pixel-long breaks in these lines. For simplicity, assume that gray level of lines is 1 and the gray level of the background is 0.

Exercise 14

Sketch the edge, gradient and Laplacian curves for the two following images



Exercise 15

Given the following edge segments (vertical, horizontal, -45° and +45°). Also, given the set of Sobel masks (vertical, horizontal, -45° and +45°). Show that applying the Sobel mask on the corresponding edge segments yields always $4a - 4b$ and 0 for the orthogonal segment.

b	b	b	b	a	a	b	b	a	a	a	a
a	a	a	b	a	a	b	a	a	b	a	a
a	a	a	b	a	a	a	a	a	b	b	a
Horizontal			Vertical			+45°			−45°		

−1	−2	−1	−1	0	1	0	1	2	−2	−1	0
0	0	0	−2	0	2	−1	0	1	−1	0	1
1	2	1	−1	0	1	−2	−1	0	0	1	2

Exercise 16

Given the following three images

2	1	0
4	5	7
M	3	**N**

X	X	X
X	4	X
X	X	X

X	X	X
X	5	X
X	X	X

The second and third images are the results of applying vertical and horizontal Sobel operators on the first image, find *M* and *N*?

Exercise 17

After convolving an image using Laplacian of Gaussian (LoG), we get the image below, locate the edge pixels

12.3	3.8	7.9	-51.3
15.6	1.4	-5.3	59.2
19.8	-1.5	6.9	56.7
-2.3	2.3	-8.1	-49.6

Exercise 18

Given the following magnitude image, if you know that $TLow$ = 12 and $THigh$ = 71 use the hysteresis thresholding to locate the edge pixels (canny)

12.3	3.8	7.9	51.3	87	95.2	40.5
9	97	15	75.6	52	91.3	17
5	3	99.2	25	69.3	33.5	12.5
4.2	100	8	100.4	65.4	89	35
15.6	1.4	5.3	59.2	16	88	17.5
19.8	1.5	6.9	56.7	10	29	71
2.3	2.3	8.1	49.6	9.3	15	78