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

DMET 901 – Computer Vision

Problem Set #2 Solution

Problem 1

Compute the co-occurrence matrix of each of the images given below for the North-South pixels relationship. Quantify the contrast in both images using the contrast measure given in class:

$$\sum_{i=1}^{m}\sum_{j=1}^{n} C_r(i,j)[f_r(i) - f_c(j)]^2$$

1	2	3	4
2	3	4	5
3	4	5	6
4	5	6	7

Image 1

10	20	30	40
20	30	40	50
30	40	50	60
40	50	60	70

Image 2

Comment on the results obtained and whether or not the obtained numbers represent a good quantification of contrast.

Image 1

North\South	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	0	1	0	0	0	0	0
2	0	0	2	0	0	0	0
3	0	0	0	3	0	0	0
4	0	0	0	0	3	0	0
5	0	0	0	0	0	2	0
6	0	0	0	0	0	0	1
7	0	0	0	0	0	0	0

$$Contrast = 1*(2-1)^2 + 2*(3-2)^2 + 3*(4-3)^2 + 3*(5-4)^2 + 2*(6-5)^2 + 1*(7-6)^2 = 12$$

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Image 2

North\South	**10**	**20**	**30**	**40**	**50**	**60**	**70**
10	0	1	0	0	0	0	0
20	0	0	2	0	0	0	0
30	0	0	0	3	0	0	0
40	0	0	0	0	3	0	0
50	0	0	0	0	0	2	0
60	0	0	0	0	0	0	1
70	0	0	0	0	0	0	0

$$Contrast = 1 * (20-10)^2 + 2 * (30-20)^2 + 3 * (40-30)^2 + 3 * (50-40)^2 + 2 * (60-50)^2 + 1 * (70-60)^2 = 1200$$

As per the calculated contrasts, Image 2 is with higher contrast than image 1. This was caused by the difference in intensity of neighboring pixels in Image 2 (10 intensity steps) being bigger than the difference in intensity of neighboring pixels in image 1 (1 intensity step).

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Problem 3

Compute the integral image of the image given below which corresponds to a bright rectangular object in the center:

1	1	2	2
2	150	200	3
2	250	175	2
1	100	120	1
1	2	1	3

Use the obtained integral image to compute the average intensity of the rectangular object.

$$s(i,j) = s(i,j-1) + f(i,j)$$

1	2	4	6
2	152	352	355
2	252	427	429
1	101	221	222
1	3	4	7

$s(i,j)$

$$ii(i,j) = ii(i-1,j) + s(i,j)$$

1	2	4	6
3	154	356	361
5	406	783	790
6	507	1004	1012
7	510	1008	1019

$ii(i,j)$

$$Average\ intensity\ of\ the\ rectangular\ object = \frac{sum\ of\ intensities}{total\ number\ of\ pixels}$$

$$sum\ of\ intensities = 1004 - 6 - 4 + 1 = 995$$

$$Average\ intensity = \frac{995}{6}$$

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Problem 4

Using the integral image method, compute the variance of the 2 x 2 region indicated with (*). Show the computations of each of the cumulative row sum matrix ***s*** and the final integral image. The variance of *N* values can be estimated as

$$Var = \left(\frac{1}{N} \sum_{i=1}^{N} x_i^2 \right) - \left(\frac{1}{N} \sum_{i=1}^{N} x_i \right)^2$$

1	1	5	2
1	10*	5*	2
5	9*	5*	10

Image

Image

1	1	5	2
1	10*	5*	2
5	9*	5*	10

$$s(i,j) = s(i,j-1) + f(i,j)$$

1	2	7	9
1	11*	16*	18
5	14*	19*	29

$$ii(i,j) = ii(i-1,j) + s(i,j)$$

1	2	7	9
2	13*	23*	27
7	27*	42*	56

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$$\sum_{(i,j)=(1,1)}^{(2,2)} f(i,j) = ii(2,2) + ii(0,0) - ii(2,0) - ii(0,2) = 42 + 1 - 7 - 7 = 29$$

Image^2

1	1	25	4
1	100*	25*	4
25	81*	25*	100

$s(i,j) = s(i,j-1) + f(i,j)$

1	2	27	31
1	101*	126*	130
25	106*	131*	231

$ii(i,j) = ii(i-1,j) + s(i,j)$

1	2	27	31
2	103*	153*	161
27	209*	284*	392

$$\sum_{(i,j)=(1,1)}^{(2,2)} f^2(i,j) = ii(2,2) + ii(0,0) - ii(2,0) - ii(0,2) = 284 + 1 - 27 - 27 = 231$$

$$Var = \left(\frac{1}{4} * \sum_{(i,j)=(1,1)}^{(2,2)} f^2(i,j)\right) - \left(\frac{1}{4} * \sum_{(i,j)=(1,1)}^{(2,2)} f(i,j)\right)^2 = \left(\frac{1}{4} * 231\right) - \left(\frac{1}{4} * 29\right)^2 = 5.1875$$

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Problem 5

Find the Run-length (RL) code for the binary image given below (coding for white pixels). The RL code is defined as: (row, {first element in run, last element in run}*)*

0	0	**1**	**1**	**1**	**1**
0	0	0	0	0	0
0	**1**	0	**1**	0	0
1	**1**	**1**	0	**1**	0
0	0	0	0	0	0

RL code: (025)(21133)(30244)

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Problem 6

Find the region adjacency graph corresponding to the image with 7 regions given below