

CSE803: Homework#2

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1 Problem 1

The program is written in Matlab. So the coordinate is row and column and the top left pixel of image is located at (1,1). The program contains several functions. Among them, function 'img_proc' is the integrated one that implements all the functionalities. The 'img_proc' has four input parameters: the path of the image file, format, threshold, and above_below which indicates foreground should be greater (above_below is greater than or equal to 0) or less than (otherwise) the threshold. The outputs of 'img_proc' includes the area, centroid, moments, inertia, circularity, circumference of each connected object in the image. Other functions in the program includes 'raster_scan_8' which searches the connected components by using raster scan algorithm for 8 connected neighbor, 'pepper_salt' which cleans the pepper and salt noise in the image, 'moments' which calculates the centroid and three moments of each object, 'inertia' calculates the maximal and minimal inertia and the corresponding radians (the radian of the inertia axis from the horizontal line in clockwise), 'dilate' which dilates object, 'circularity' calculating the circularity of object and 'circumference' which calculates the circumference of object by distracting the original image from the dilated image to get the boundary pixels.

For image 'hw2-2B', the threshold I choose is 55, and foreground is greater than threshold. For image 'hw2-3A' and 'my', the threshold is 135 and foreground is less than threshold.

A sample command is

```
img_proc('hw2-3A','jpg',135,-1)
```

Then it will print out the result in the command window of Matlab.

For image 'hw2-2B', the original image and the image after thresholding are shown in figure 1.1, and the connected component analysis results are shown in table 1.1. For the result of connected component recognition, see Problem 2.



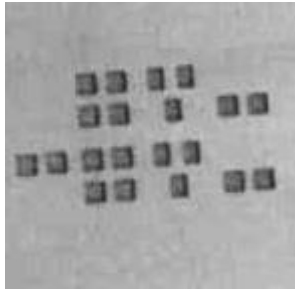
(a) The original image

(b) The image after thresholding

Figure 1.1: Image of Hw2-2B

For image 'hw2-3A', the original image and the image after thresholding are shown in figure 1.2, and the connected component analysis results are shown in table 1.2. There are 20 objects. Since the objects in the image are squares and rectangles, the rc moment should be close to zero because of symmetry, which is in accordance with the analysis results.

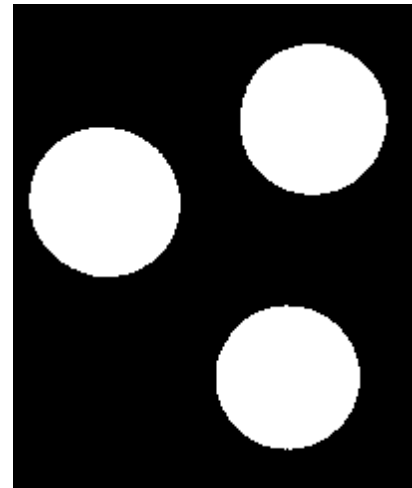
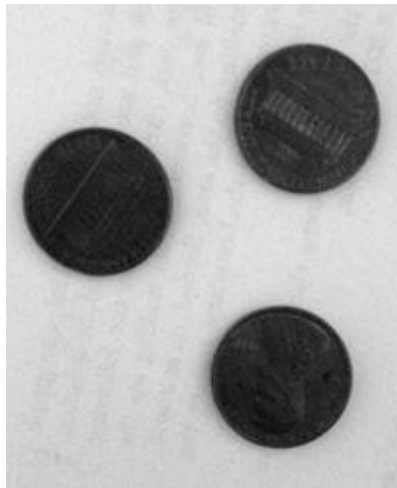
For the image 'my.jpg' I took, the original image and the image after thresholding are shown in figure 1.3, and the connected component analysis results are shown in table 1.3. Since the 3 objects in this image are circles, we can see from the analysis results that the rr and cc are large and similar while rc is close to 0, and that the maximal and minimal inertias are also close, and that the circularity is large.



(a) The original image

(b) The image after thresholding

Figure 1.2: Image of Hw2-3A



(a) The original image

(b) The image after thresholding

Figure 1.3: Image of 'my.jpg'

Table 1.1: Connected component analysis of ‘Hw2-2B’

Region	Area	Centroid		Moments			Inertia				Circularity	Perimeter
		r	c	rr	rc	cc	radian_max	max	radian_min	min		
1	46	9.00	7.50	23.57	0.00	20.68	0.00	23.57	1.57	20.68	4.92	92
2	12	6.50	5.00	1.25	0.00	0.67	0.00	1.25	1.57	0.67	6.71	18
3	8	9.50	7.50	5.25	-5.25	5.25	0.79	10.50	2.36	0.00	2.08	36
4	11	18.00	7.00	0.00	0.00	10.00	1.57	10.00	0.00	0.00	2.08	28

Table 1.2: Connected component analysis of ‘Hw2-3A’

Region	Area	Centroid		Moments			Inertia				Circularity	Perimeter
		r	c	rr	rc	cc	radian_max	max	radian_min	min		
1	107	38.96	75.88	12.30	0.63	6.33	-0.10	12.36	1.47	6.27	6.96	53
2	106	37.56	90.49	11.28	0.86	6.74	-0.18	11.44	1.39	6.58	7.43	48
3	127	40.50	56.13	11.43	0.02	9.48	-0.01	11.43	1.56	9.48	9.51	54
4	136	41.68	41.22	11.55	0.38	10.69	-0.36	11.70	1.21	10.54	10.28	55
5	109	51.12	126.62	9.70	-0.23	8.29	0.16	9.74	1.73	8.25	9.16	48
6	115	52.17	112.00	9.36	-0.23	9.25	0.67	9.55	2.24	9.07	11.57	50
7	101	54.41	84.54	11.51	1.01	6.15	-0.18	11.69	1.39	5.97	6.58	48
8	131	56.47	57.44	10.97	0.24	10.26	-0.30	11.04	1.27	10.19	11.39	55
9	137	57.45	42.71	11.60	-0.28	10.76	0.29	11.69	1.86	10.68	10.79	56
10	103	75.54	93.79	11.12	0.71	6.34	-0.14	11.22	1.43	6.24	7.74	48
11	106	76.49	79.05	11.68	0.15	6.35	-0.03	11.69	1.54	6.34	7.50	48
12	139	79.37	44.37	11.99	-0.06	10.88	0.05	11.99	1.62	10.88	9.86	58
13	130	78.21	59.08	10.49	-0.15	10.92	1.26	10.97	-0.31	10.44	10.01	57
14	129	80.70	26.55	10.63	0.68	10.57	-0.76	11.28	0.81	9.92	9.64	55
15	125	81.87	11.70	10.11	0.30	10.70	1.96	10.83	0.39	9.99	8.73	54
16	117	89.04	129.73	9.46	0.56	9.60	2.29	10.09	0.72	8.97	10.66	50
17	117	90.00	115.00	9.49	0.00	9.49	0.79	9.49	0.79	9.49	10.97	48
18	112	92.38	87.54	11.74	0.62	7.11	-0.13	11.82	1.44	7.03	8.04	50
19	130	95.26	45.76	11.45	-0.07	10.04	0.05	11.46	1.62	10.04	9.37	54
20	133	94.39	60.53	10.90	0.02	10.62	-0.09	10.90	1.48	10.62	11.94	54

Table 1.3: Connected component analysis of ‘my.jpg’

Region	Area	Centroid		Moments			Inertia				Circularity	Perimeter
		r	c	rr	rc	cc	radian_max	max	radian_min	min		
1	4395	58.39	151.04	359.53	-4.88	340.32	0.24	360.70	1.81	339.15	67.20	304
2	4458	99.95	46.54	352.29	10.99	357.59	2.24	366.25	0.67	343.63	66.65	306
3	4082	188.03	138.29	323.83	-0.61	325.87	1.30	326.04	-0.27	323.66	93.48	295.41

2 Problem 2

The connected component recognition of ‘Hw2-2A’ and ‘Hw2-2B’ are shown in table 2.1 and table 2.2 respectively and the area and centroid of each region are listed in table 2.3 and table 2.4 respectively. We can easily see the corresponding regions between the two images while their ordinals are permuted. The region 1 and 2 in ‘Hw2-2B’ correspond to region 2 and 4 in ‘Hw2-2A’. By using their centroids, according to the equation (11.10) in textbook, the radian of rotation is $\frac{\pi}{2}$ clockwise and the translation is 21 pixels in column positively and 0 pixel in row. The centroid of each region after mapping ‘Hw2-2B’ is shown in table 2.5. We can see that even though the ordinals are permuted, the mapped positions are equal to those of the corresponding regions in ‘Hw2-2A’, so the mapping error should be zero.

Table 2.1: Connected component recognition of Hw2-2A

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	0	0	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0
0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0
0	0	1	0	0	2	0	3	0	0	0	0	4	4	4	4	0	2	0	0
0	0	1	0	0	2	0	0	3	0	0	0	4	4	4	4	0	2	0	0
0	0	1	0	0	2	0	0	0	3	0	0	4	4	4	4	0	2	0	0
0	0	1	0	0	2	0	0	0	0	3	0	0	0	0	0	0	2	0	0
0	0	1	0	0	2	0	0	0	0	0	3	0	0	0	0	0	2	0	0
0	0	1	0	0	2	0	0	0	0	0	0	3	0	0	0	0	2	0	0
0	0	1	0	0	2	0	0	0	0	0	0	0	3	0	0	0	2	0	0
0	0	1	0	0	2	0	0	0	0	0	0	0	0	3	0	0	2	0	0
0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0
0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 2.2: Connected component recognition of Hw2-2B

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	1	1	1	1	1	1	1	1	1	1	1	1	0	0
0	1	0	0	0	0	0	0	0	0	0	0	1	0	0
0	1	0	2	2	2	0	0	0	0	0	0	1	0	0
0	1	0	2	2	2	0	0	0	0	3	0	1	0	0
0	1	0	2	2	2	0	0	0	3	0	0	1	0	0
0	1	0	2	2	2	0	0	3	0	0	0	1	0	0
0	1	0	0	0	0	0	3	0	0	0	0	1	0	0
0	1	0	0	0	0	3	0	0	0	0	0	1	0	0
0	1	0	0	0	3	0	0	0	0	0	0	1	0	0
0	1	0	0	3	0	0	0	0	0	0	0	1	0	0
0	1	0	3	0	0	0	0	0	0	0	0	1	0	0
0	1	0	0	0	0	0	0	0	0	0	0	1	0	0
0	1	1	1	1	1	1	1	1	1	1	1	1	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	4	4	4	4	4	4	4	4	4	4	4	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 2.3: Area and centroid of each region in Hw2-2A

Region#	Area	Centroid	
		r	c
1	11	7	3
2	46	7.5	12
3	8	7.5	11.5
4	12	5	14.5

Table 2.4: Area and centroid of each region in Hw2-2B

Region#	Area	Centroid	
		r	c
1	46	9	7.5
2	12	6.5	5
3	8	9.5	7.5
4	11	18	7

Table 2.5: Centroid of each region by mapping Hw2-2B

Region#	Centroid	
	r	c
1	7.5	12
2	5	14.5
3	7.5	11.5
4	7	3