Name : . . . . PRINCE OF SONGKHLA UNIVERSITY

Student number : . . . . FACULTY OF ENGINEERING

Department of Computer Engineering

_____

Final examination : Semester 2   Academic year : 2004 – 2005

Course : 240-382 Image Processing   Date : February 27th, 2005

Duration : 3 hours (13.30 – 16.30)

_____

1. Consider the following 6 x 6 image and the following 3 x 3 mask :

1	1	1	1	1	1
1	8	8	8	8	1
1	8	8	8	8	1
1	8	8	8	8	1
1	8	8	8	8	1
1	1	1	1	1	1

1	1	1
0	0	0
-1	-1	-1

a. Apply convolution with this mask to the image and draw the result below.   (2 marks)

b. Explain why we obtain this result and what is the meaning.   (2 marks)

. . . .

. . . .

2. Consider the following image of local edges. Local edges are represented by x.
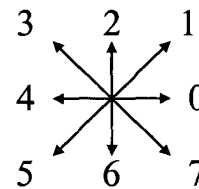
Apply the algorithm of edge linking by testing the neighbours according to the order above and write the coordinates of the pixels in the array, the first pixel first, then the second and so on...   (3 marks)

x

y

3. Consider the following image :

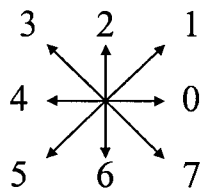|	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0																
1				X												
2			X		X		X	X								
3		X				X		X								
4			X						X	X	X	X				
5				X								X				
6					X							X				
7					X									X		
8					X							X				
9					X							X				
10					X							X				
11						X					X					
12							X		X	X	X					
13								X								
14																
15																

a. Represent the boundary of the following image by a chain-code according to the following coding and give the coordinates of the first pixel.   (2 marks)

```
3   2   1
 \  |  /
4 --+-- 0
 /  |  \
5   6   7
```

Coordinates of the first pixel : . . . .

. . . .

b. Give the derivative of the chain-code.   (1 mark)

. . . .

c. Re-sample the image and keep only the pixels on the even rows and even columns. Give the new chain-code when using the same coding :   (2 marks)

```
3   2   1
 \  |  /
4 --+-- 0
 /  |  \
5   6   7
```
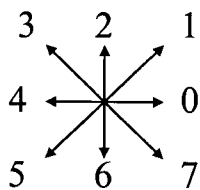
(even means   = 2p , not 2p + 1)

. . . .

d. Normalize this chain-code to obtain a shape number (smallest number).   (1 mark)

. . . .

4. Give a quad-tree description of the following image which has only 3 grey levels : Black (B), White (W), Grey (G). (3 marks)

. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
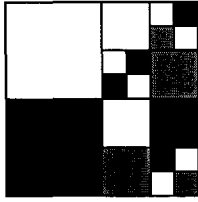
5. Use the successive division method to approximate the following contour by a polygon with 4 vertices (vertices means points).
Draw the construction of the polygon and explain each step of the processing. (4 marks)

Grid 1 (top-left):

	0		2		4		6		8	
0									x	
				x		x		x		x
2		x	x		x		x			x
			x							x
4			x						x	
				x						x
6					x					x
						x	x	x	x	
8										

Grid 2 (top-right):

	0		2		4		6		8	
0									x	
				x		x		x		x
2		x	x		x		x			x
			x							x
4			x					x		
				x						x
6					x					x
						x	x	x	x	
8										

. . . .
. . . .
. . . .

Grid 3 (bottom-left):

	0		2		4		6		8	
0									x	
				x		x		x		x
2		x	x		x		x			x
			x							x
4			x						x	
				x						x
6					x					x
						x	x	x	x	
8										

Grid 4 (bottom-right):

	0		2		4		6		8	
0									x	
				x		x		x		x
2		x	x		x		x			x
			x							x
4			x					x		
				x						x
6					x					x
						x	x	x	x	
8										

. . . .
. . . .
. . . .
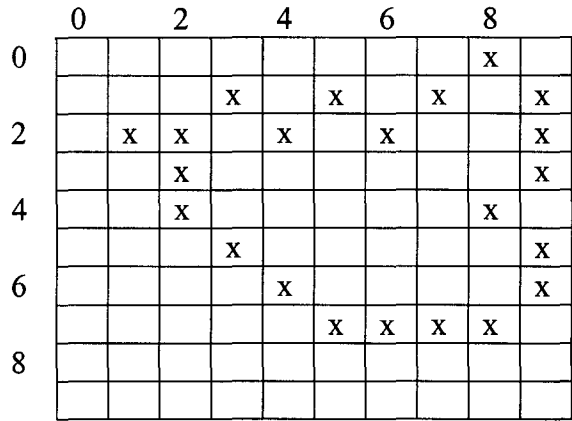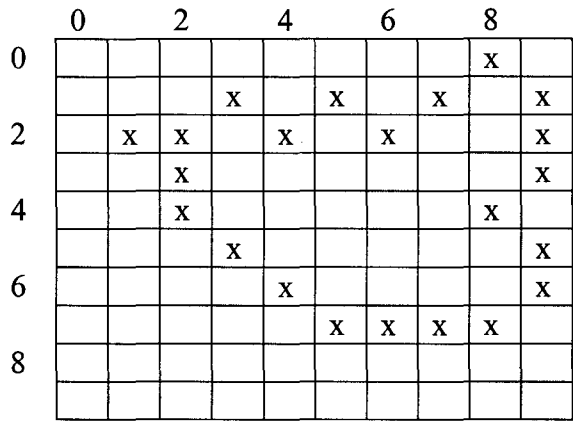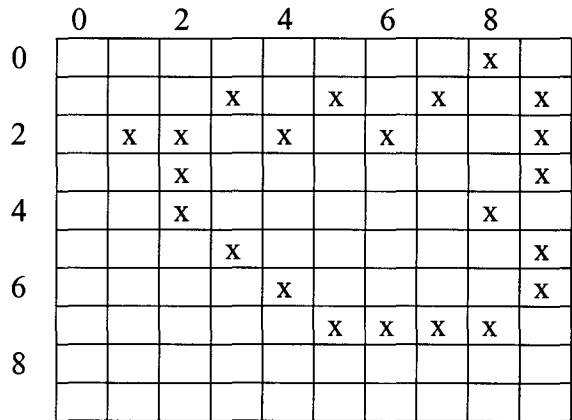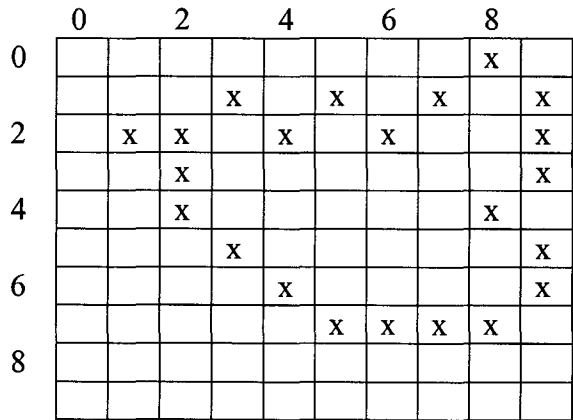
6. Consider a rectangle of length equal to 2a and width equal to 2b with centroid G.

2 a

2 b

G
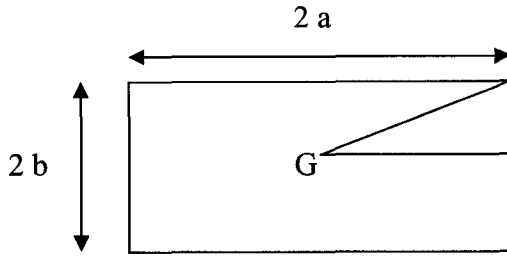
a. Plot the signature from the centroid to the boundary   (3 marks)

u

v

w

0

0    $\pi/4$ $\pi/2$ $3\pi/4$ π $5\pi/4$ $3\pi/2$ $7\pi/4$ 2π
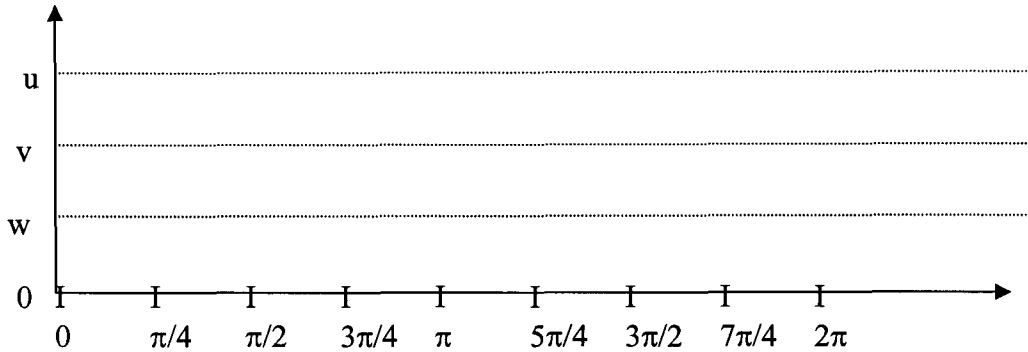
b. Give the values u, v, w.   (1 mark)

u = ...   v = ...   w = ...

7. Consider the following image   (4 marks)

0		2		4		6	
2	3	2	3	4	29	31	31
5	3	2	2	33	34	35	33
4	2	5	18	33	33	34	35
4	6	18	19	19	32	33	36
5	19	17	16	20	22	31	36
17	19	20	21	22	22	23	34
5	3	3	5	8	9	10	31
5	2	2	4	5	9	34	35

(Row labels: 0, 2, 4, 6)

(Empty array at right with labels 0, 2, 4, 6)

a. Define three seed-points and a criterion to segment this image by using a pixel gathering method.
(mark the seed-points with a circle). The result of the segmentation must be a triangle (with vertices
(2, 3) (5, 0) (5, 6)) and 2 other regions.

Criterion :   . . . .
. . . .
. . . .

b. Draw the result of your segmentation process on the empty array (above near the image) by marking
each pixel of the same region with the same value "a" , "b" , "c".

8. Consider the following binary image containing an object X represented by "1" values :

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

	1	
1	1	1
	1	

B1

1	1	1
1	1	1
1	1	1

B2

a. Apply an erosion processing to the image with the two structuring elements B1 and B2 and draw the result on the following arrays. (2 marks)

$$X \ominus B1$$

$$X \ominus B2$$

b. Draw the result of the opening processing of the image by the two structuring elements. (2 marks)

$$X_{B1}$$

$$X_{B2}$$

9. Consider the following image of a pen and a hand-phone : (8 marks)

. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .

The image above is represented by a 19x19 image with values :

64	69	71	73	75	76	89	91	96	103	105	112	113	119	121	121	124	126	129
78	81	86	95	102	105	106	115	116	118	121	123	124	126	127	129	130	131	131
87	89	100	105	115	116	129	131	129	127	131	132	135	136	138	139	140	141	142
95	102	118	124	132	134	134	135	136	137	139	140	141	142	143	146	149	157	159
89	95	102	120	132	24	22	22	21	21	21	24	23	141	142	144	145	152	160
85	86	100	115	129	23	21	1	2	3	20	2	3	22	22	141	141	145	158
74	80	102	118	126	22	1	1	3	1	21	5	7	8	8	23	24	146	159
72	85	105	119	125	21	2	3	3	4	21	6	7	7	7	9	25	135	157
42	86	104	115	120	22	24	23	22	22	21	2	2	3	4	9	25	126	155
41	85	98	118	122	123	124	126	126	126	125	22	23	23	24	25	115	124	158
41	42	53	68	78	86	89	91	93	98	102	103	105	106	116	121	125	135	141
40	43	46	55	2	3	75	76	79	82	86	98	102	103	104	109	110	120	122
39	41	46	49	3	4	4	75	79	79	83	85	89	94	99	101	103	105	111
35	36	39	41	42	4	5	5	5	65	69	73	79	84	89	91	94	97	99
28	29	35	46	67	70	78	5	6	7	7	72	76	84	86	89	91	92	92
25	26	31	35	36	42	48	54	58	7	8	8	65	67	69	74	78	81	83
21	22	22	24	26	30	31	32	32	35	36	9	8	54	56	57	61	67	74
19	21	22	23	24	26	27	29	30	31	32	34	9	9	41	42	45	51	55
9	12	15	19	21	24	29	28	30	31	34	35	35	36	37	39	41	42	43

Note that the pixels of the background and the pixels of the two objects can have the **same** values !!

We want to recognize the **pen**.
Give a complete description of all the processing necessary to locate the pen starting from the grey-level image and giving a precise location of the pen. Explain how you can extract the two objects from the background and which descriptors you use to make a difference between the pen and the hand-phone. Locate the pen by giving the coordinates of some pixel **that you will choose and explain**. (you can draw some processing results on the image above).
Give all details for each step of the processing.

. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . . (continue on back of the page)