EE4704 Image Processing and Analysis

Semester 1, 2020/21

Tutorial Set E

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1. You are given these edge points in an image:

   $P1:\ (-4, 0)$
   $P2:\ (-2, 1)$
   $P3:\ (0, 1)$
   $P4:\ (2, 1.5)$
   $P5:\ (4, 2)$
   $P6:\ (6, 2)$

   (a) Obtain the Hough transform of these points using the ab representation. Sketch the transform space for $-0.5 \leq a \leq 0.5$ and visually estimate the ab parameters of the straight line that exist in the image. Plot this line together with the edge points, in the xy plane.

   (b) Plot their Hough transforms in $\theta\rho$ space and estimate the $\theta\rho$ parameters of the detected straight line.

2. The following edge points have been detected in an image:

   $$(4, 9), (5, 3), (6, 9), (8, 5), (8, 8), (10, 10), (12, 6), (14, 10), (16, 5), (16, 12)$$

   It is known that these points come from two straight lines whose gradients lie in the range $[-45°, +45°]$ and y intercepts in the range $[-2, +14]$. Use the Hough transform technique to determine the line equations and estimate the x, y coordinates of the intersection point. (Use a cell size $\Delta a = 0.2$, $\Delta b = 1$.)

3. Using the intermeans algorithm, obtain a suitable threshold for the image whose histogram is given below.

Gray level:	0	1	2	3	4	5	6	7	8	9
No. of pixels:	400	800	800	1200	400	800	2000	1600	1200	800

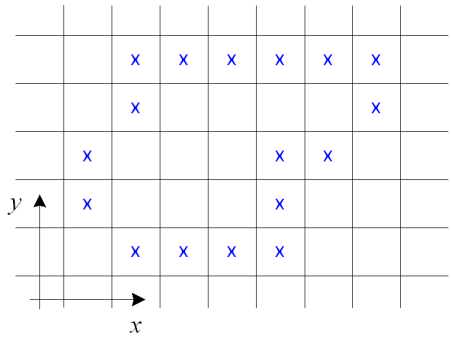
4. The figure shows the boundary of an object.

   (a) Using 8-connectivity, obtain a chain code (normalised for starting point) to represent the boundary.

   (b) Obtain the distance-angle function ($r\theta$ plot) of this boundary. Hence, determine the following features: maximum radial distance, minimum radial distance, average radial distance, and eccentricity. (The boundary pixel coordinates may be used to estimate the centroid.)

   (c) Sketch the normalised histogram $p(r)$. The bins for r are of width 0.5 and centred at $0, 0.5, 1.0, 1.5, \ldots$.

   (d) Sketch the bounding box. Calculate the lengths of the major and minor axis, respectively, and its orientation. (This may be useful: the distance from point (x_1, y_1) to the line $Ax + By + C = 0$ is $|Ax_1 + By_1 + C|/\sqrt{A^2 + B^2}$.)



5. The slope density graph $\psi(s)$ is a plot of the tangential orientation ψ as a function of boundary distance s.

   (a) Sketch accurately $\psi_1(s)$ for the boundary B_1 shown below. P is the start point. Indicate on the graph the points corresponding to P, Q, R and S.

   (b) Sketch the boundaries B_2 and B_3 corresponding to $\psi_2(s)$ and $\psi_3(s)$, respectively:

$$\begin{aligned} \psi_2(s) &= \psi_1(2s) \\ \psi_3(s) &= \psi_1(s) + \frac{\pi}{6} \end{aligned}$$