10. Feature Extraction

Chapter 10

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강의 개요

I. Background
II. Boundary Processing
III. Boundary Feature Descriptors
IV. Region Feature Descriptors

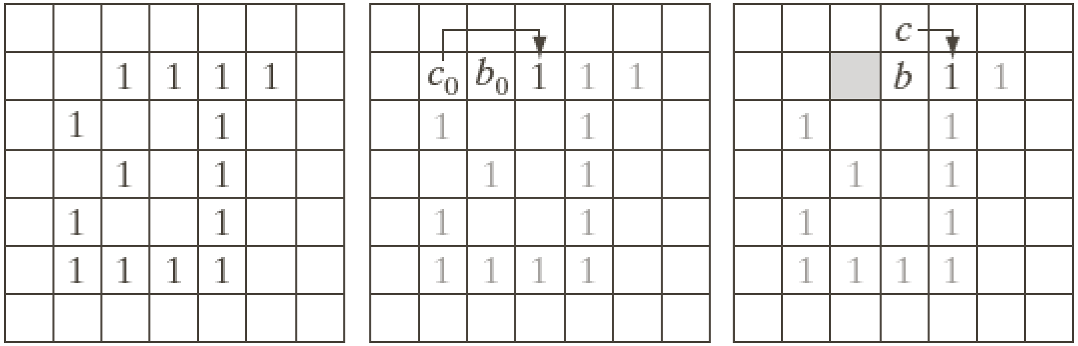
Feature Extraction

- Feature detection
- Feature description

Algorithm

- Let the starting point, b_0, be the *uppermost-left* point in the image that is labeled 1.
  - Denote by c_0 the west neighbor of b_0, Clearly c_0 is always a background point. Examine 8-neighbor of b_0, starting at c_0, and proceeding in a clockwise direction.
  - Let b_1 denote the first neighbor encountered whose value is 1, and c_1 be the point immediately proceeding b_1, in the sequence.
- Let $b = b_1$ and $c = c_1$
- Let the 8-neighbors of b, starting at c and proceeding in a clockwise direction, be denoted by $n_1, n_2, \ldots, n_8$. Find the first neighbor labeled 1 and denote it by n_k.
- Let $b = n_k$ and $c = n_{k-1}$.
- Repeat Step 3 and 4 until $b = b_0$. The sequence of b points found when the algorithm stops is the set of ordered boundary points.

2.1 Boundary Following (Tracing)

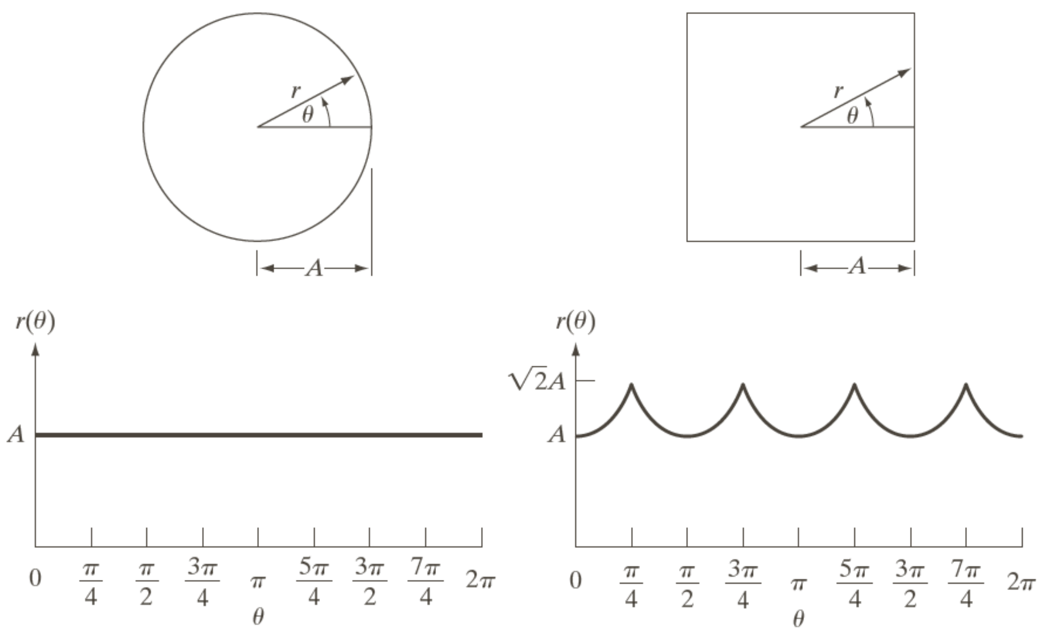


a b c d e

FIGURE 11.1 Illustration of the first few steps in the boundary-following algorithm. The point to be processed next is labeled in black, the points yet to be processed are gray, and the points found by the algorithm are labeled as gray squares.

Signature

- A signature is 1-D functional representation of a 2-D boundary.
- The basic idea of using signatures is to reduce the boundary representation to a 1-D function that presumably is easier to describe than the original 2-D boundary.



a b

FIGURE 11.10 Distance-versus-angle signatures. In (a) $r(\theta)$ is constant. In (b), the signature consists of repetitions of the pattern $r(\theta) = A \sec\theta$ for $0 \leq \theta \leq \pi/4$ and $r(\theta) = A \csc\theta$ for $\pi/4 < \theta \leq \pi/2$.

2.3 Signatures

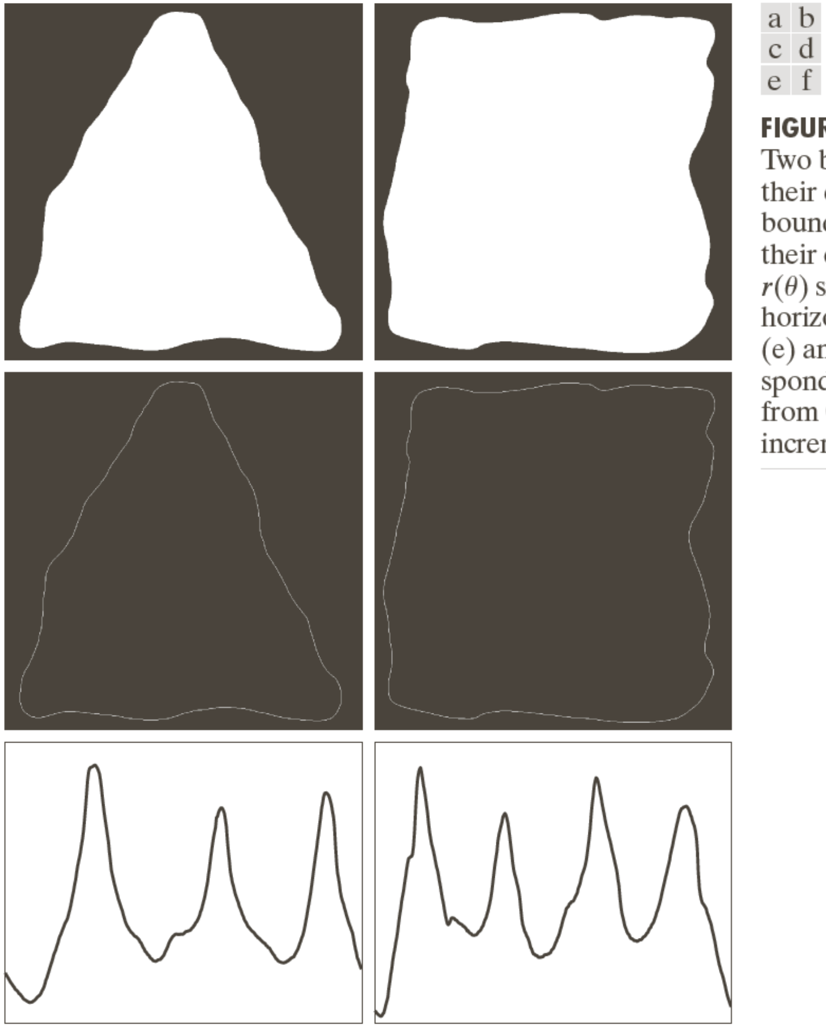


FIGURE 11.11 Two binary regions, their external boundaries, and their corresponding $r(\theta)$ signatures. The horizontal axes in (e) and (f) correspond to angles from 0° to 360°, in increments of 1°.

Basic boundary descriptors

- $diameter(B) = \max_{i,j}[D(p_i, p_j)]$

  $D =$ distance between pixel p_i and p_j

- $length_m = [(x_2 - x_1)^2 + (y_2 - y_1)^2]^{1/2}$

  $$angle_m = \tan^{-1}[\frac{y_2 - y_1}{x_2 - x_1}]$$

  $major\ axis$ is defined by point (x_1, y_1) and (x_2, y_2)

  $minor\ axis$ is the line perpendicular to the major axis.

Statistic Moments

- Statistical moments of one variable are useful descriptors to 1-D renditions of 2-D boundaries, such as signatures.
- nth moment of z about its means is

$$\mu_n(z) = \sum_{i=0}^{A-1} (z_i - m)^n p(z_i)$$

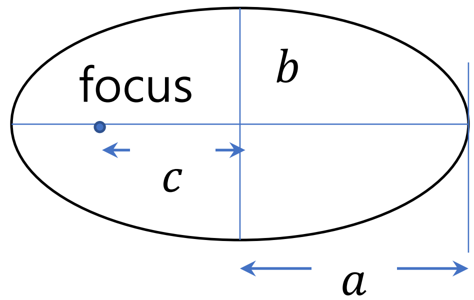
mean: $m = \sum_{i=0}^{A-1} z_i p(z_i)$

Some basic descriptors

A =area

p=perimeter

- compactness $= \frac{p^2}{A}$
- circularity (roundness) $= \frac{4\pi A}{p^2}$
- effective diameter $d_e = 2\sqrt{\frac{A}{\pi}}$
- eccentricity $= \frac{c}{a} = \frac{\sqrt{a^2 - b^2}}{a} \quad a \geq b$



Statistic Moments

- Statistical
- nth moment of z about its means is

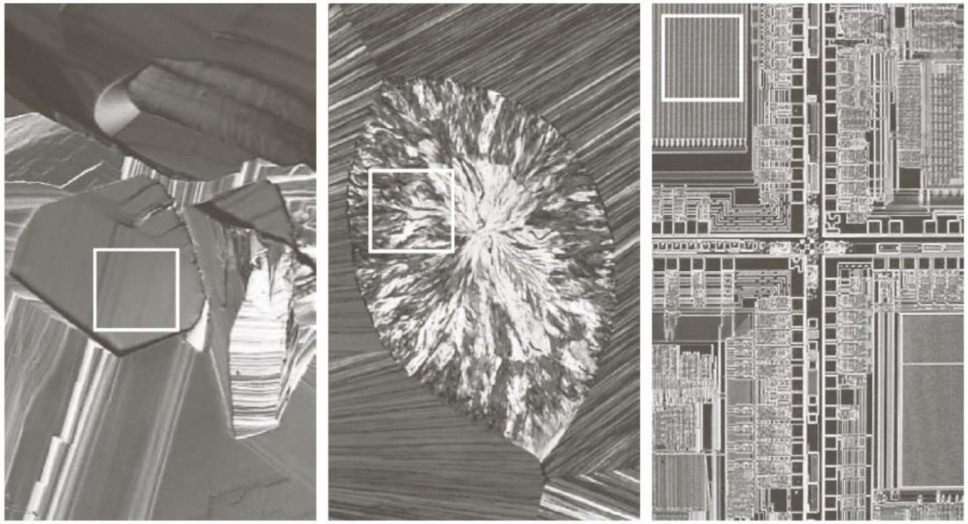
$$\mu_n(z) = \sum_{i=0}^{L-1} (z_i - m)^n p(z_i)$$

mean: $m = \sum_{i=0}^{L-1} z_i p(z_i)$

- Relative intensity $R(z) = 1 - \frac{1}{1+\sigma^2(z)}$

variance: $\sigma^2(z) = \mu_2(z)$

- Uniformity $U(z) = \sum_{i=0}^{L-1} p^2(z_i)$
- Average entropy $e(z) = -\sum_{i=0}^{L-1} p(z_i) \log_2 p(z_i)$



a b c

FIGURE 11.28 The white squares mark, from left to right, smooth, coarse, and regular textures. These are optical microscope images of a superconductor, human cholesterol, and a microprocessor. (Courtesy of Dr. Michael W. Davidson, Florida State University.)

TABLE 11.2 Texture measures for the subimages shown in Fig. 11.28.

Texture	Mean	Standard deviation	*R* (normalized)	Third moment	Uniformity	Entropy
Smooth	82.64	11.79	0.002	−0.105	0.026	5.434
Coarse	143.56	74.63	0.079	−0.151	0.005	7.783
Regular	99.72	33.73	0.017	0.750	0.013	6.674