

Mathematical Morphology

CS/BIOEN 6640

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Chapter 9 DIP Textbook

Materials

- Gonzales & Woods DIP Book Chapter 9
- Dougherty & Lotufo, Hands-on Morphological Image Processing
- Serra, 1982
- Matheron 1967
- PDFs, Slides (see course homepage):
 - Brian Morse Lectures (BYU)
 - R.A. Peters Lectures (EECE Vanderbilt)

Materials

- Nice Java Demonstrations (binary and gray-level morphological image processing:
- <http://bigwww.epfl.ch/demo/jmorpho/start.php>
- (hit: for binary, choose image “forms” to test)

The screenshot shows the website of the Biomedical Imaging Group at EPFL. The header includes the EPFL logo and the text 'ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE'. The main navigation bar is purple and contains the text 'Biomedical Imaging Group' and 'Imaging Web Demonstrations'. Below this, a gray bar shows the breadcrumb 'BIG > Demo > Morphological Operators'. On the left, a dark blue sidebar lists various categories: 'CONTENTS', 'Home Page', 'News & Events', 'Seminars', 'People', 'Search', 'Publications', 'Tutorials and Reviews', 'Movies', 'Download Algorithms', 'Archiving', 'Student Projects', and 'Contact'. The main content area is titled 'Morphological Operators' and features a 'Start Demo' button with a red arrow. Below the title, there is a 'Description' section that explains the demonstration shows basic operators of mathematical morphology on binary and gray-level images. It lists eight operators: 1. Min (Erosion for binary image), 2. Max (Dilation for binary image), 3. Close: Min(Max(Image)), 4. Open: Max(Min(Image)), 5. Top Hat Bright, 6. Top Hat Dark, 7. Gradient, and 8. Median. A convention note at the bottom states: 'Convention: for the binary image, we consider that the object is white.'

EPFL
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Biomedical Imaging Group

Imaging Web Demonstrations

English only

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Morphological Operators

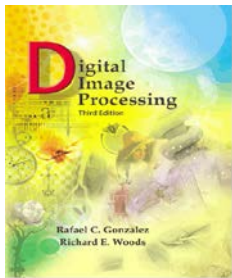
Start Demo ►

Description

This demonstration shows the basic operators of the mathematic morphology on the binary images or on the gray level image. The structuring element is a 3*3 block (8-connected) or a 3*3 cross (4-connected).

1. Min (Erosion for binary image)
2. Max (Dilation for binary image)
3. Close: Min(Max(Image))
4. Open: Max(Min(Image))
5. Top Hat Bright
6. Top Hat Dark
7. Gradient
8. Median

Convention: for the binary image, we consider that the object is white.

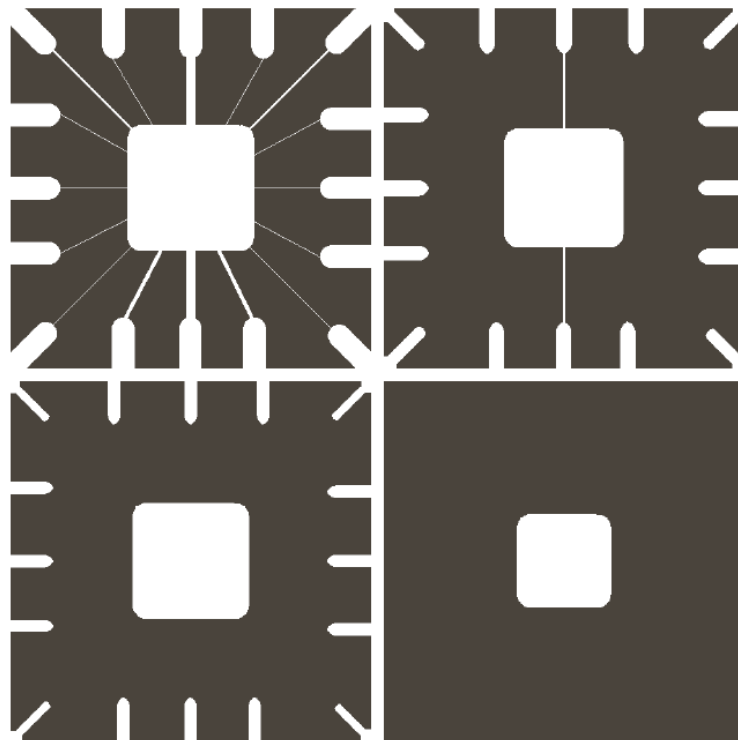


Digital Image Processing, 3rd ed.

Gonzalez & Woods

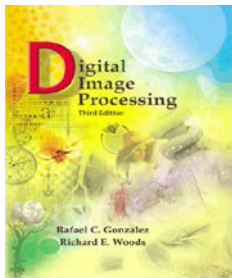
www.ImageProcessingPlace.com

Chapter 9 Morphological Image Processing



a b
c d

FIGURE 9.5 Using erosion to remove image components. (a) A 486×486 binary image of a wire-bond mask. (b)–(d) Image eroded using square structuring elements of sizes 11×11 , 15×15 , and 45×45 , respectively. The elements of the SEs were all 1s.



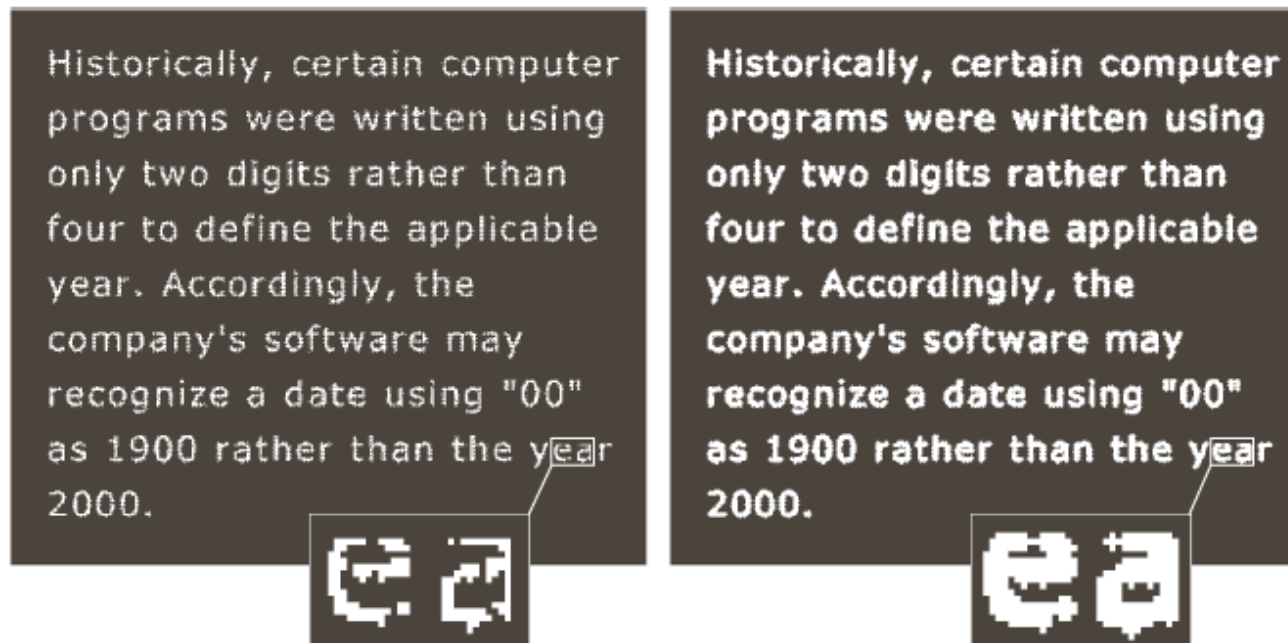
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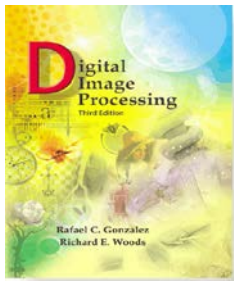


0	1	0
1	1	1
0	1	0

a c
b

FIGURE 9.7

(a) Sample text of poor resolution with broken characters (see magnified view). (b) Structuring element. (c) Dilation of (a) by (b). Broken segments were joined.



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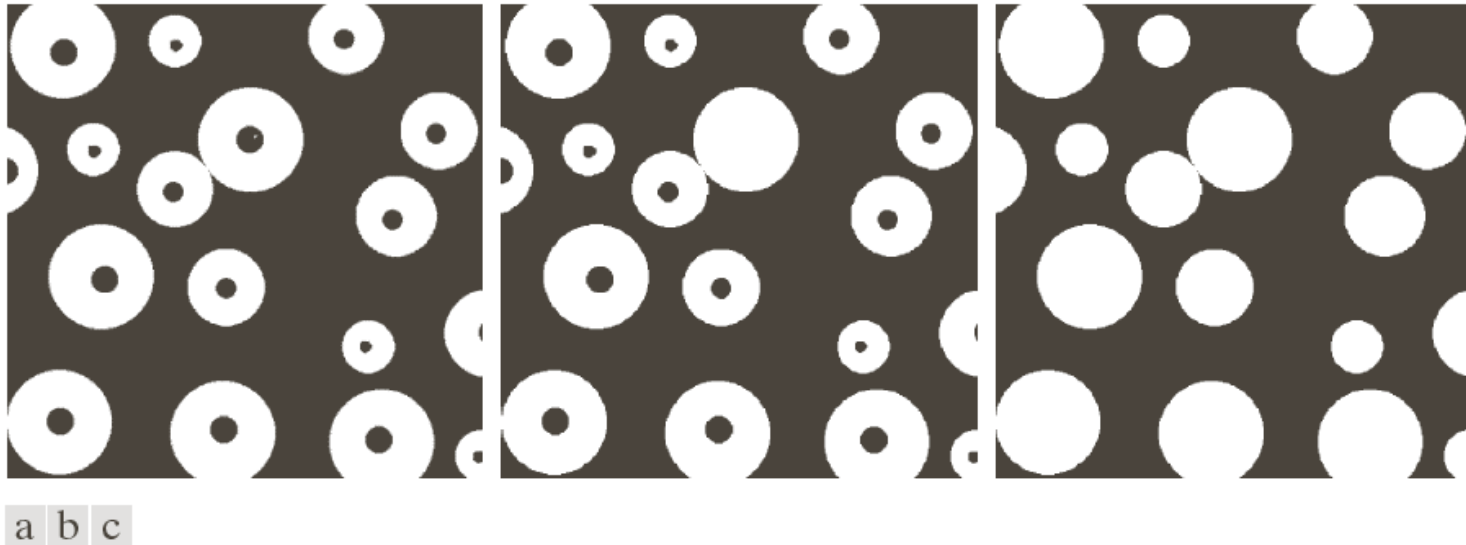


FIGURE 9.16 (a) Binary image (the white dot inside one of the regions is the starting point for the hole-filling algorithm). (b) Result of filling that region. (c) Result of filling all holes.

Typical Applications

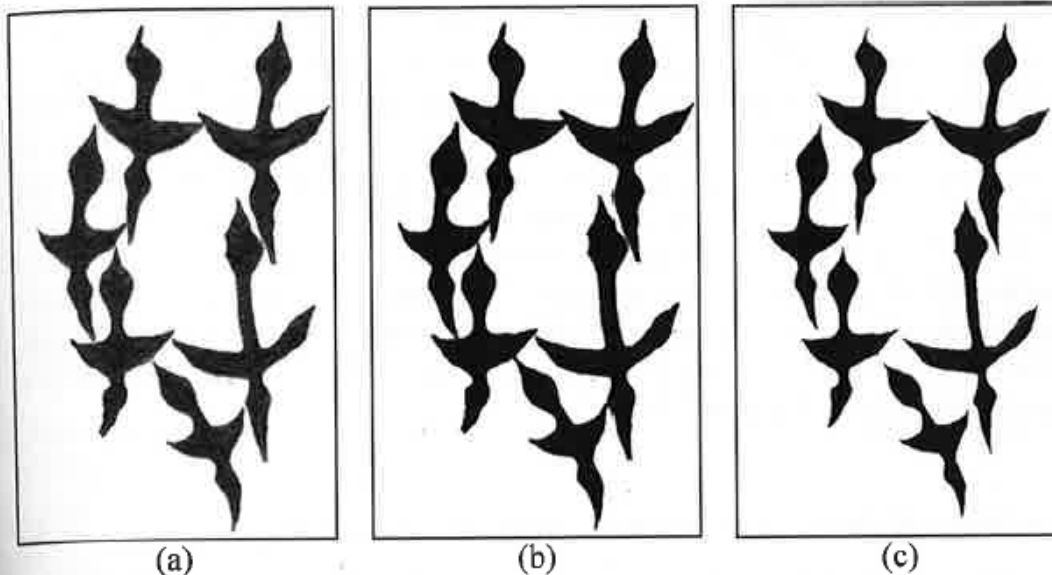


Figure 3.41: *Practical application of image erosion: original image (a); segmented image(b); and eroded image yielding the separated objects (c).*

Object Separation for Segmentation

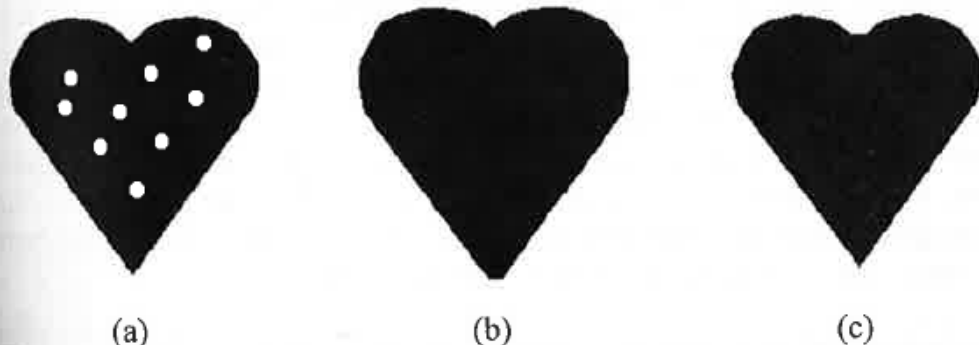
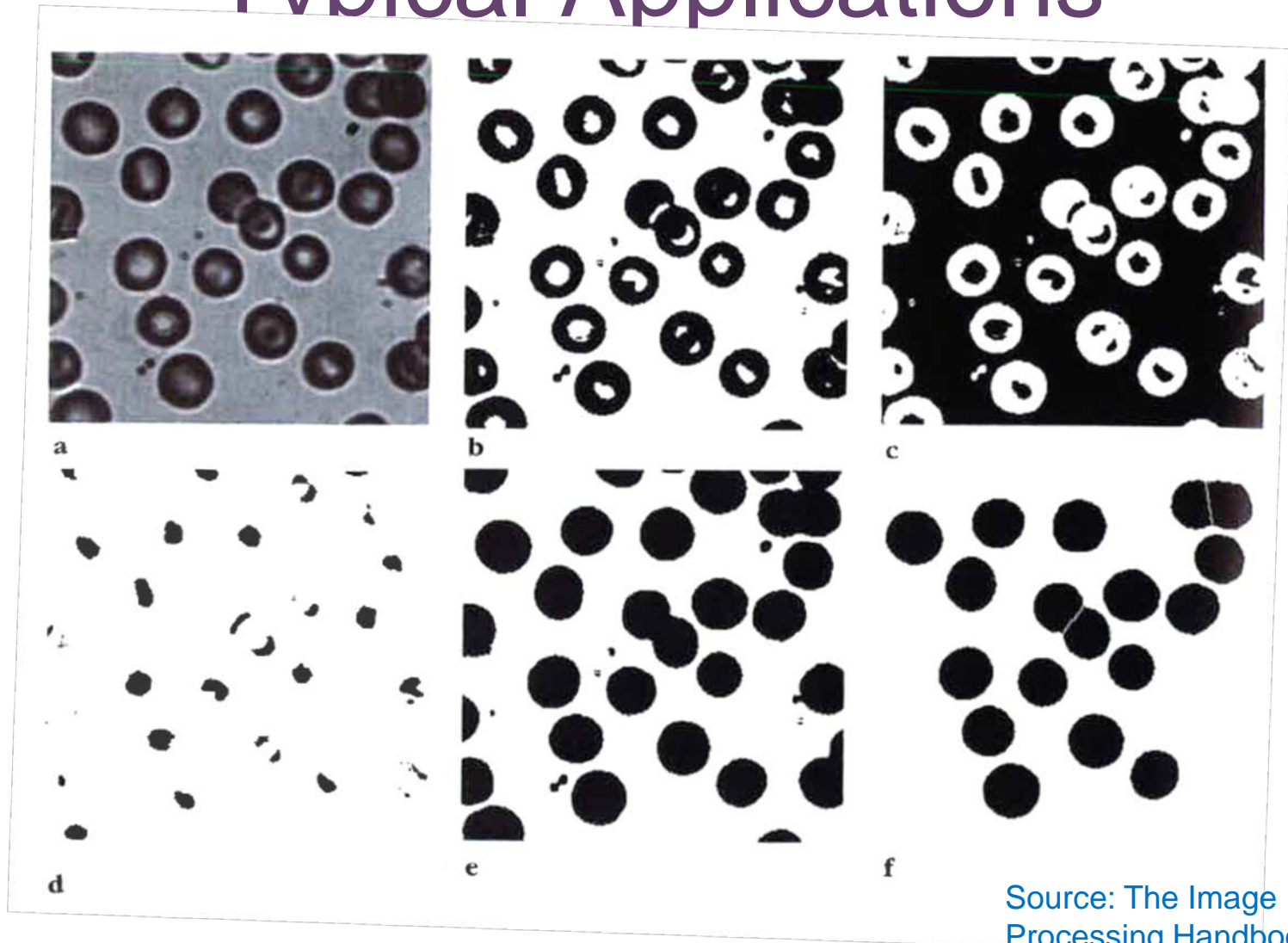


Figure 3.42: *Original shape (a); its dilated version (b); and shape obtained by morphological closing (c). The structuring element was a 3×3 square.*

Closing holes (noise removal)

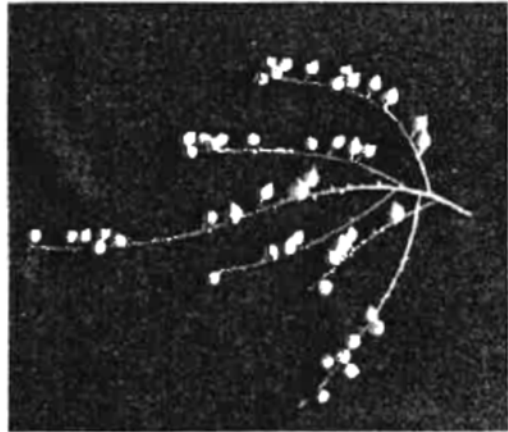
Source: Shape Analysis and Classification, Costa & Cesar

Typical Applications

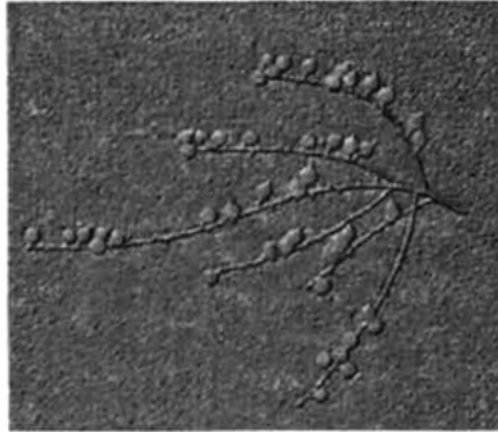


Source: The Image
Processing Handbook,
John C. Russ, p. 394

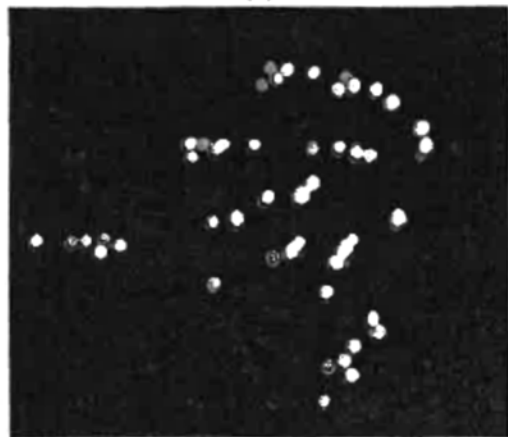
Typical Applications



(a)



(b)



(c)



(d)

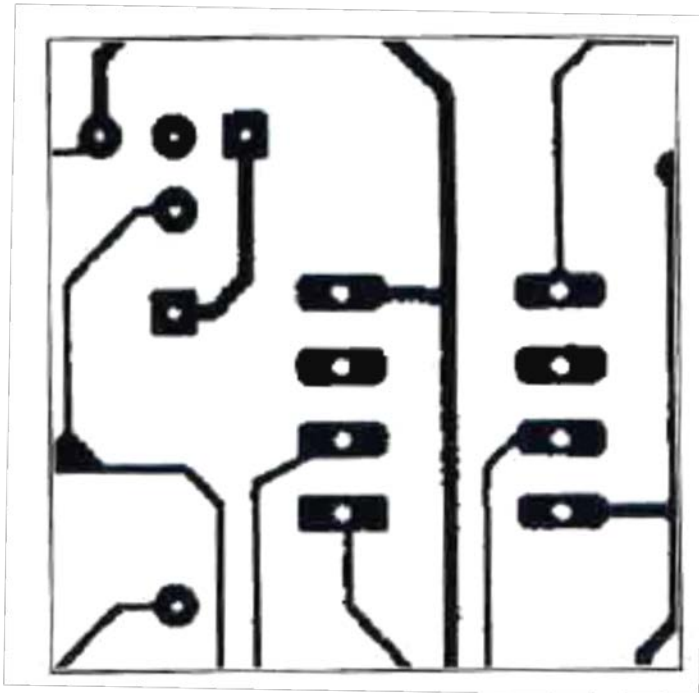
Figure 5.29 Illustration of gray-scale opening by a flat disk: (a) input image f , (b) surface view of f , (c) opened $f \circ D$, (d) surface view of $f \circ D$.

Source: Hands-on
Morphological Image
Processing, Dougherty &
Lotufo, p. 120

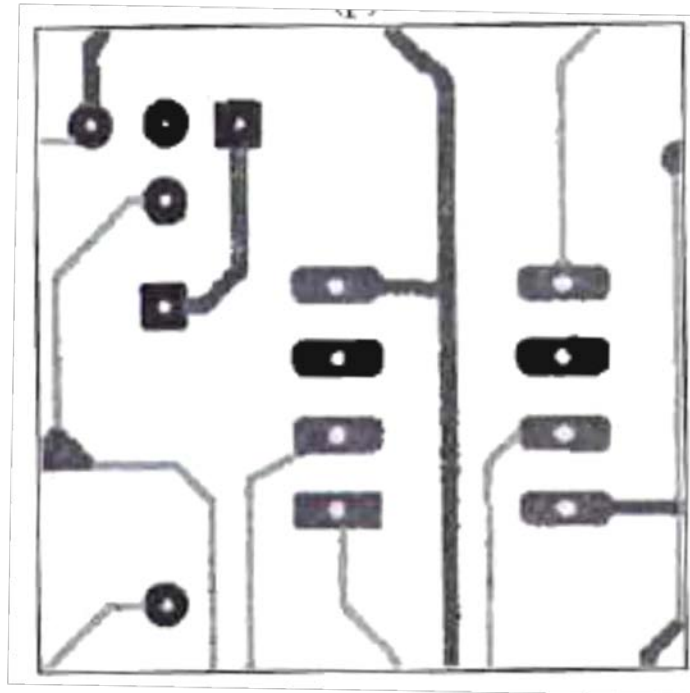
Typical Applications: PCB Component Detection

Printed circuit board:

Automatic quality control and error detection?

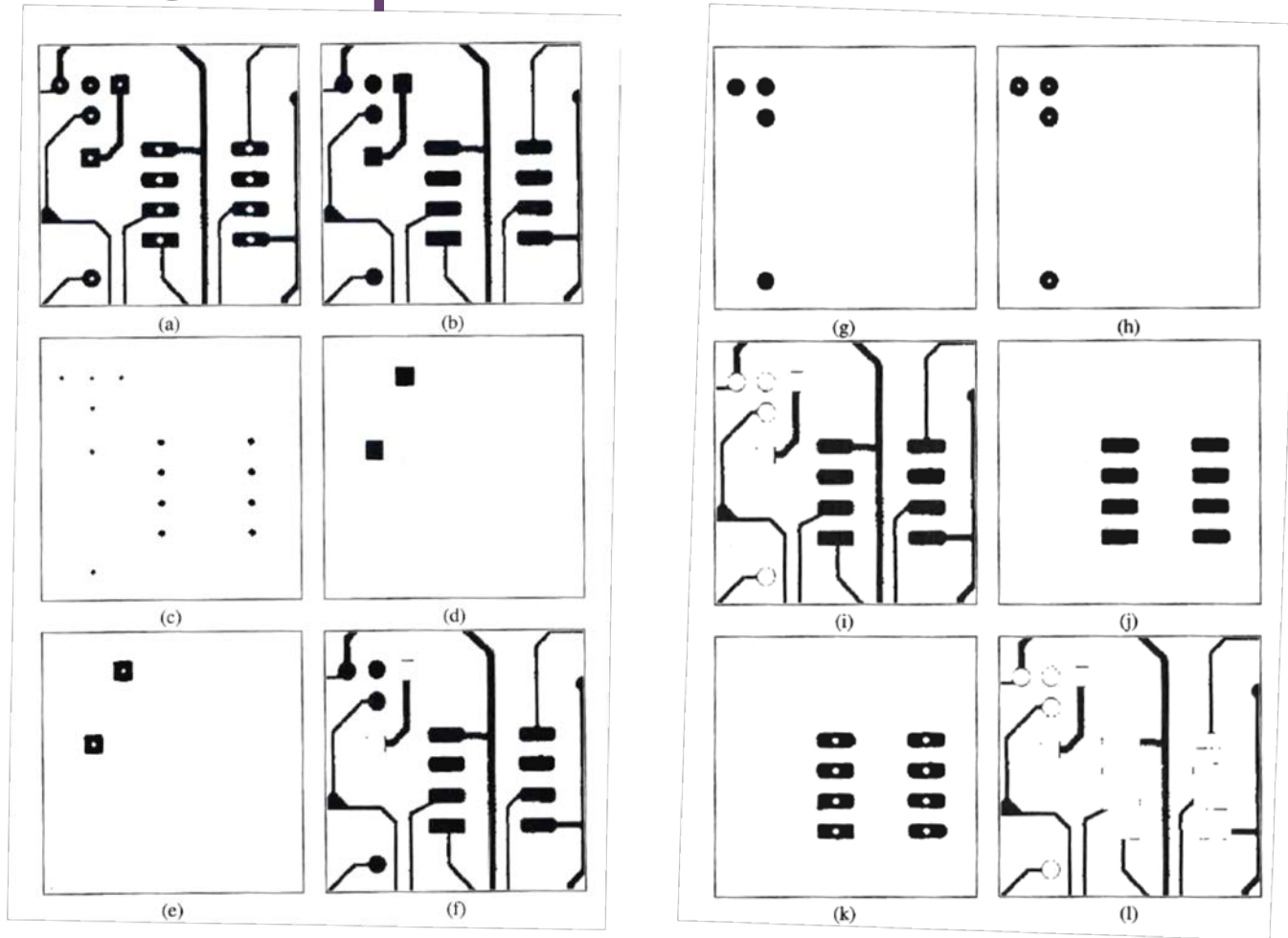


Binary image

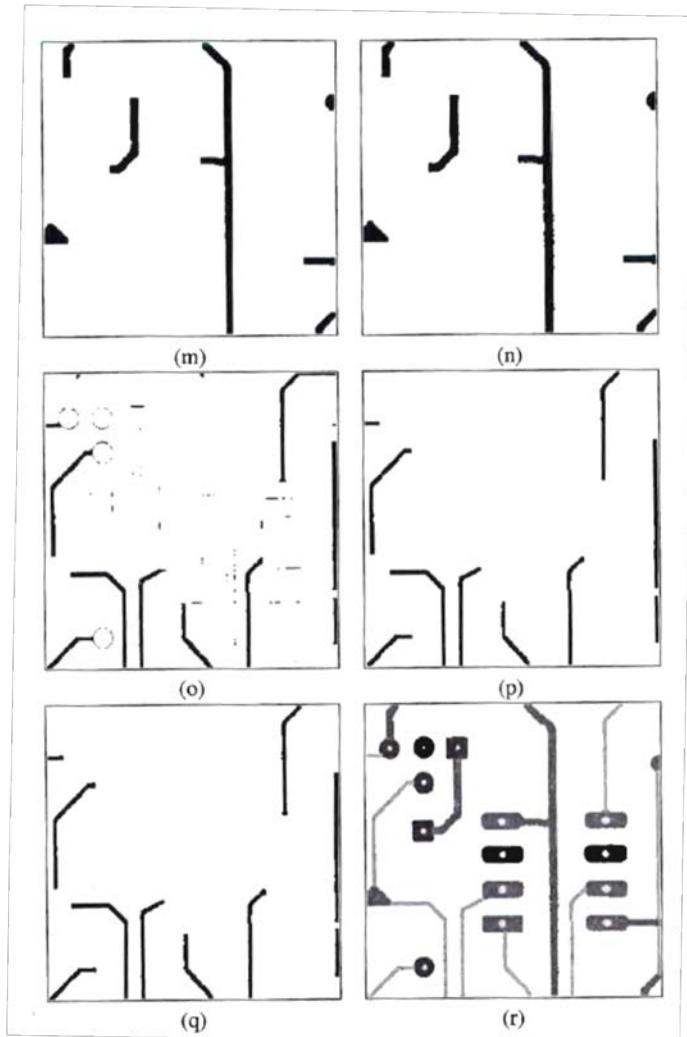


Labelled components (gray)

Typical Applications: PCB Component Detection



Typical Applications: PCB Component Detection



Source: Hands-on Morphological Image Processing, Dougherty & Lotufo, pp. 37-41

