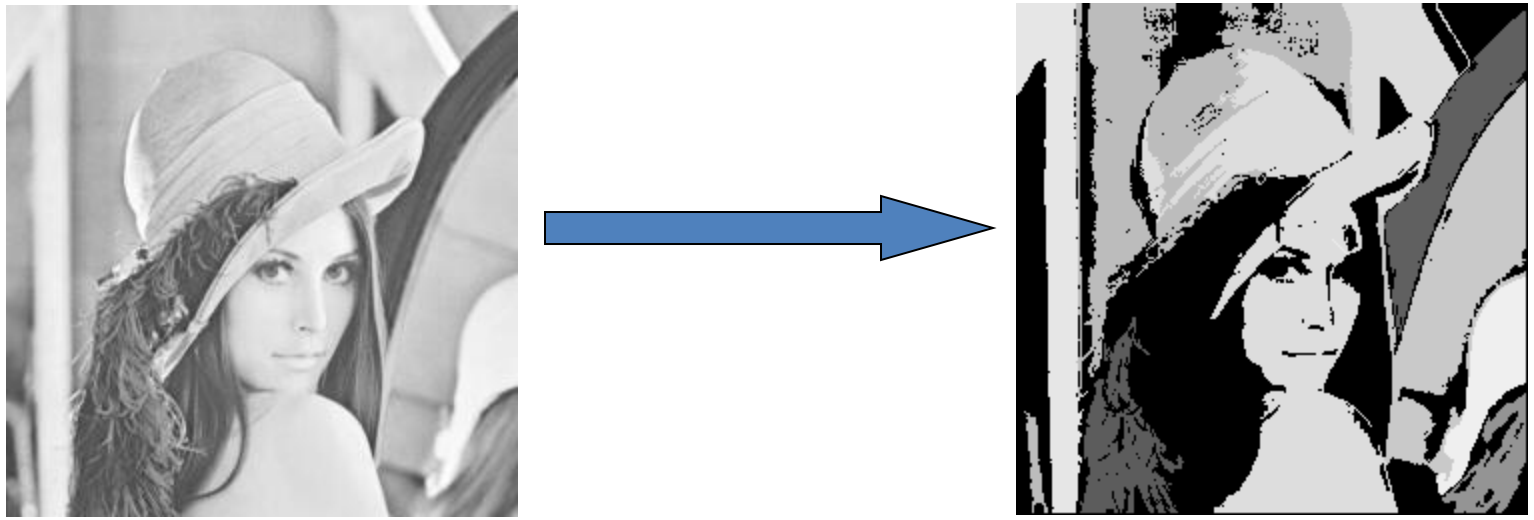
Lecture 8: PHÂN ĐOẠN ẢNH

Image Segmentation (cont)



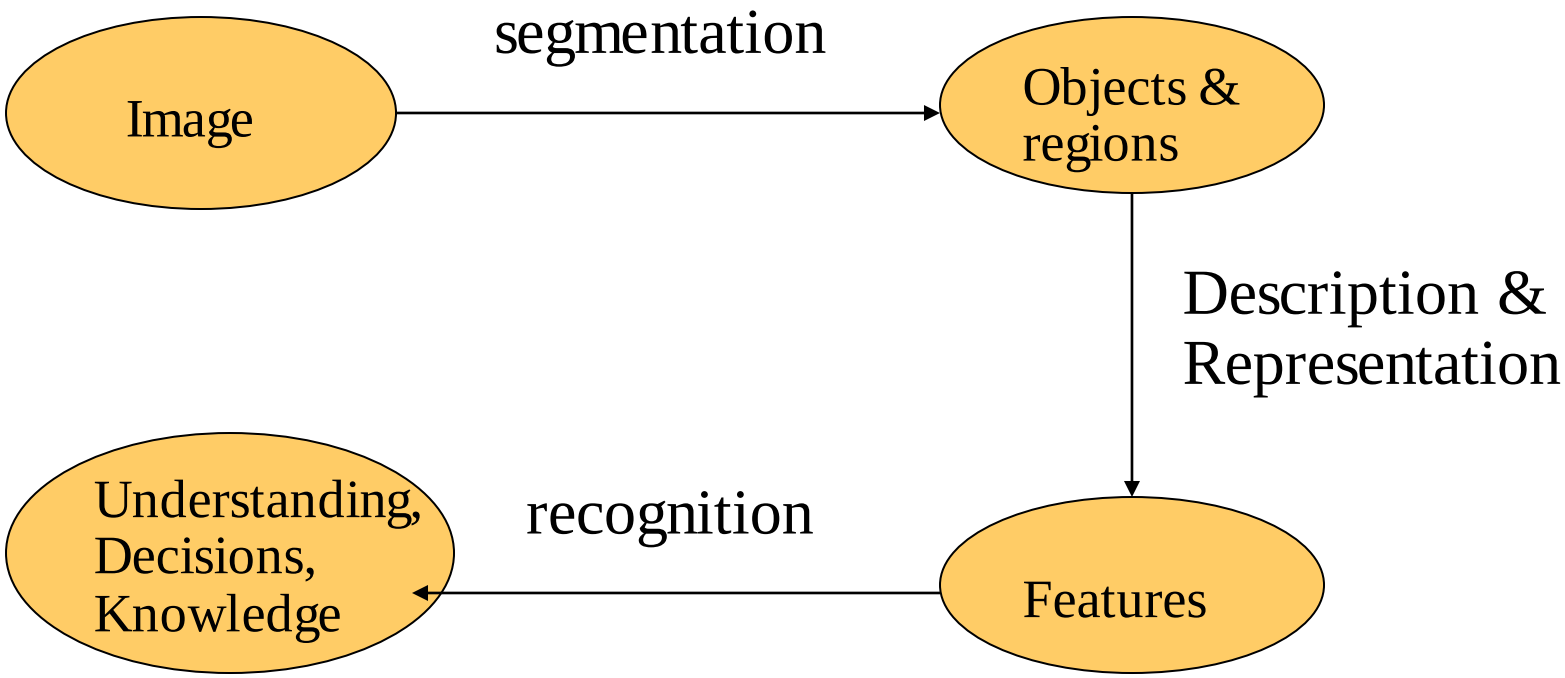


Image
segmentation
Objects & regions
Description & Representation
Features
recognition
Understanding, Decisions, Knowledge

Image Segmentation

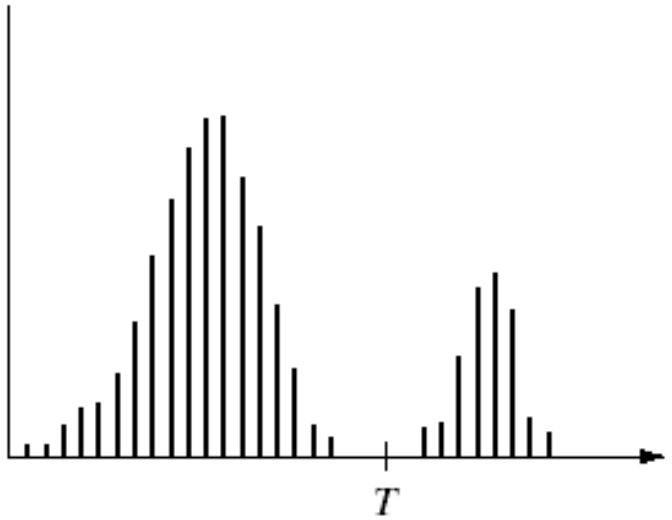
- Segmentation algorithms for monochrome images generally are based on one of two basic properties of gray-scale values:
  - Discontinuity
    - The approach is to partition an image based on abrupt changes in gray-scale levels.
    - The principal areas of interest within this category are detection of isolated points, lines, and edges in an image.
  - Similarity
    - The principal approaches in this category are based on thresholding, region growing, and region splitting/merging.

Nội dung

- By Histogram Thresholding
- By Region growing and Shrinking (split /merge)
  - Region Growing
  - Watersheds

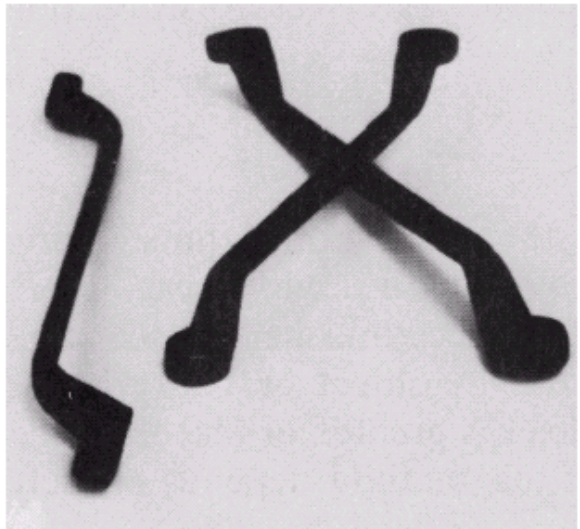
Thresholding

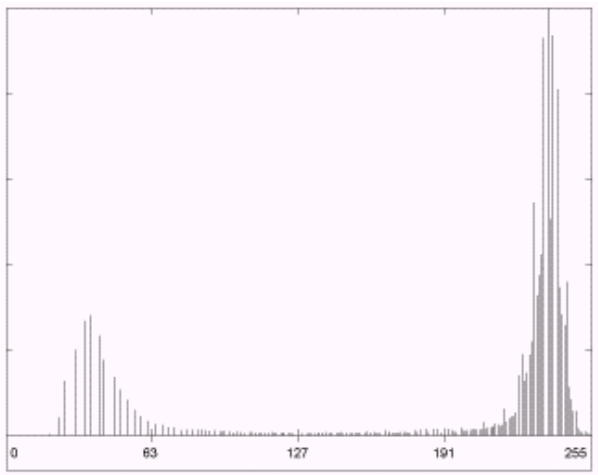
- Suppose that an image, f(x,y), is composed of light objects on a dark backround, and the following figure is the histogram of the image.

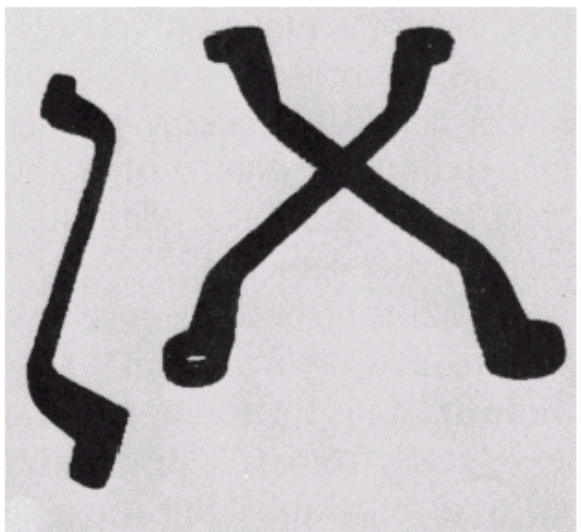


- Then, the objects can be extracted by comparing pixel values with a threshold T.

Thresholding



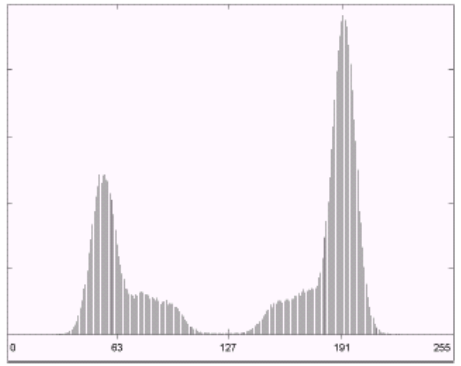




a
b c

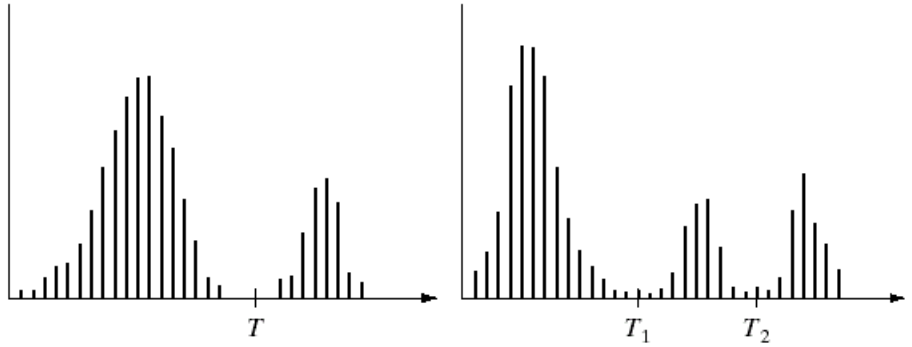
FIGURE 10.28
(a) Original image. (b) Image histogram. (c) Result of global thresholding with T midway between the maximum and minimum gray levels.

Thresholding



Thresholding

- It is also possible to extract objects that have a specific intensity range using multiple thresholds.



a b

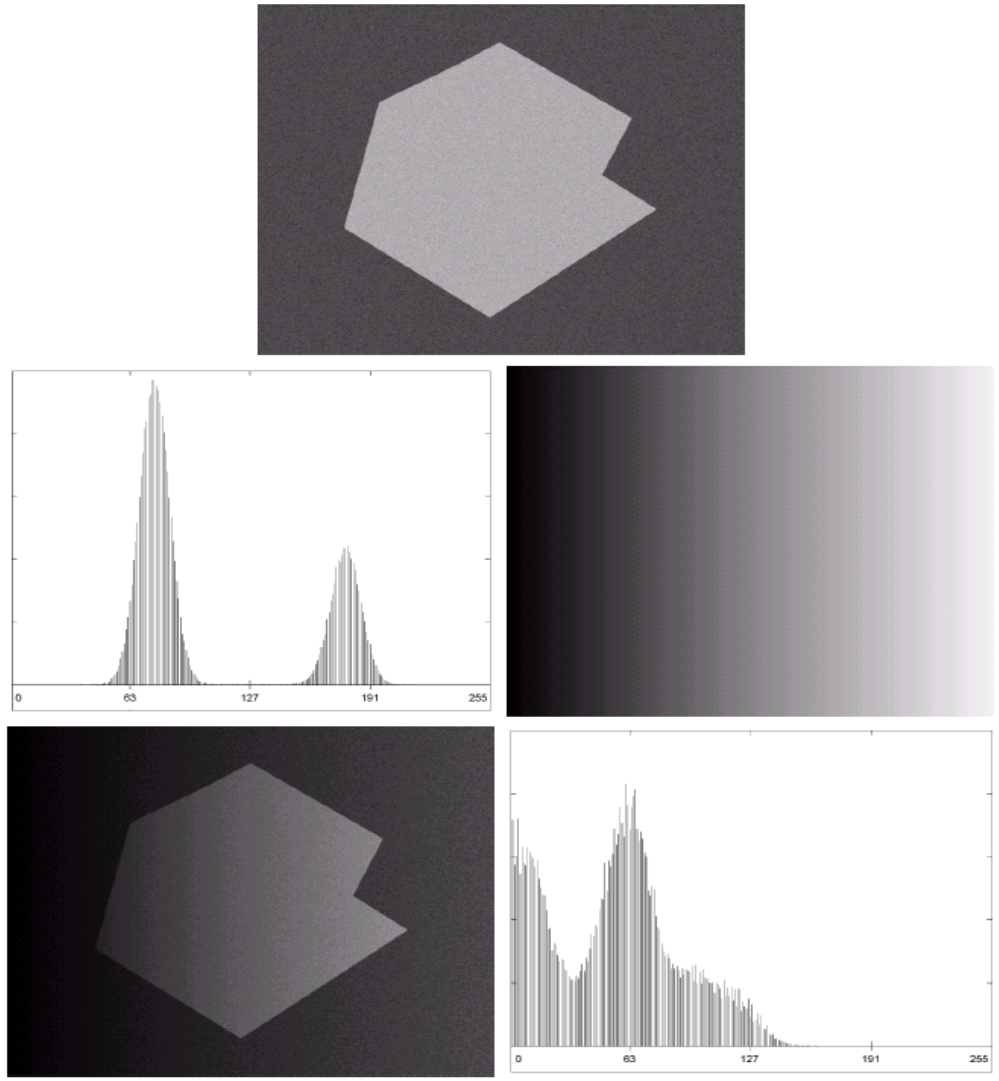
FIGURE 10.26 (a) Gray-level histograms that can be partitioned by (a) a single threshold, and (b) multiple thresholds.

Extension to color images is straightforward: There are three color channels, in each one specify the intensity range of the object… Even if objects are not separated in a single channel, they might be with all the channels… Application example: Detecting/Tracking faces based on skin color…

Thresholding

- Non-uniform illumination may change the histogram in a way that it becomes impossible to segment the image using a single global threshold.
- Choosing local threshold values may help.

Thresholding



a
b c
d e

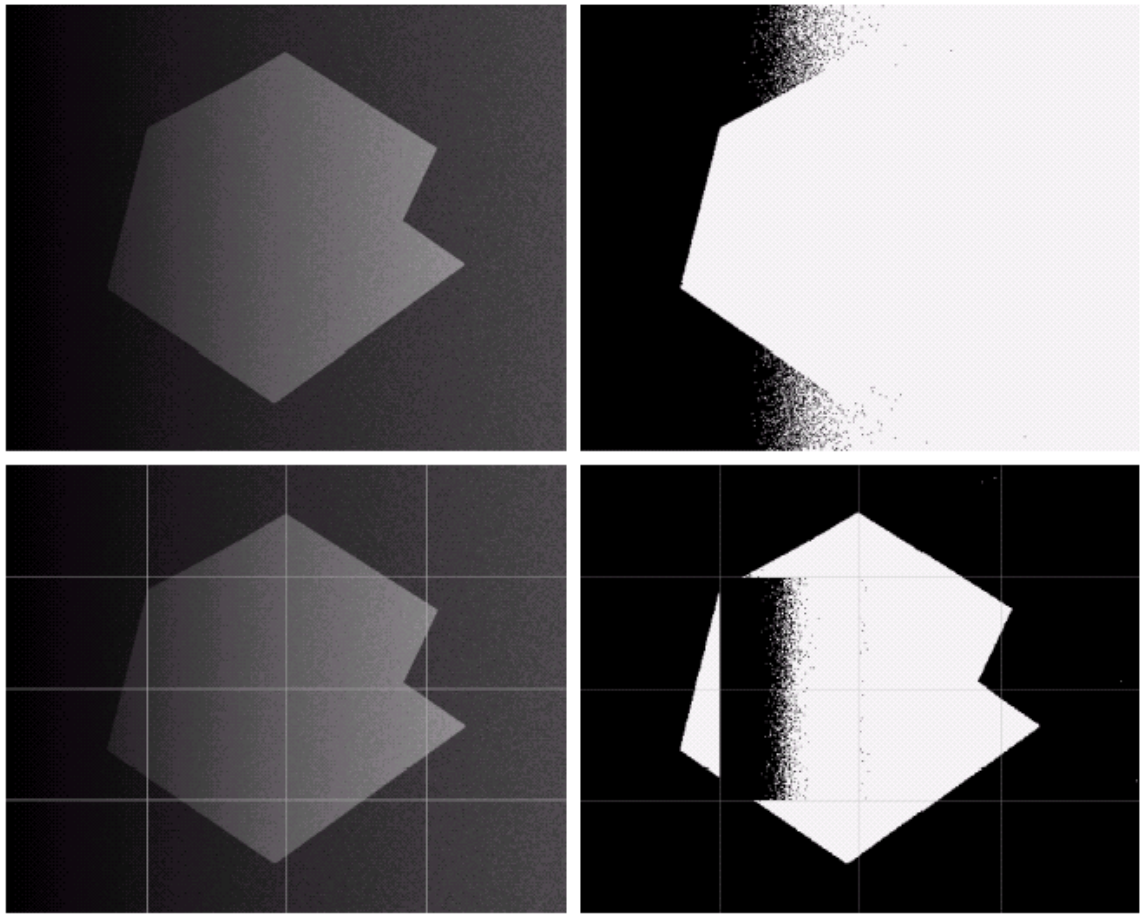
FIGURE 10.27
(a) Computer generated reflectance function.
(b) Histogram of reflectance function.
(c) Computer generated illumination function.
(d) Product of (a) and (c).
(e) Histogram of product image.

Thresholding

- Adaptive thresholding

a b
c d

FIGURE 10.30
(a) Original image. (b) Result of global thresholding. (c) Image subdivided into individual subimages. (d) Result of adaptive thresholding.



Region-based segmentation Region Growing

Algorithm:

a. Choose a random pixels (seed)

b. Use 8-connected/ 4-connected and threshold to determine

Exam: $P(R_i) = True : if |z - z_{seed}| < T$

c. Repeat a and b until almost points are classified.

Results – Region grow

Region Growing – Example 1

- Choose a random pixels
- 4-connected neighborhood

1	1	9	9	9
1	1	9	9	9
5	1	1	9	9
5	5	5	3	9
3	3	3	3	3

(a) original image

1	1	9	9	9
1	1	9	9	9
5	1	1	9	9
5	5	5	3	9
3	3	3	3	3

(b) step 1

1	1	9	9	9
1	1	9	9	9
5	1	1	9	9
5	5	5	3	9
3	3	3	3	3

(c) step2

1	1	9	9	9
1	1	9	9	9
5	1	1	9	9
5	5	5	3	9
3	3	3	3	3

(d) step 3

1	1	9	9	9
1	1	9	9	9
5	1	1	9	9
5	5	5	3	9
3	3	3	3	3

(e) step 4

1	1	9	9	9
1	1	9	9	9
5	1	1	9	9
5	5	5	3	9
3	3	3	3	3

(f) step5

Region Growing – Example 2

Suppose that we have the image given below.

(a) Use the region growing idea to segment the object. The seed for the object is the center of the image. Region is grown in horizontal and vertical directions, and when the difference between two pixel values is less than or equal to 5.

Table 1: Show the result of Part (a) on this figure.

10	10	10	10	10	10	10
10	10	10	69	70	10	10
59	10	60	64	59	56	60
10	59	10	60	70	10	62
10	60	59	65	67	10	65
10	10	10	10	10	10	10
10	10	10	10	10	10	10

Suppose that we have the image given below.

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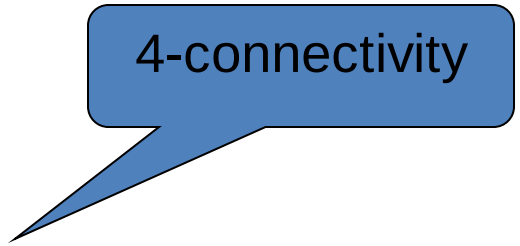
10	60	59	65	67	10	65
10	10	10	10	10	10	10
10	10	10	10	10	10	10



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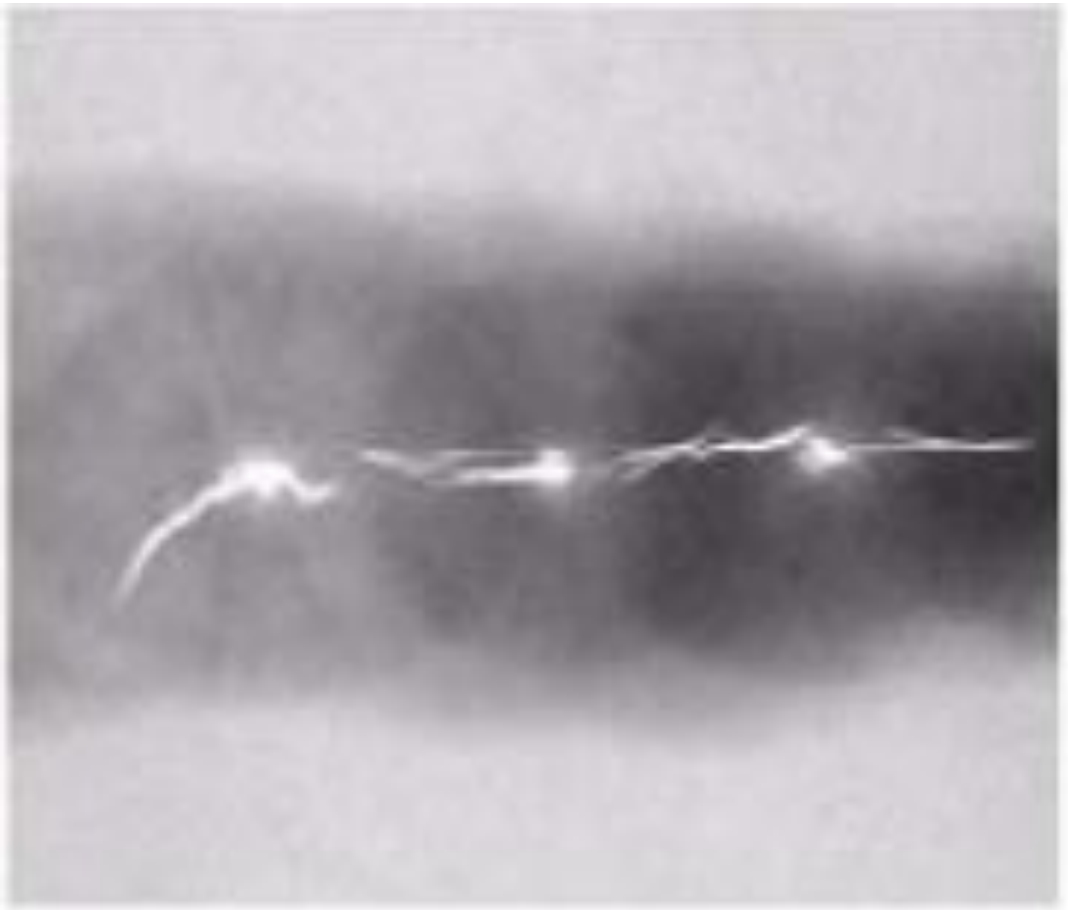
10	60	59	65	67	10	65
10	10	10	10	10	10	10
10	10	10	10	10	10	10

8-connectivity

Seed-based Region Growing – Example 3

- **Problem:** Phân vùng tia sét của ảnh???



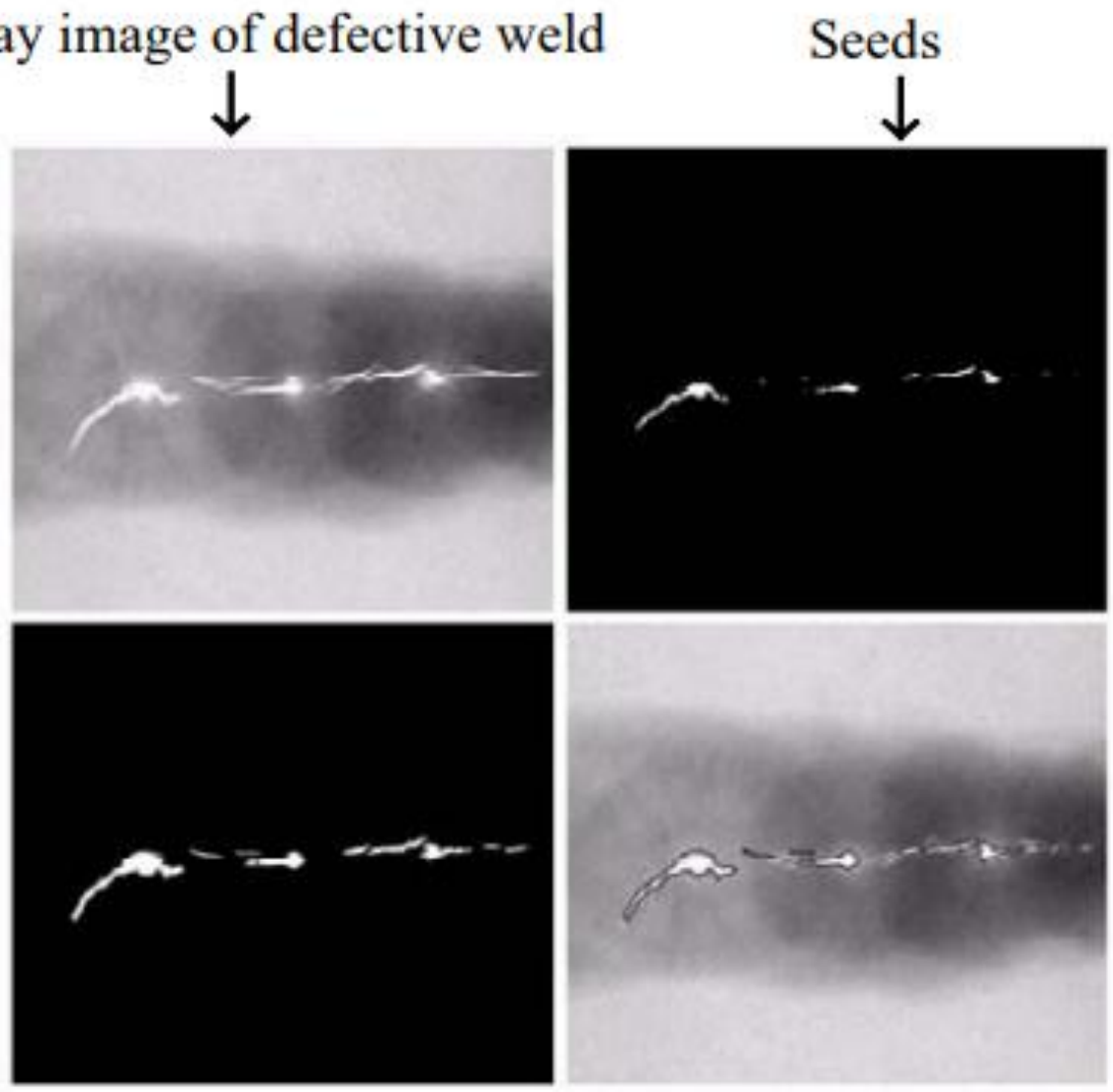
Solution

- Seeds: f(x,y) = 255
- P(R) = TRUE if
  | seed gray level – new pixel gray level | < 65

  and

  – New pixel must be 8-connected with at least one pixel in the region

Result of region growing →



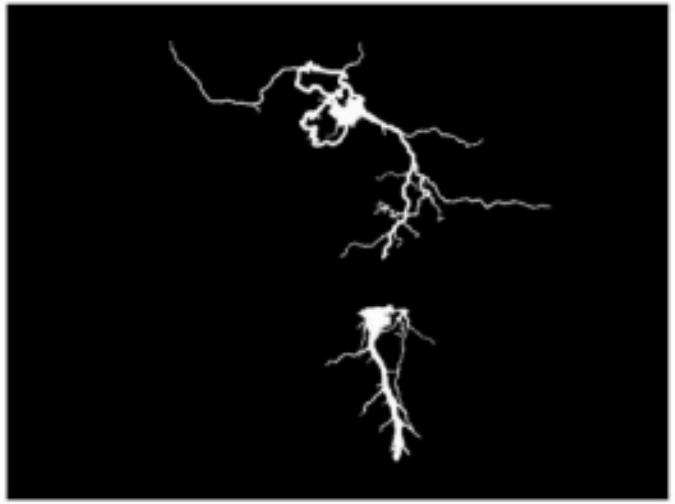
Example 4

Example 4

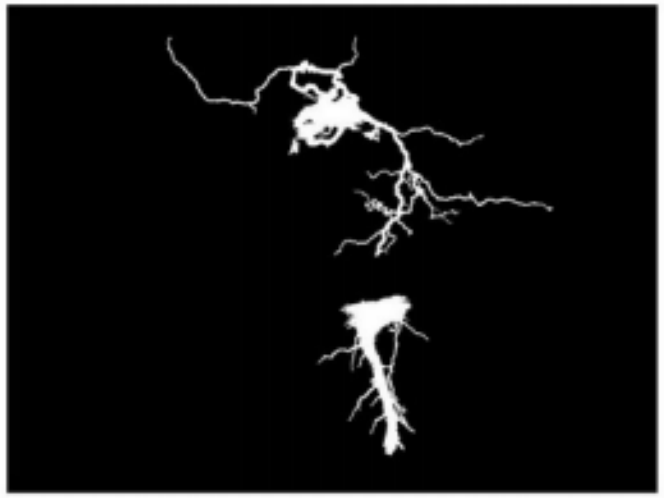
threshold = 255 returns multiple seeds

threshold: 225~255

threshold: 190~225



threshold: 155~255



BÀI TẬP

Phân vùng ảnh sau thành các vùng có chứa giá trị max (sự sai khác < 3)

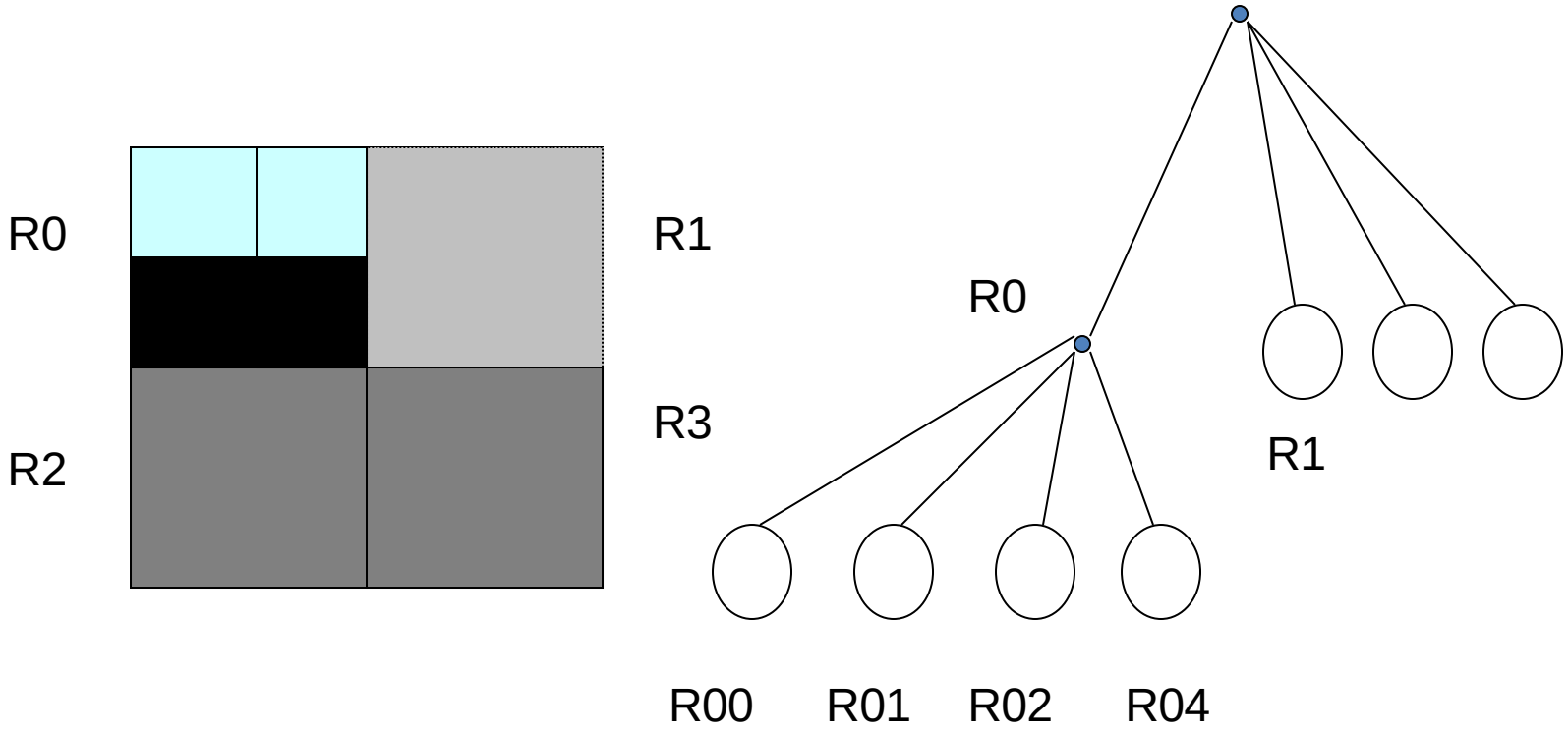
0	0	1	2	5	7	1	0	1	1	1	1	1	0
0	0	1	6	6	7	1	0	0	0	0	0	0	0
0	1	2	1	2	1	1	0	0	7	7	7	1	1
1	2	1	1	1	2	0	0	0	6	6	7	1	1
1	2	7	6	6	6	5	5	1	6	7	7	1	1
2	3	1	1	1	6	6	1	1	6	6	7	1	1
0	0	0	1	1	1	1	1	1	6	6	7	1	1
0	0	0	0	0	0	1	1	0	0	0	0	1	1

Split / Merge

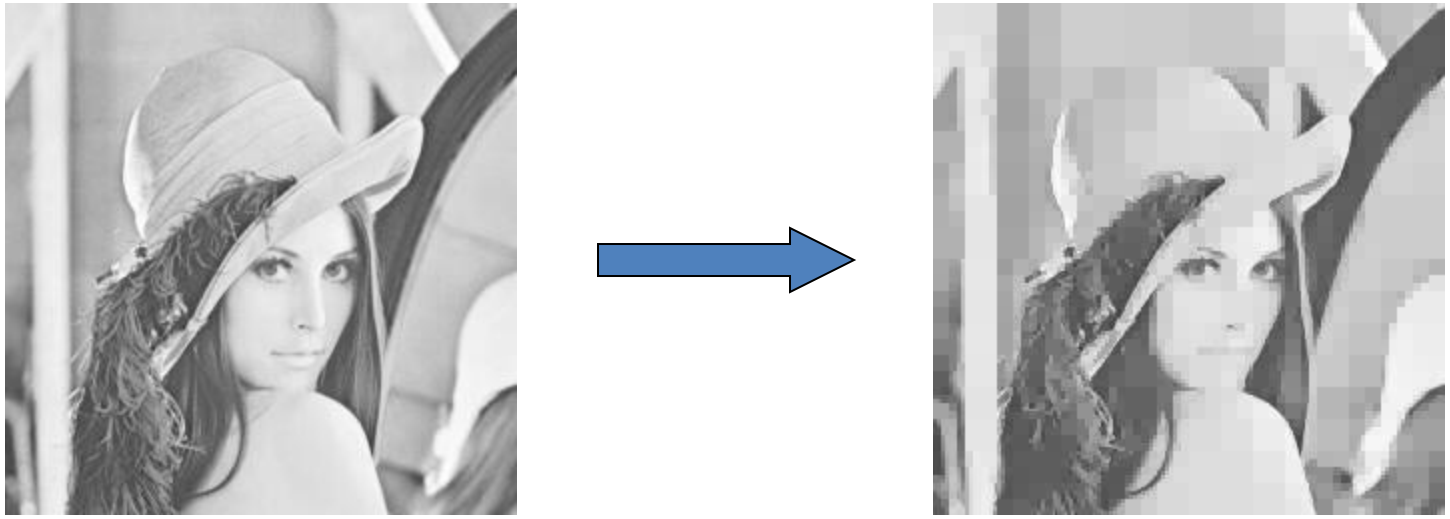
- The opposite approach to region growing is region shrinking (splitting).
- It is a top-down approach and it starts with the assumption that the entire image is homogeneous
- If this is not true , the image is split into four sub images
- This splitting procedure is repeated recursively until we split the image into homogeneous regions

Split / Merge

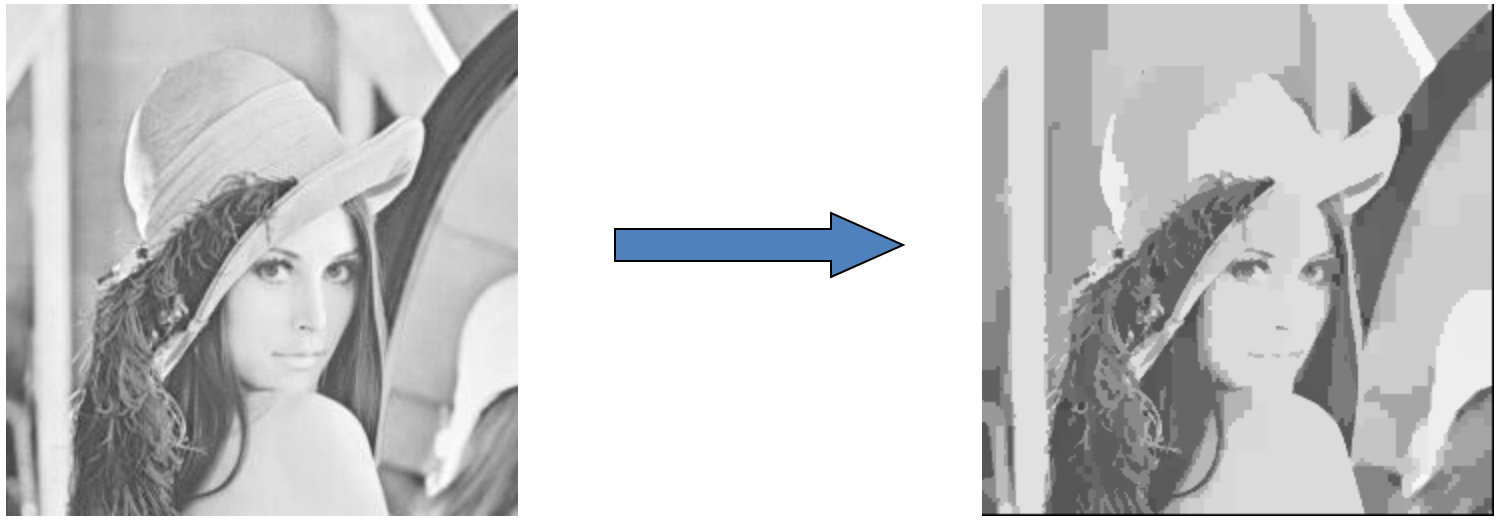
Quadtree



Results – Region Split



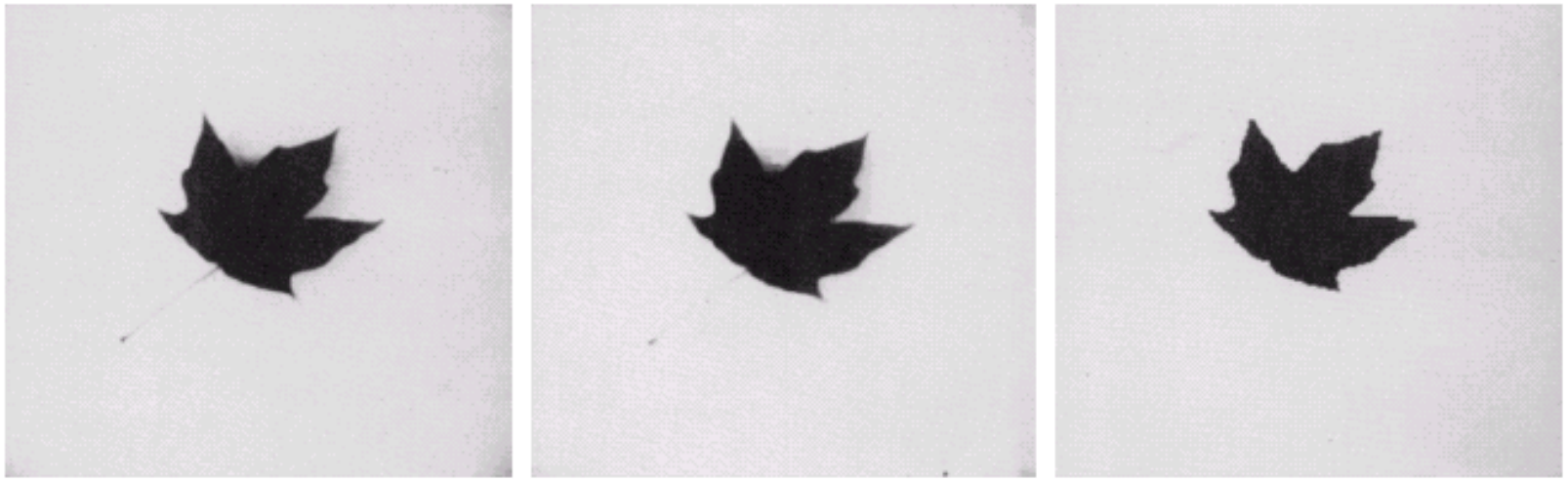
Results – Region Split and Merge



Split / Merge

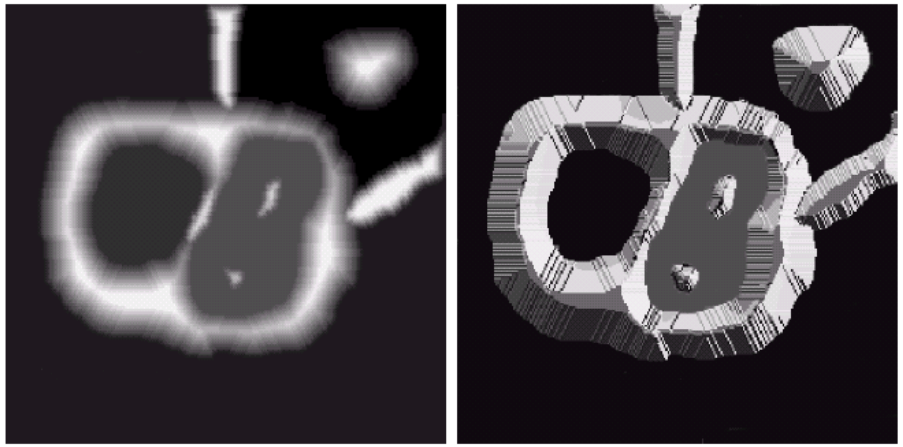
a b c

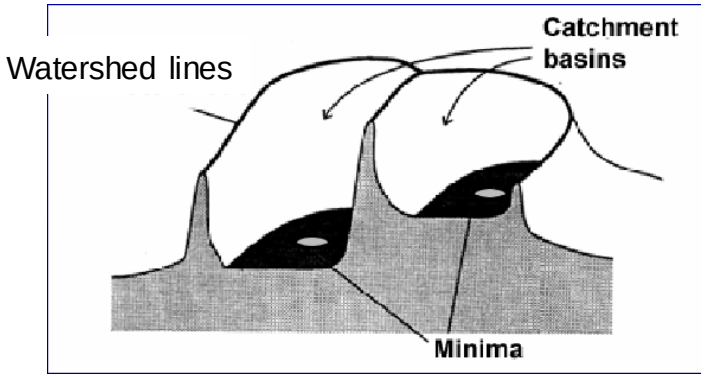
FIGURE 10.43
(a) Original image. (b) Result of split and merge procedure. (c) Result of thresholding (a).



Watershed Segmentation Algorithm

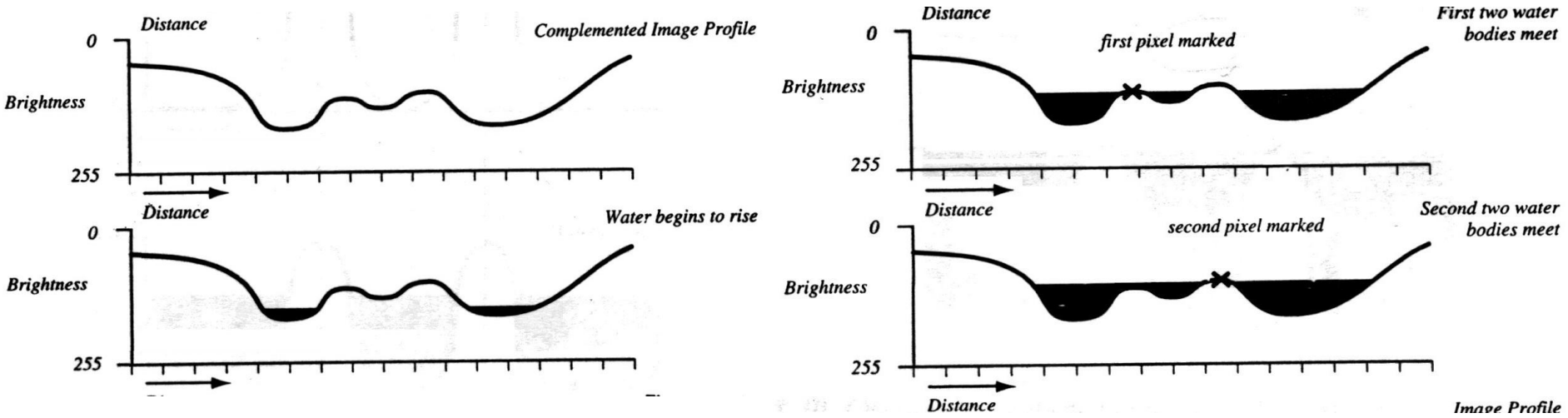
- Visualize an image in 3D: spatial coordinates and gray levels.
- In such a topographic interpretation, there are 3 types of points:
  - Points belonging to a regional minimum
  - Points at which a drop of water would fall to a single minimum. (→The *catchment basin* or *watershed* of that minimum.)
  - Points at which a drop of water would be equally likely to fall to more than one minimum. (→The *divide lines* or *watershed lines*.)



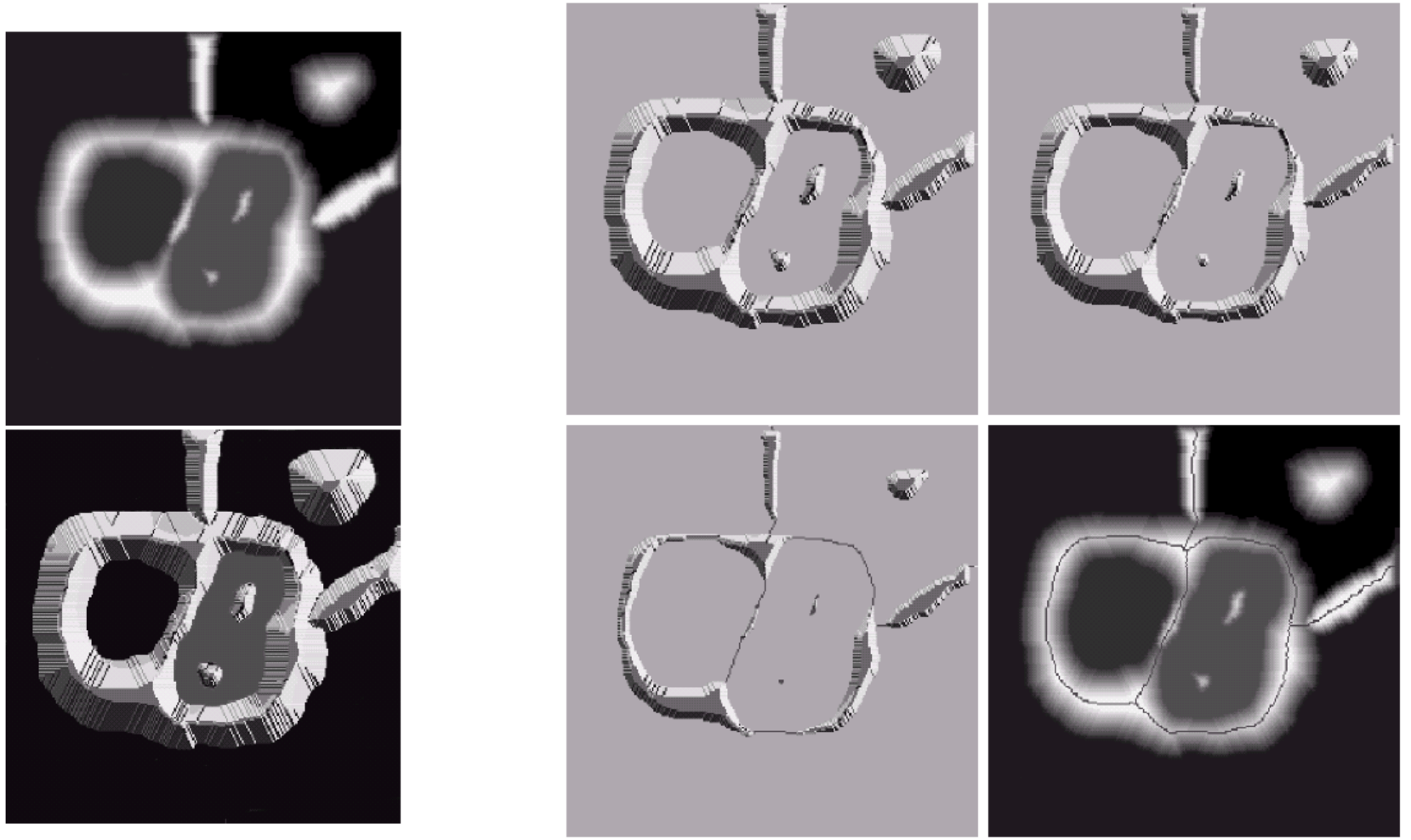


Watershed Segmentation Algorithm

- The objective is to find watershed lines.
- The idea is simple:
  - Suppose that a hole is punched in each regional minimum and that the entire topography is flooded from below by letting water rise through the holes at a uniform rate.
  - When rising water in distinct catchment basins is about the merge, a dam is built to prevent merging. These dam boundaries correspond to the watershed lines.



Watershed Segmentation Algorithm



e f
g h

FIGURE 10.44
(Continued)
(e) Result of further flooding. (f) Beginning of merging of water from two catchment basins (a short dam was built between them). (g) Longer dams. (h) Final watershed (segmentation) lines. (Courtesy of Dr. S. Beucher, CMM/Ecole des Mines de Paris.)

Watershed Segmentation Algorithm

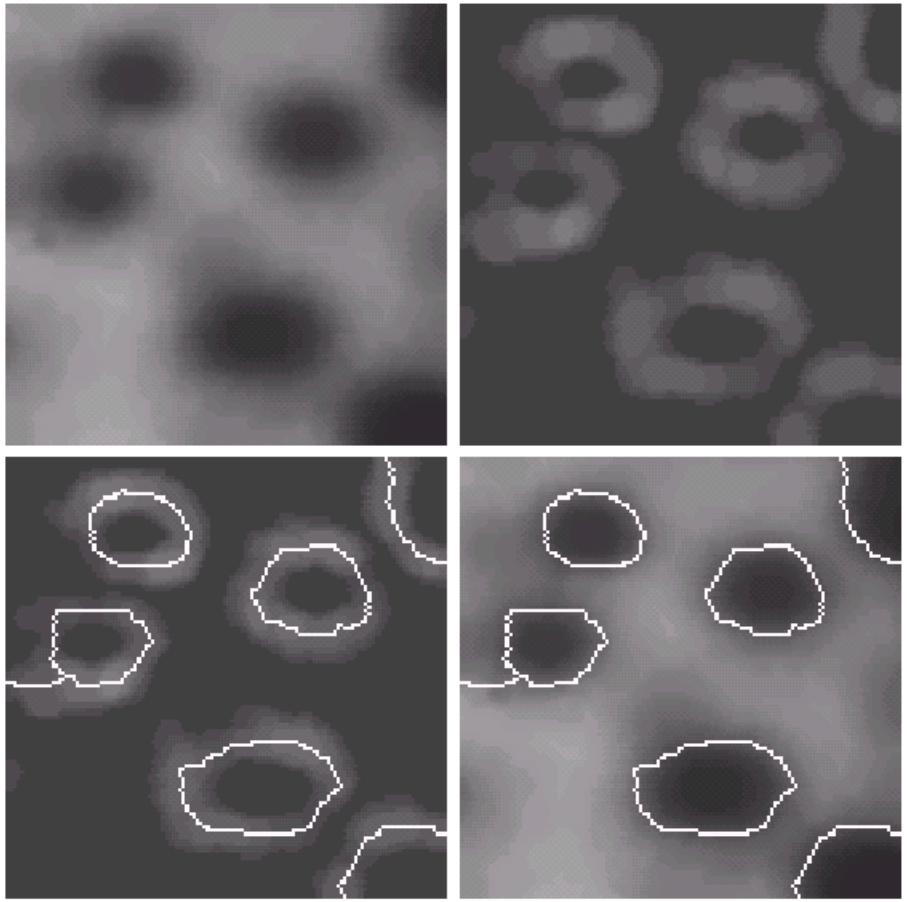
- Start with all pixels with the lowest possible value.
  - These form the basis for initial watersheds
- For each intensity level k:
  - For each group of pixels of intensity k
    - If adjacent to exactly one existing region, add these pixels to that region
    - Else if adjacent to more than one existing regions, mark as boundary
    - Else start a new region

Watershed Segmentation Algorithm

Watershed algorithm might be used on the gradient image instead of the original image.

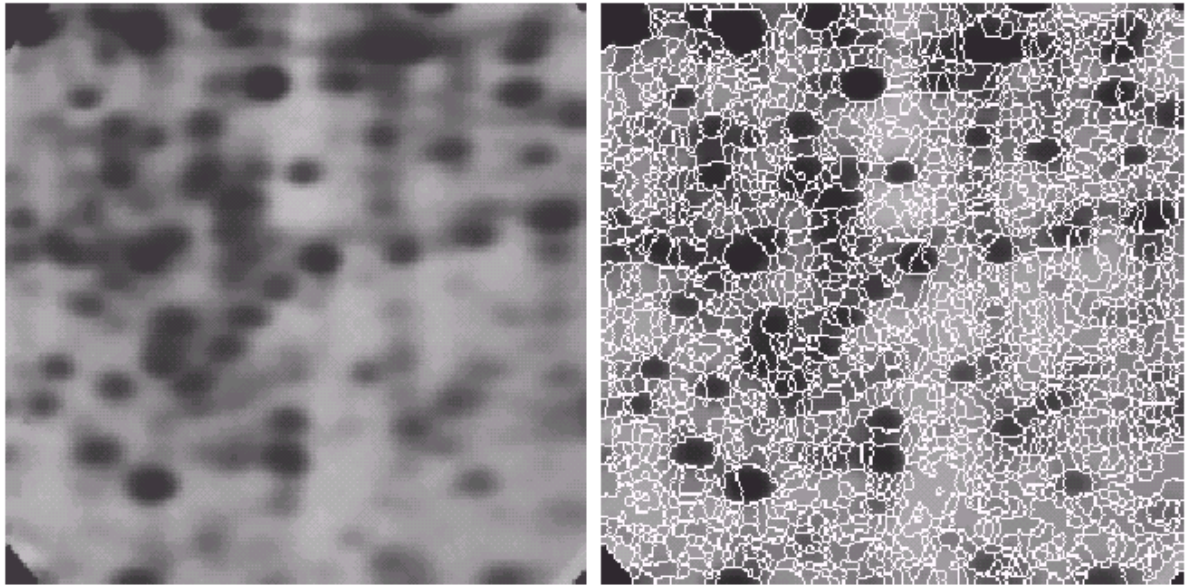
a b
c d

FIGURE 10.46
(a) Image of blobs. (b) Image gradient. (c) Watershed lines. (d) Watershed lines superimposed on original image. (Courtesy of Dr. S. Beucher, CMM/Ecole des Mines de Paris.)



Watershed Segmentation Algorithm

Due to noise and other local irregularities of the gradient, oversegmentation might occur.

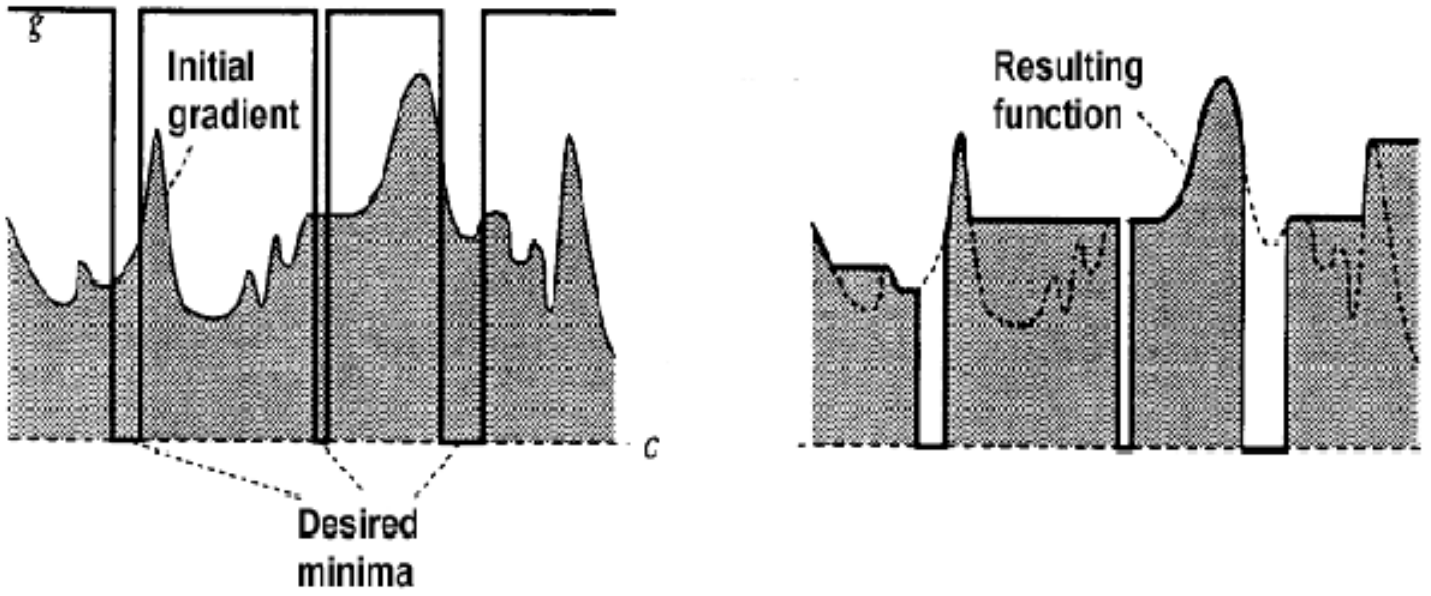


a b

FIGURE 10.47
(a) Electrophoresis image. (b) Result of applying the watershed segmentation algorithm to the gradient image. Oversegmentation is evident. (Courtesy of Dr. S. Beucher, CMM/Ecole des Mines de Paris.)

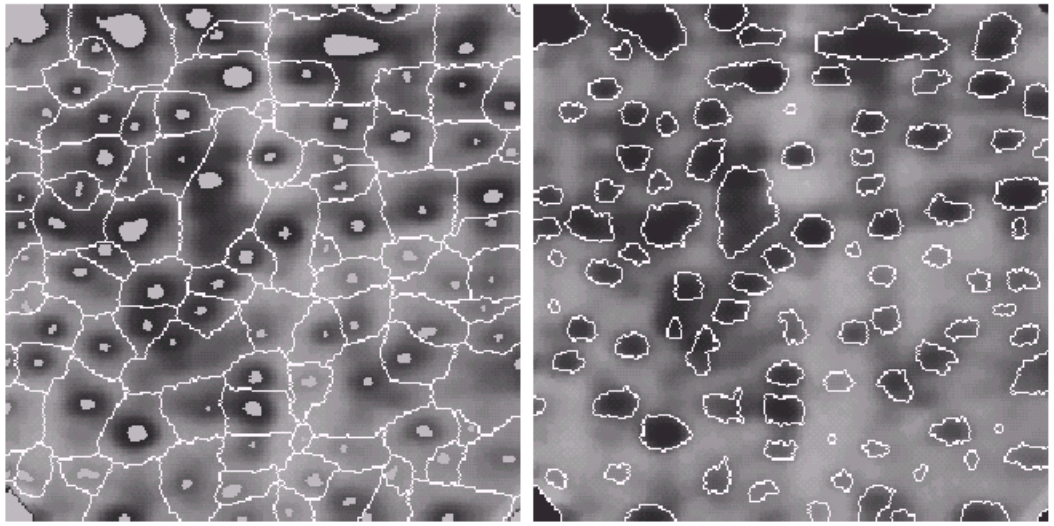
Watershed Segmentation Algorithm

A solution is to limit the number of regional minima. Use markers to specify the only allowed regional minima.



Watershed Segmentation Algorithm

A solution is to limit the number of regional minima. Use markers to specify the only allowed regional minima. (For example, gray-level values might be used as a marker.)



a b

FIGURE 10.48
(a) Image showing internal markers (light gray regions) and external markers (watershed lines). (b) Result of segmentation. Note the improvement over Fig. 10.47(b). (Courtesy of Dr. S. Beucher, CMM/Ecole des Mines de Paris.)