

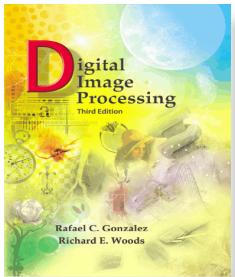
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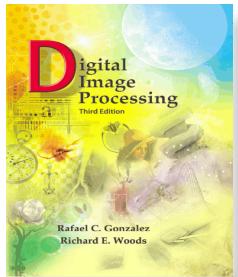
Tópicos Especiais em Visão Computacional
Prof. Romuere Silva



Chapter 10

Segmentation

- A segmentação subdivide uma imagem em regiões ou objetos que a compõem:
 - O nível de detalhe depende do problema;
 - Segmentação finaliza quando objetos de interesse ao problema são detectados.
- A separação dos pixels relativos a cada objeto, ou região, é uma etapa fundamental para o sucesso do processo de análise da imagem;
- Embora o ser humano possa facilmente identificar regiões com as mesmas características ou objetos em uma imagem, em um computador essa tarefa pode ser complexa.

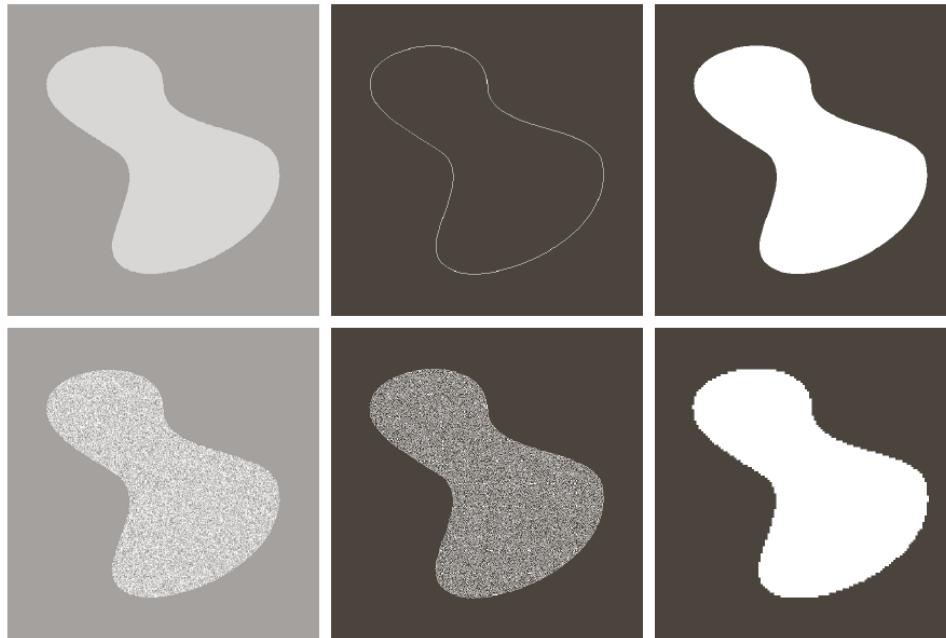


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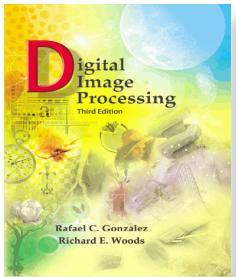
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a
b
c
d
e
f

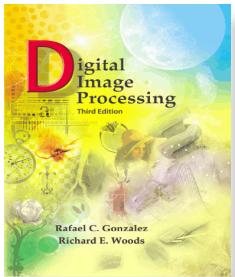
FIGURE 10.1 (a) Image containing a region of constant intensity. (b) Image showing the boundary of the inner region, obtained from intensity discontinuities. (c) Result of segmenting the image into two regions. (d) Image containing a textured region. (e) Result of edge computations. Note the large number of small edges that are connected to the original boundary, making it difficult to find a unique boundary using only edge information. (f) Result of segmentation based on region properties.



Chapter 10

Segmentation

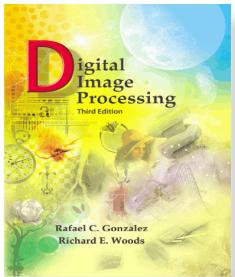
- O processo de agrupamento dos pixels pertencentes a um mesmo objeto ou região é chamado de segmentação;
- As técnicas de segmentação de imagens podem ser classificadas nas seguintes categorias:
 - Detecção de descontinuidades;
 - Técnicas de limiar;
 - Métodos baseados em agrupamento;
 - **Métodos em crescimento de região;**
 - **Redes Neurais Convolucionais.**



Chapter 10
Segmentation

Detecção de descontinuidades

- Levam em consideração o fato de que entre duas regiões deve existir uma fronteira;
- Procura-se identificar descontinuidades que possam representar as bordas da região;
- A operação clássica: **gradiente**
 - intensifica variações de tonalidade resultando em uma imagem com pixels mais intensos;
- Problema na aplicação do gradiente:
 - Obtenção de regiões com bordas abertas devido a ruídos ou uso de iluminação não uniforme no processo de aquisição da imagem

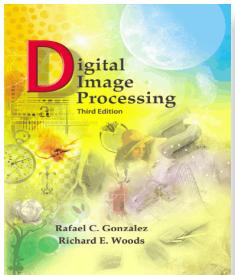


Chapter 10
Segmentation

Gradiente de uma Imagem

- Derivadas de uma função digital são definidas por diferenças; Tais aproximações devem considerar que a derivada deve ser:
 - zero em áreas de intensidade constante;
 - zero no início de um degrau ou rampa de intensidade;
 - diferente de zero ao longo de uma rampa de intensidade.
- A derivada de primeira ordem de uma função $f(x)$ é obtida da seguinte forma:

$$\frac{\delta f}{\delta x} = f'(x) = f(x + 1) - f(x).$$

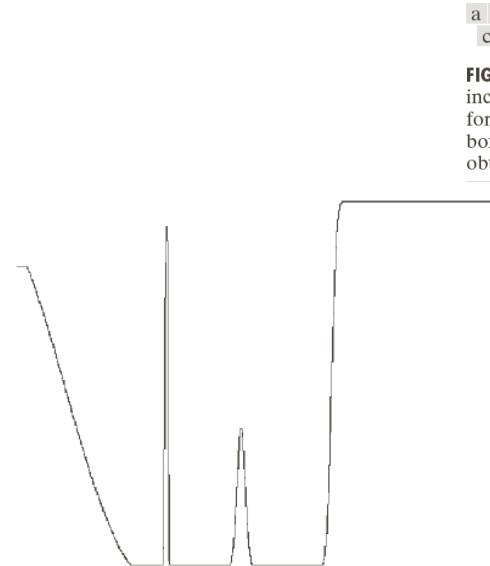
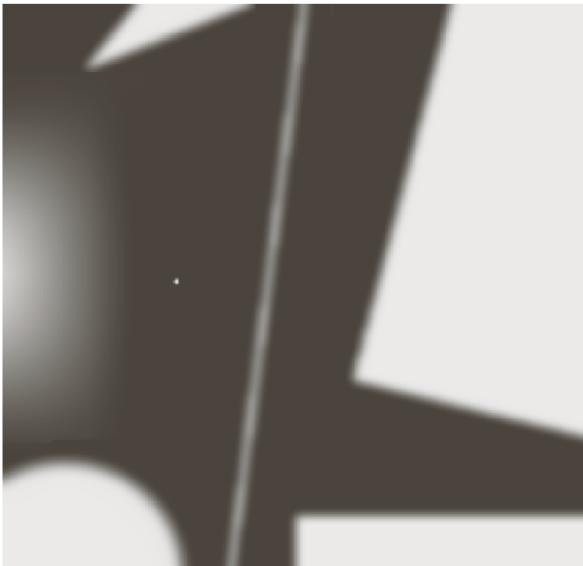


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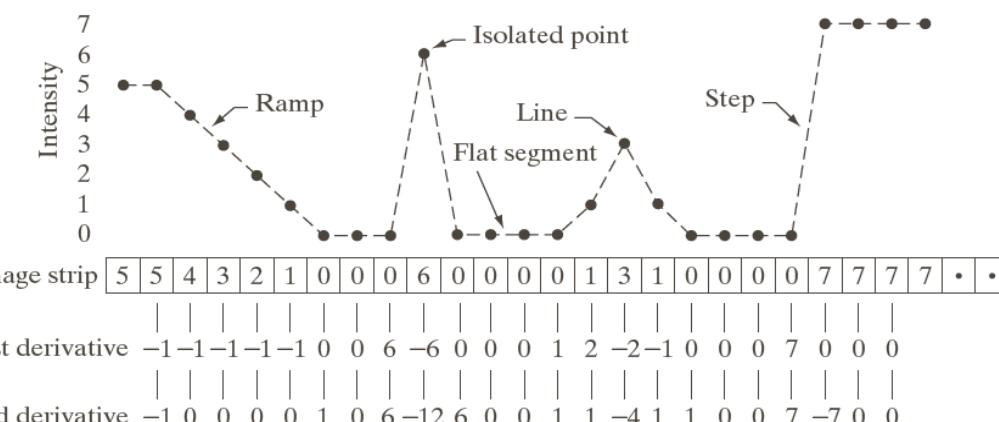
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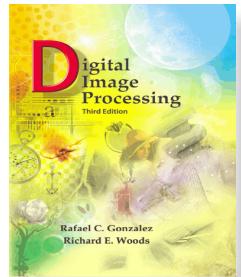
Chapter 10 Segmentation



a
b
c

FIGURE 10.2 (a) Image. (b) Horizontal intensity profile through the center of the image, including the isolated noise point. (c) Simplified profile (the points are joined by dashes for clarity). The image strip corresponds to the intensity profile, and the numbers in the boxes are the intensity values of the dots shown in the profile. The derivatives were obtained using Eqs. (10.2-1) and (10.2-2).





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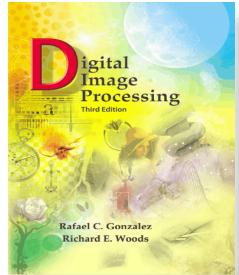
1	1	1
1	-8	1
1	1	1



a
b c d

FIGURE 10.4

(a) Point detection (Laplacian) mask.
(b) X-ray image of turbine blade with a porosity. The porosity contains a single black pixel.
(c) Result of convolving the mask with the image. (d) Result of using Eq. (10.2-8) showing a single point (the point was enlarged to make it easier to see). (Original image courtesy of X-TEK Systems, Ltd.)

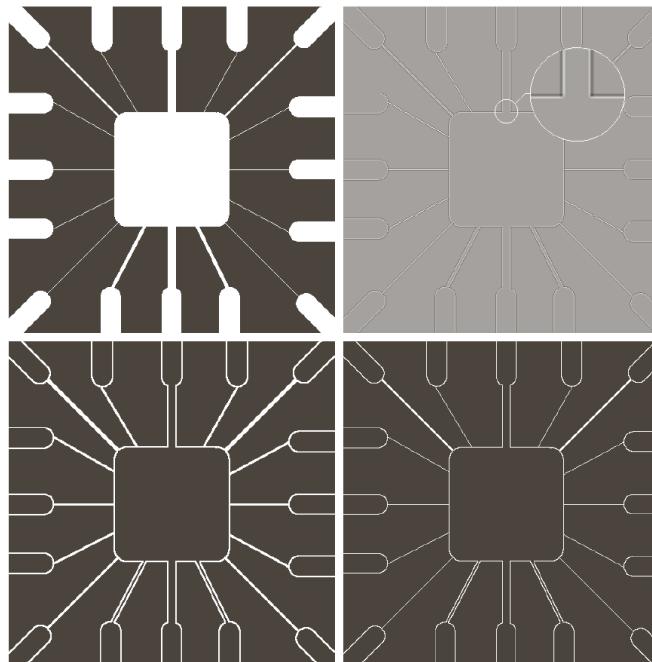


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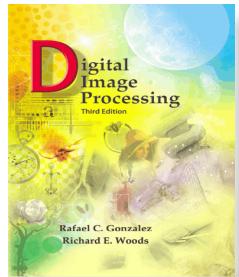
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a b
c d

FIGURE 10.5
(a) Original image.
(b) Laplacian
image; the
magnified section
shows the
positive/negative
double-line effect
characteristic of the
Laplacian.
(c) Absolute value
of the Laplacian.
(d) Positive values
of the Laplacian.



Chapter 10 Segmentation

-1	-1	-1
2	2	2
-1	-1	-1

Horizontal

2	-1	-1
-1	2	-1
-1	-1	2

$+45^\circ$

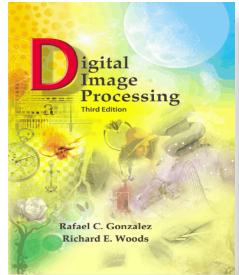
-1	2	-1
-1	2	-1
-1	2	-1

Vertical

-1	-1	2
-1	2	-1
2	-1	-1

-45°

FIGURE 10.6 Line detection masks. Angles are with respect to the axis system in Fig. 2.18(b).

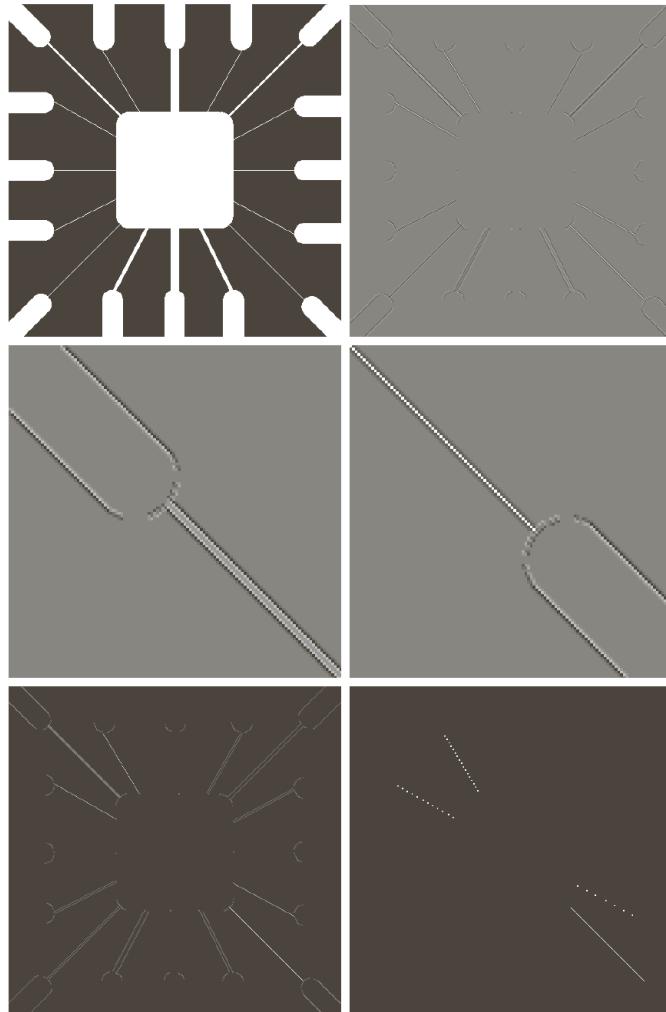


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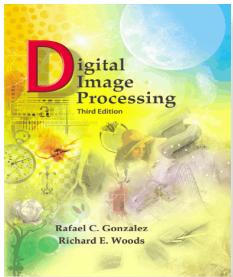
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a b
c d
e f

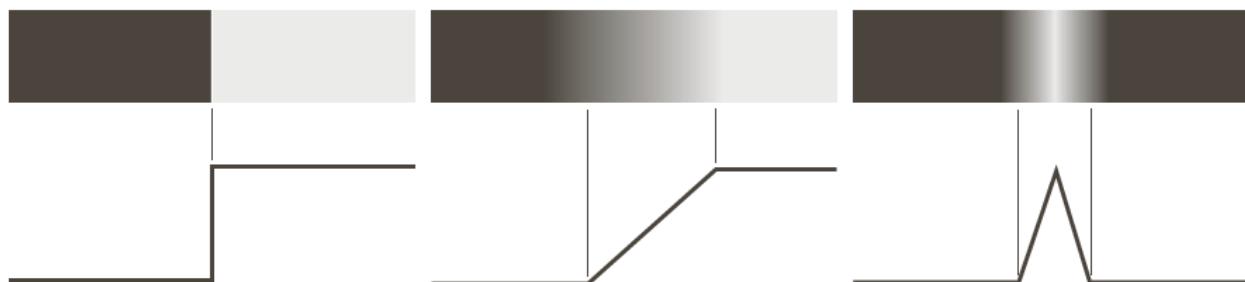
FIGURE 10.7
(a) Image of a wire-bond template.
(b) Result of processing with the $+45^\circ$ line detector mask in Fig. 10.6.
(c) Zoomed view of the top left region of (b).
(d) Zoomed view of the bottom right region of (b).
(e) The image in (b) with all negative values set to zero.
(f) All points (in white) whose values satisfied the condition $g \geq T$, where g is the image in (e). (The points in (f) were enlarged to make them easier to see.)



Chapter 10 Segmentation

Detecção de Bordas

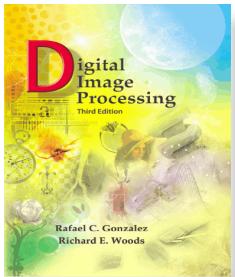
- Método mais usado para segmentar imagens com base em variações abruptas de intensidade;
- Modelos de borda:
 - degrau
 - rampa
 - telhado



a b c

FIGURE 10.8

From left to right, models (ideal representations) of a step, a ramp, and a roof edge, and their corresponding intensity profiles.



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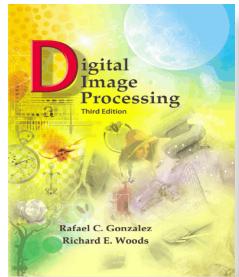
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FIGURE 10.9 A 1508×1970 image showing (zoomed) actual ramp (bottom, left), step (top, right), and roof edge profiles. The profiles are from dark to light, in the areas indicated by the short line segments shown in the small circles. The ramp and “step” profiles span 9 pixels and 2 pixels, respectively. The base of the roof edge is 3 pixels. (Original image courtesy of Dr. David R. Pickens, Vanderbilt University.)

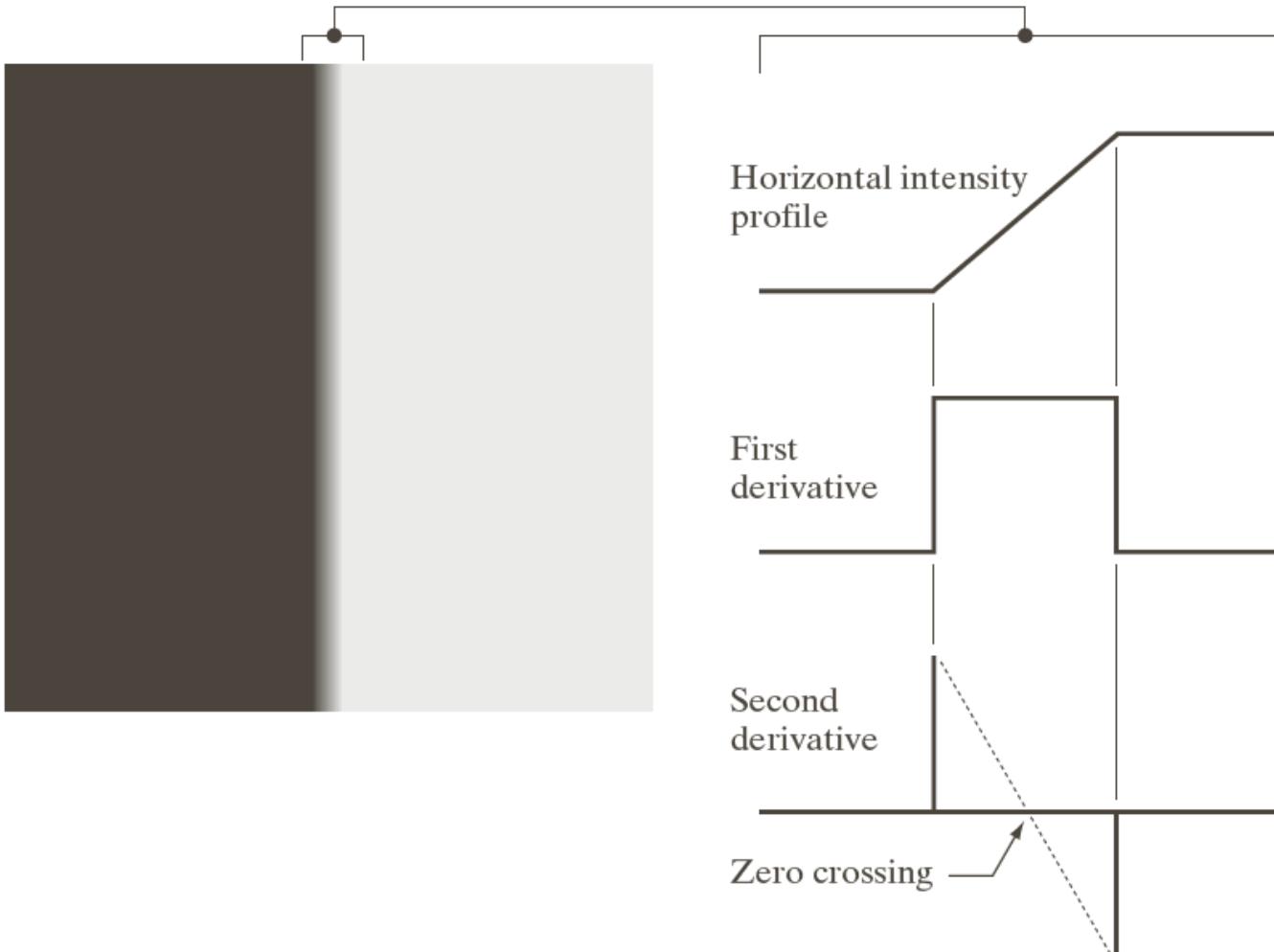


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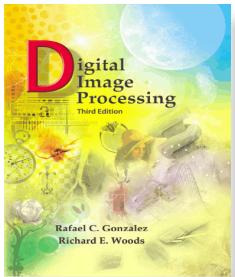
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a | b

FIGURE 10.10

(a) Two regions of constant intensity separated by an ideal vertical ramp edge.
(b) Detail near the edge, showing a horizontal intensity profile, together with its first and second derivatives.

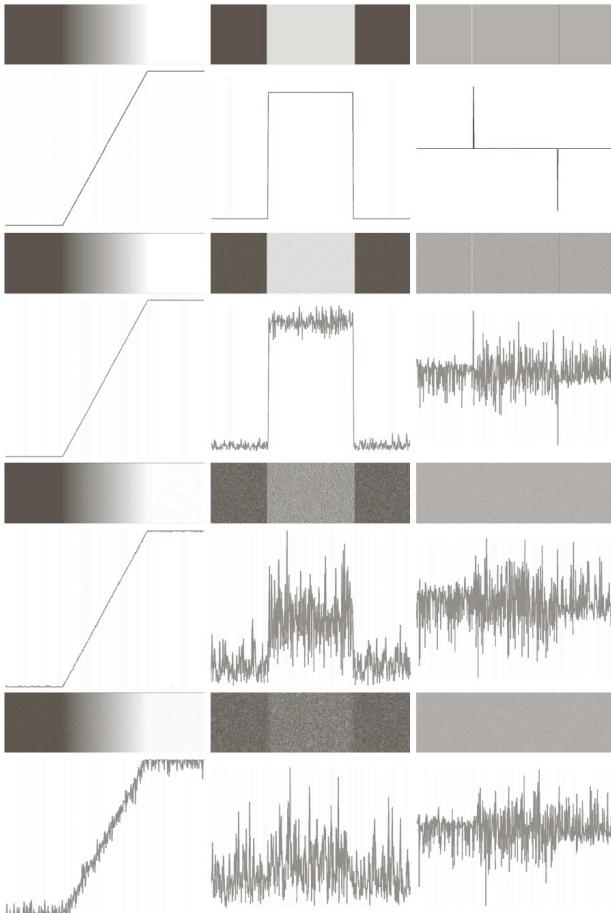


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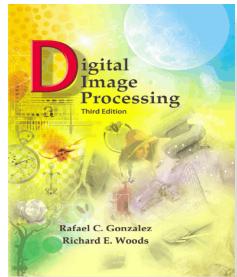
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Três passos fundamentais devem ser considerados:

- Suavização da imagem para redução de ruído;
- Detecção dos pontos de borda;
- Localização da borda;

FIGURE 10.11 First column: Images and intensity profiles of a ramp edge corrupted by random Gaussian noise of zero mean and standard deviations of 0.0, 0.1, 1.0, and 10.0 intensity levels, respectively. Second column: First-derivative images and intensity profiles. Third column: Second-derivative images and intensity profiles.



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

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

Prewitt

-1	-2	-1
0	0	0
1	2	1

-1	0	1
-2	0	2
-1	0	1

Sobel

a
b
c
d
e
f
g

FIGURE 10.14
A 3×3 region of an image (the z 's are intensity values) and various masks used to compute the gradient at the point labeled z_5 .

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

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

Prewitt

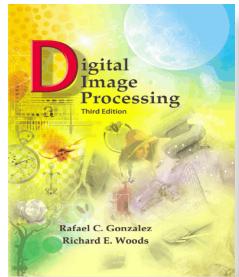
0	1	2
-1	0	1
-2	-1	0

-2	-1	0
-1	0	1
0	1	2

Sobel

a
b
c
d

FIGURE 10.15
Prewitt and Sobel masks for detecting diagonal edges.

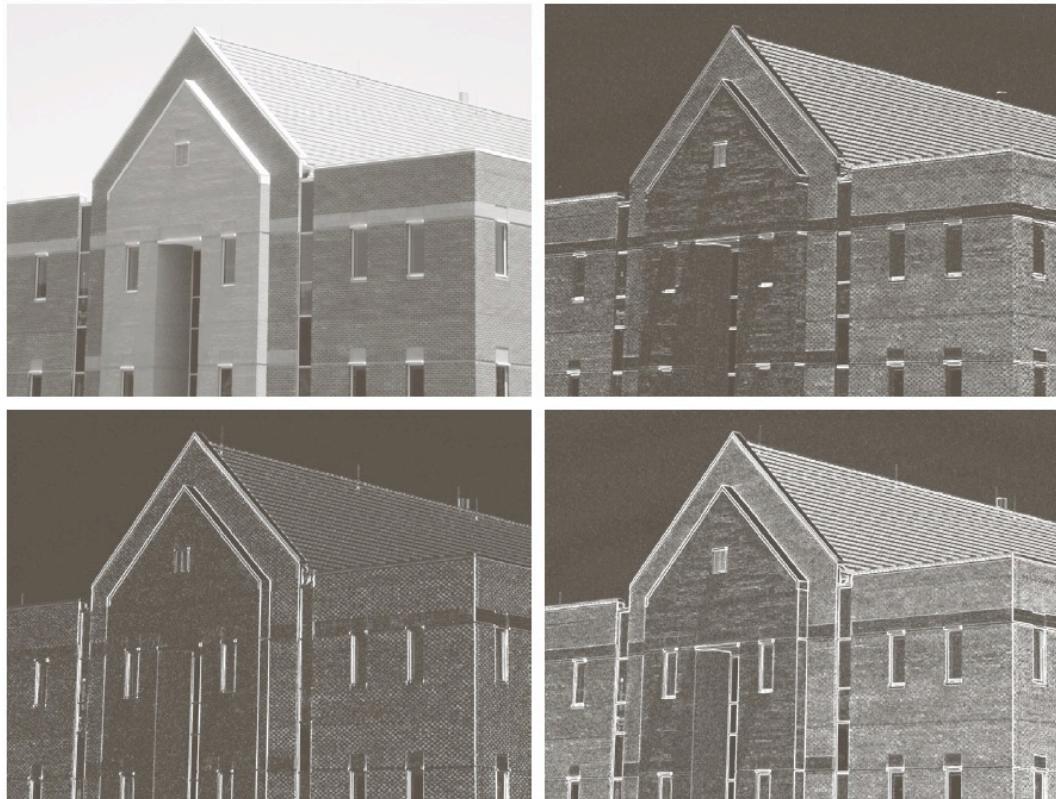


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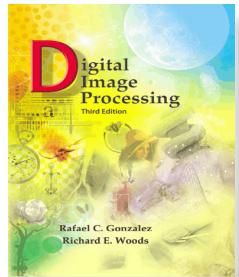
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a b
c d

FIGURE 10.16
(a) Original image of size 834×1114 pixels, with intensity values scaled to the range $[0, 1]$.
(b) $|g_x|$, the component of the gradient in the x -direction, obtained using the Sobel mask in Fig. 10.14(f) to filter the image.
(c) $|g_y|$, obtained using the mask in Fig. 10.14(g).
(d) The gradient image, $|g_x| + |g_y|$.

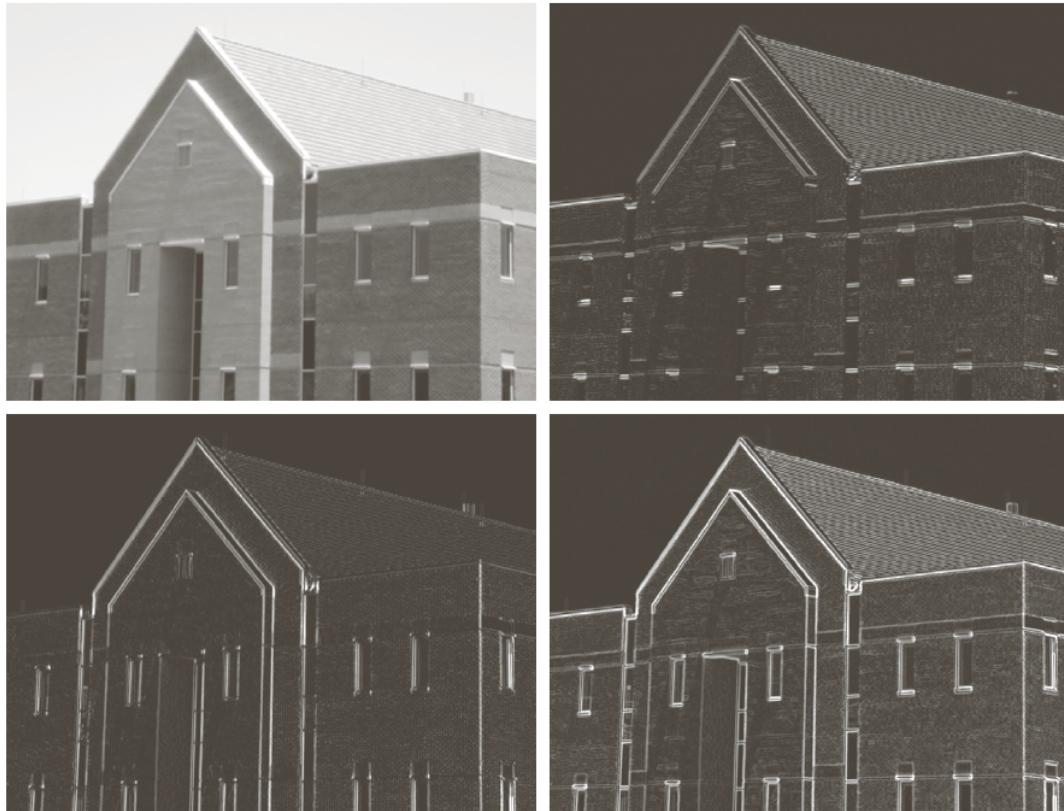


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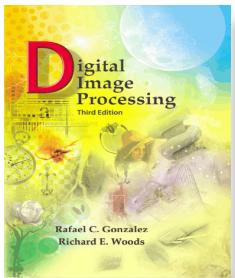
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a b
c d

FIGURE 10.18
Same sequence as
in Fig. 10.16, but
with the original
image smoothed
using a 5×5
averaging filter
prior to edge
detection.

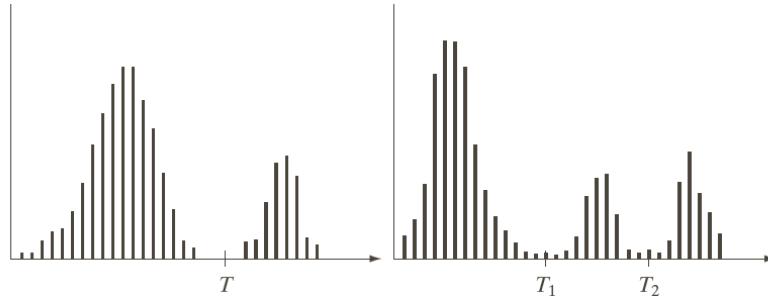


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Limiarização

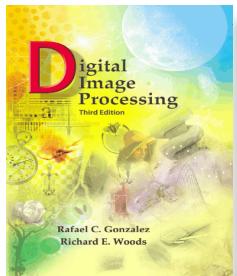
- Características:
 - propriedades intuitivas;
 - simplicidade de implementação;
 - desempenho computacional.
- As bases da limiarização de intensidade:
 - Suponha objetos claros em um fundo escuro. Uma maneira de separá-los, seria gerar uma imagem segmentada, baseada na análise do histograma da imagem original, onde:

$$g(x, y) = \begin{cases} 1 & \text{se } f(x, y) > T \\ 0 & \text{se } f(x, y) \leq T \end{cases}$$



a b

FIGURE 10.35
Intensity histograms that can be partitioned (a) by a single threshold, and (b) by dual thresholds.



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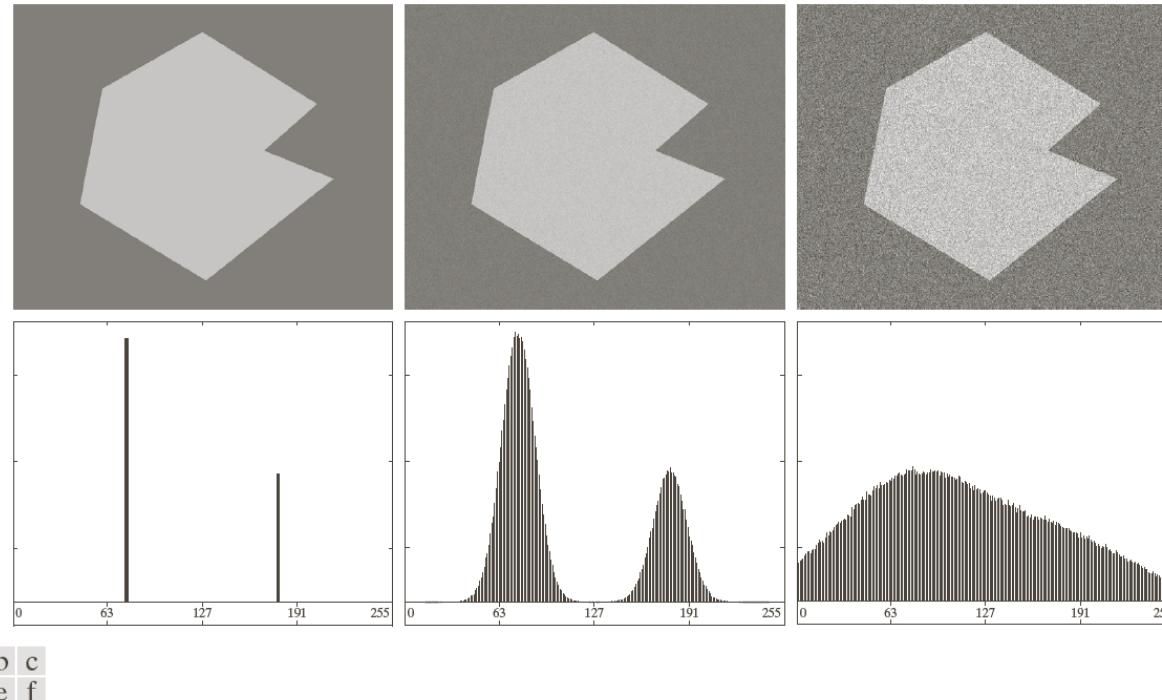
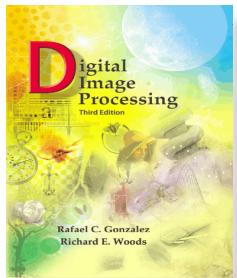


FIGURE 10.36 (a) Noiseless 8-bit image. (b) Image with additive Gaussian noise of mean 0 and standard deviation of 10 intensity levels. (c) Image with additive Gaussian noise of mean 0 and standard deviation of 50 intensity levels. (d)–(f) Corresponding histograms.



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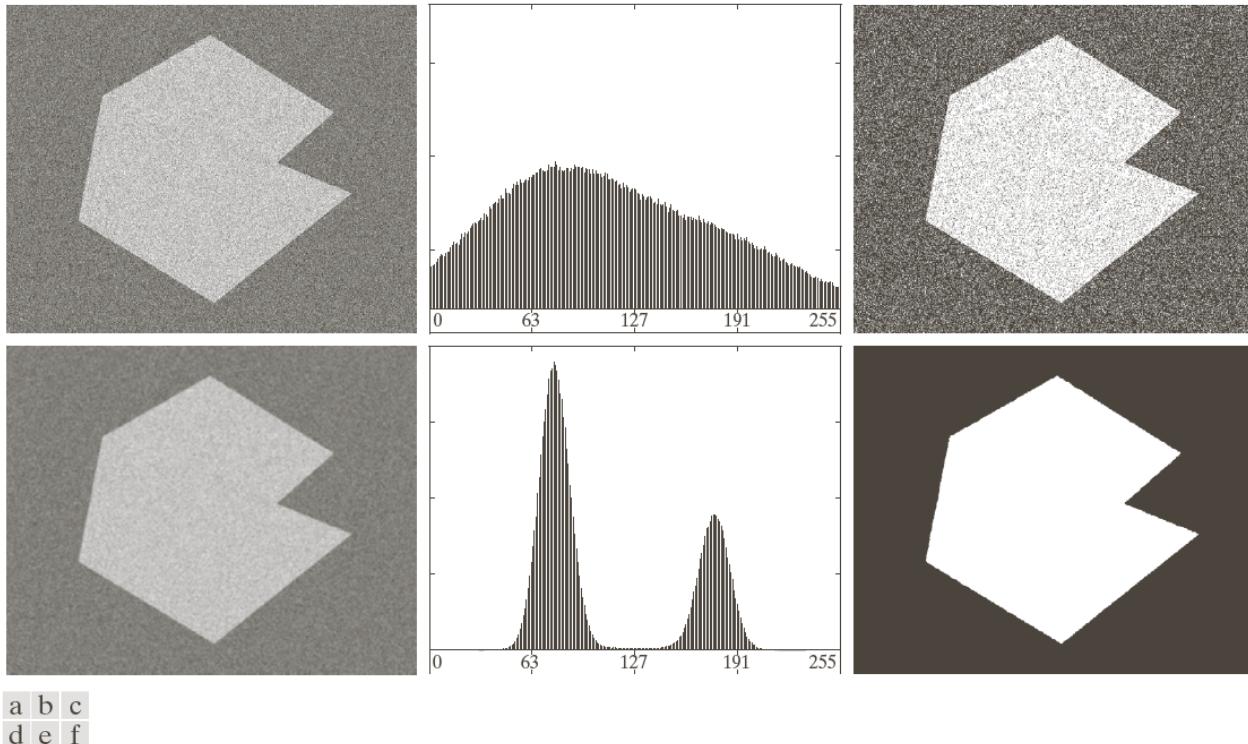
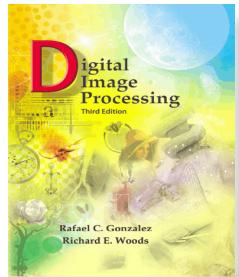


FIGURE 10.40 (a) Noisy image from Fig. 10.36 and (b) its histogram. (c) Result obtained using Otsu's method. (d) Noisy image smoothed using a 5×5 averaging mask and (e) its histogram. (f) Result of thresholding using Otsu's method.

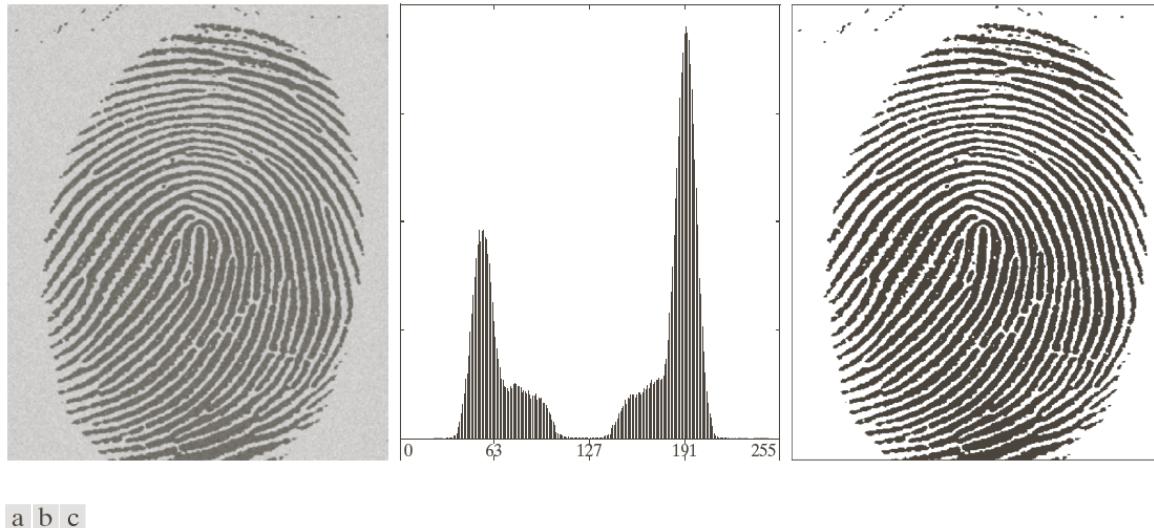


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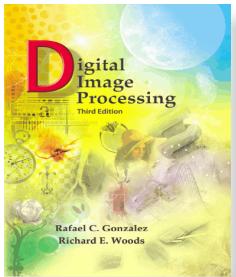
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a b c

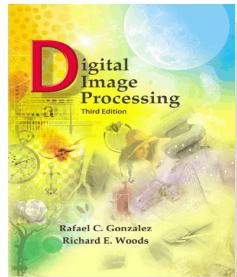
FIGURE 10.38 (a) Noisy fingerprint. (b) Histogram. (c) Segmented result using a global threshold (the border was added for clarity). (Original courtesy of the National Institute of Standards and Technology.)



Chapter 10
Segmentation

Método baseado em agrupamento: K-means

- Técnica de agrupamento de regiões;
- Conjunto de dados → classes disjuntas;
- *K-means*: particionar n objetos em K agrupamentos;
- Características:
 - possibilidade de trabalhar com grandes bases de dados;
 - baixo custo computacional
 - mudança de pertinência durante o processo;
 - **classe**: representada por um centro (ponto);
 - número de classes iniciais pode impor estrutura errônea;
 - Implementação disponível no *skimage*.

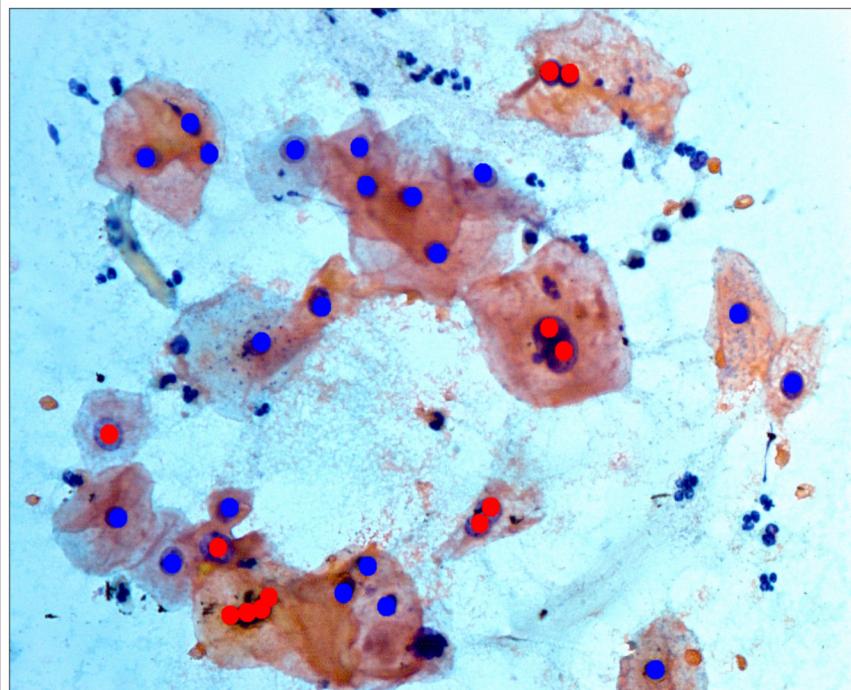


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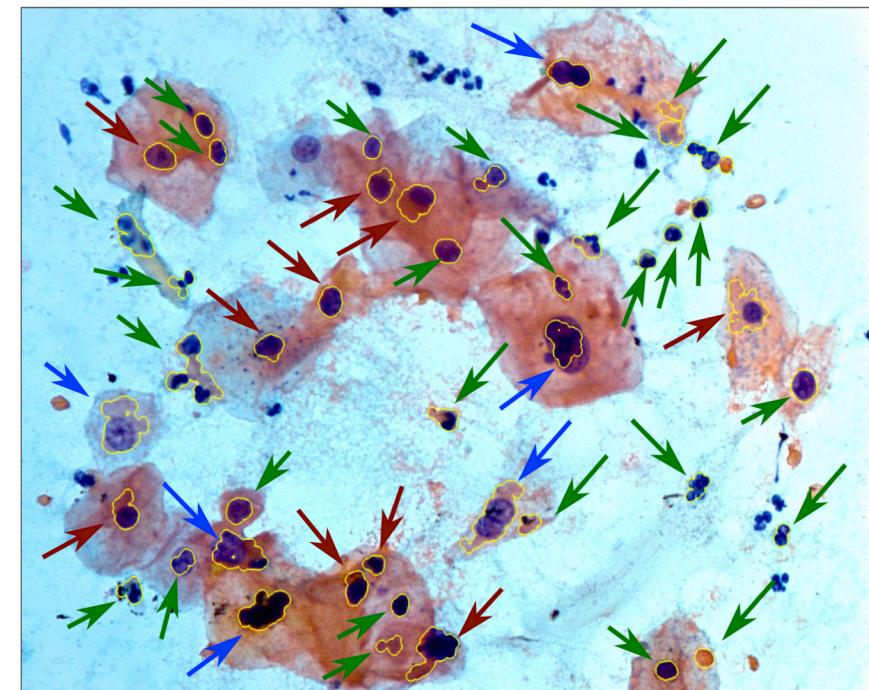
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Chapter 10 Segmentation



- Normal
- Anormal

(a)



- Regiões normais corretamente classificadas
- Regiões anormais corretamente classificadas
- Regiões normais incorretamente classificadas

(b)