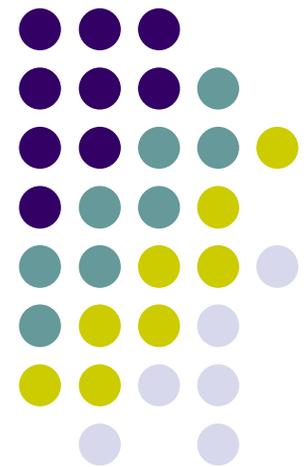


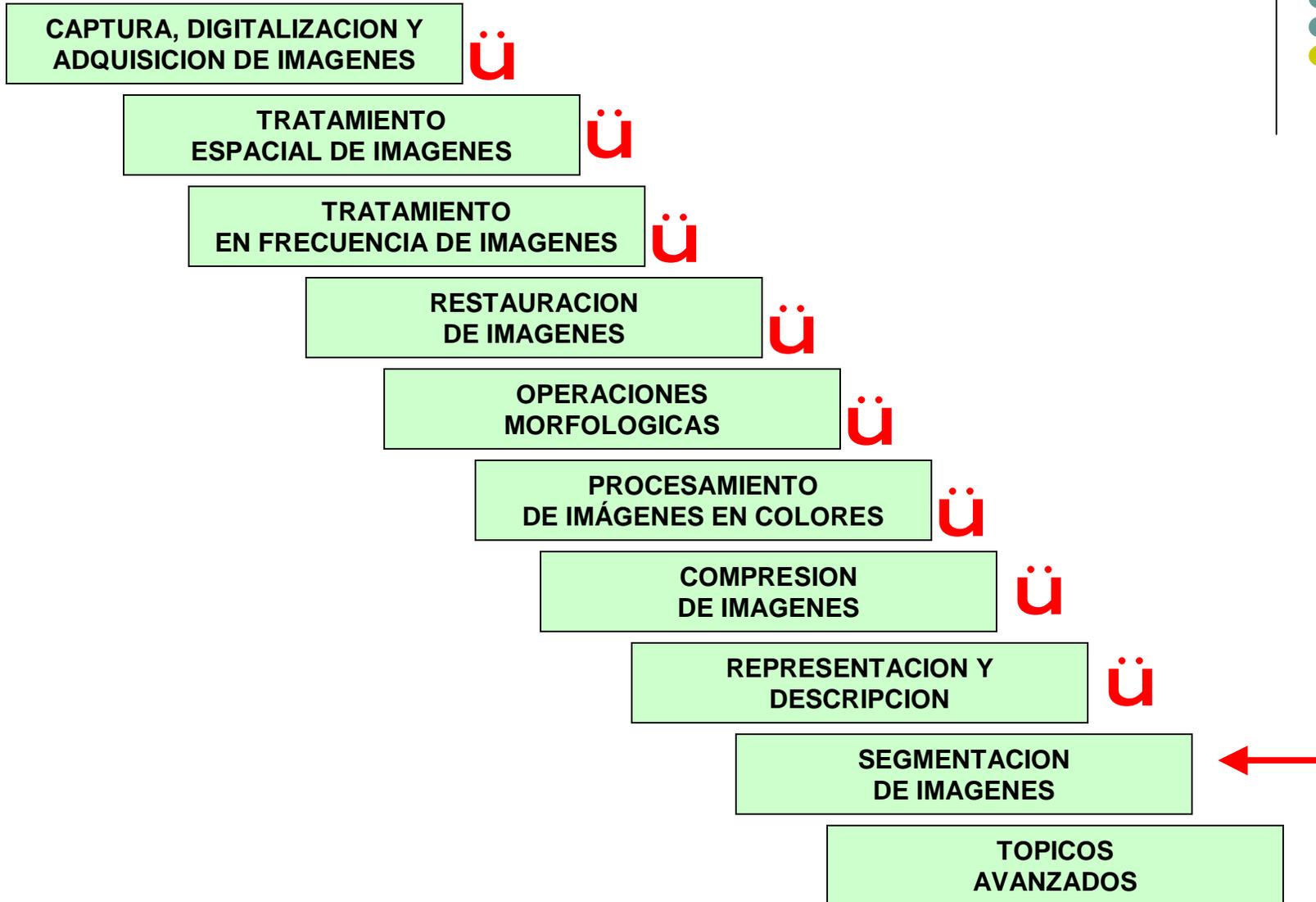
Procesamiento Digital de Imágenes

Pablo Roncagliolo B.

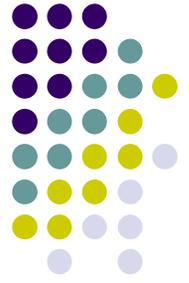
Nº 18



Orden de las clases...



Segmentación



La segmentación de una imagen permite separar o destacar zonas con características específicas de forma o de color.

El método más básico de segmentación es la aplicación de filtros.

FIGURE 10.1 A
general 3×3
mask.

w_1	w_2	w_3
w_4	w_5	w_6
w_7	w_8	w_9

Segmentación

Segmentación de “Puntos”: Una forma es aplicar el clásico filtro laplaciano

-1	-1	-1
-1	8	-1
-1	-1	-1

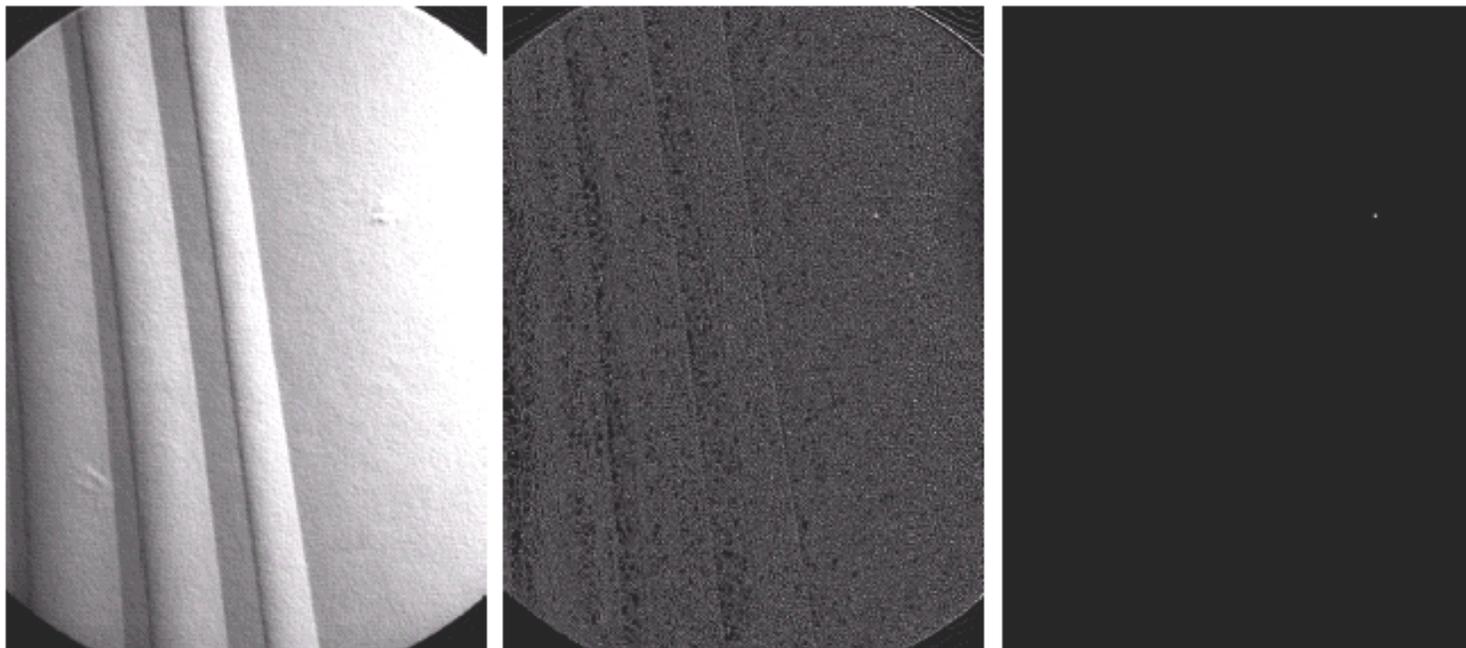


a

b c d

FIGURE 10.2

(a) Point detection mask.
(b) X-ray image of a turbine blade with a porosity.
(c) Result of point detection.
(d) Result of using Eq. (10.1-2).
(Original image courtesy of X-TEK Systems Ltd.)



Segmentación



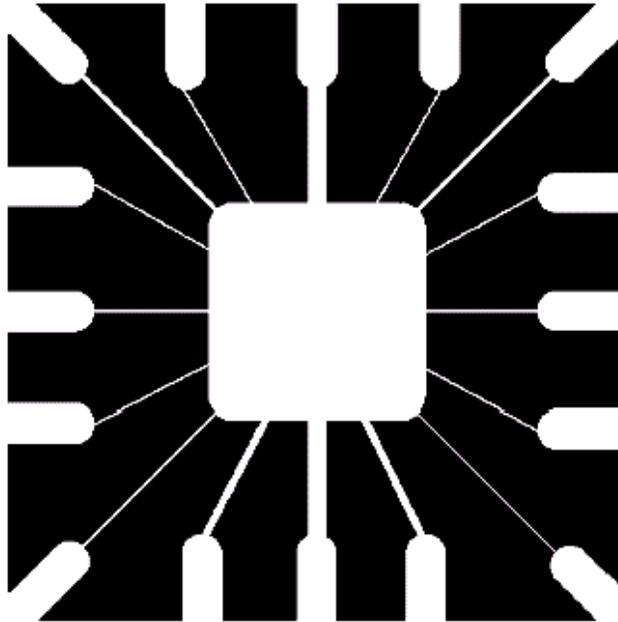
Segmentación de “Líneas”: Una forma es aplicar filtros de borde (en las 4 direcciones)

FIGURE 10.3 Line masks.

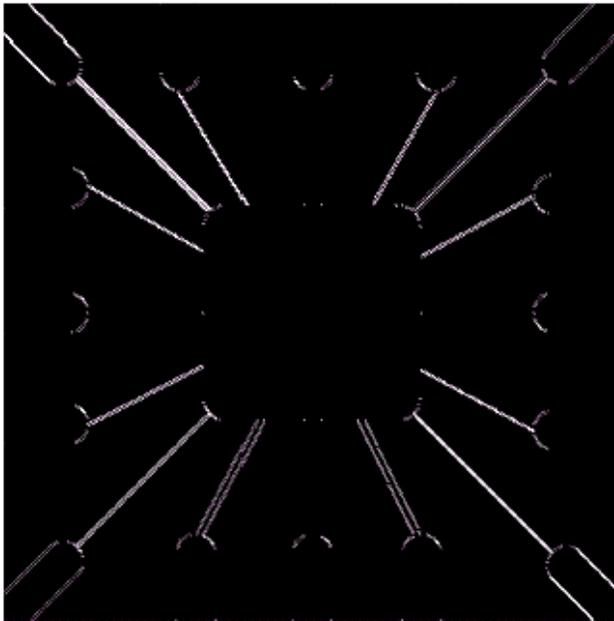
-1	-1	-1	-1	-1	2	-1	2	-1	2	-1	-1
2	2	2	-1	2	-1	-1	2	-1	-1	2	-1
-1	-1	-1	2	-1	-1	-1	2	-1	-1	-1	2
Horizontal			+45°			Vertical			-45°		

Segmentación

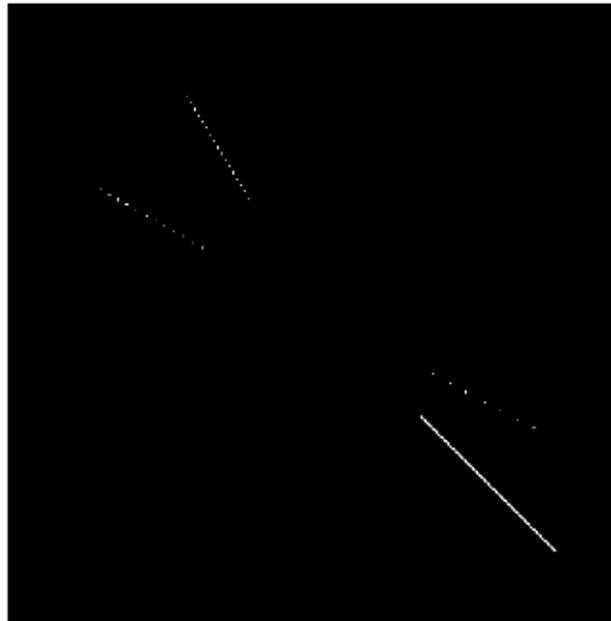
Original



4 Filtros...



Sólo filtro -45°



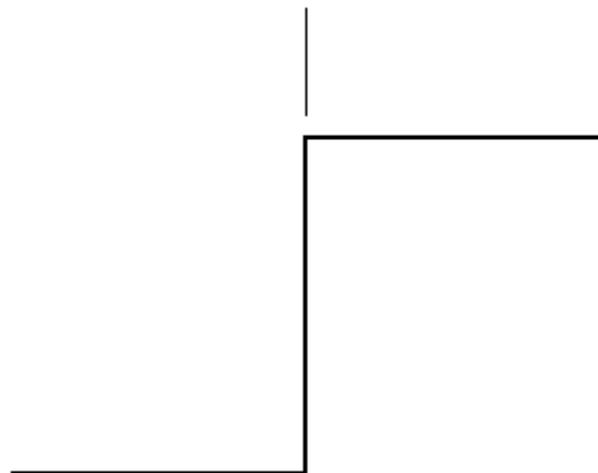
(a)
(b) c
FIGURE 10.4
Illustration of line
detection.
(a) Binary wire-
bond mask.
(b) Absolute
value of result
after processing
with -45° line
detector.
(c) Result of
thresholding
image (b).



Segmentación

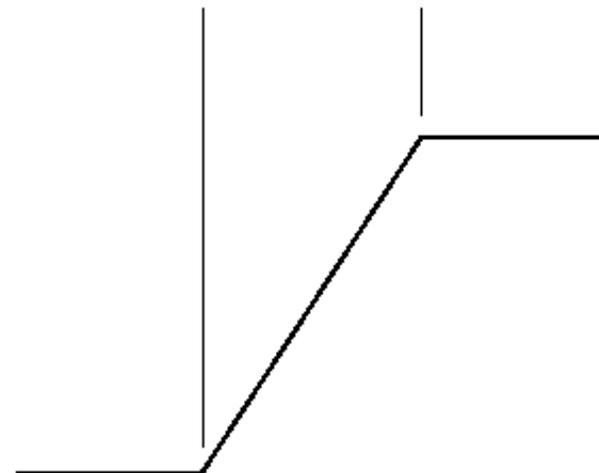
Detección de bordes ideales...

Model of an ideal digital edge



Gray-level profile of a horizontal line through the image

Model of a ramp digital edge



Gray-level profile of a horizontal line through the image



a b

FIGURE 10.5

(a) Model of an ideal digital edge.
(b) Model of a ramp edge. The slope of the ramp is proportional to the degree of blurring in the edge.

Segmentación

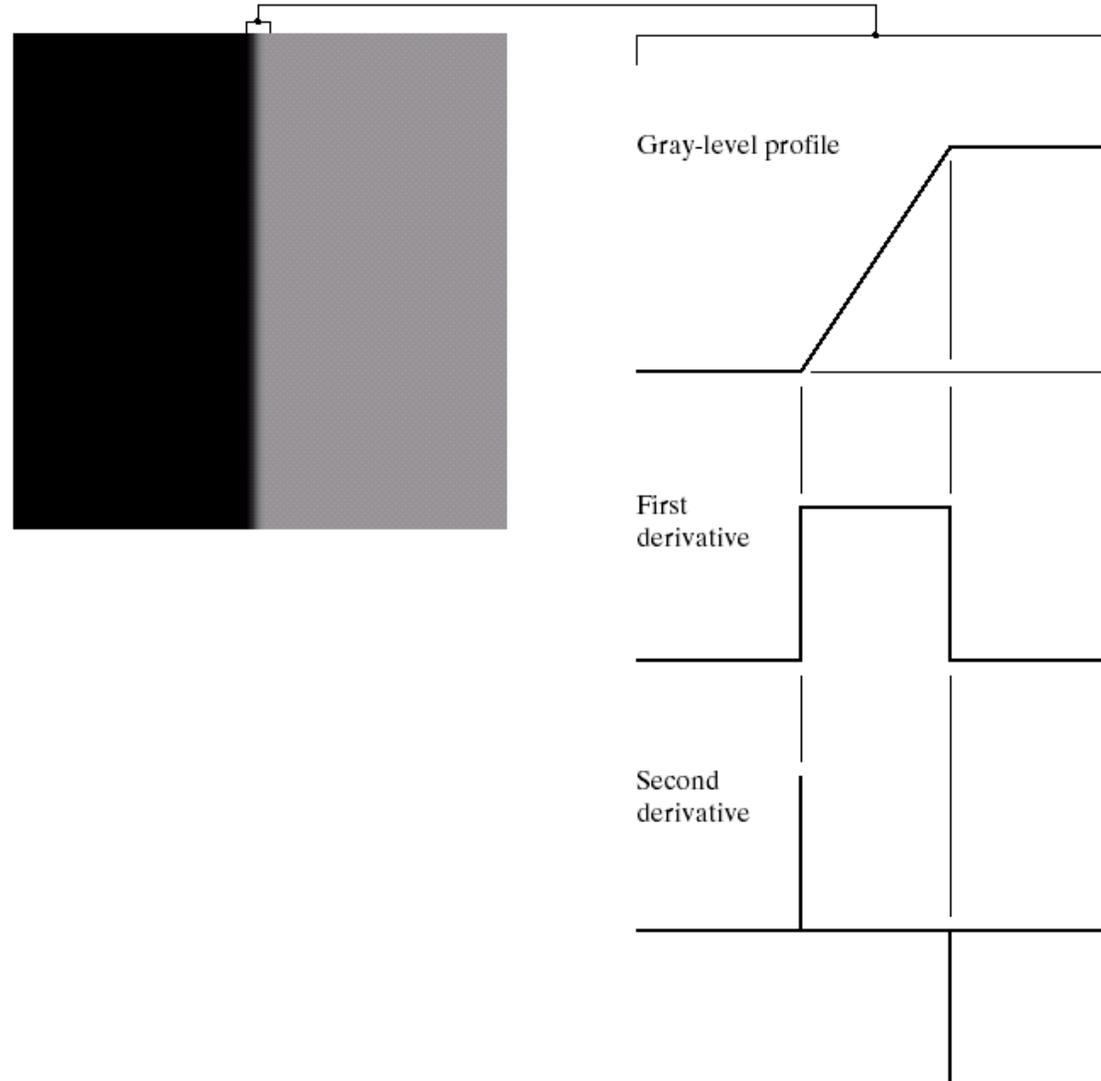
Detección de bordes ideales: 1ª y 2ª derivada



a b

FIGURE 10.6

(a) Two regions separated by a vertical edge.
(b) Detail near the edge, showing a gray-level profile, and the first and second derivatives of the profile.



Segmentación

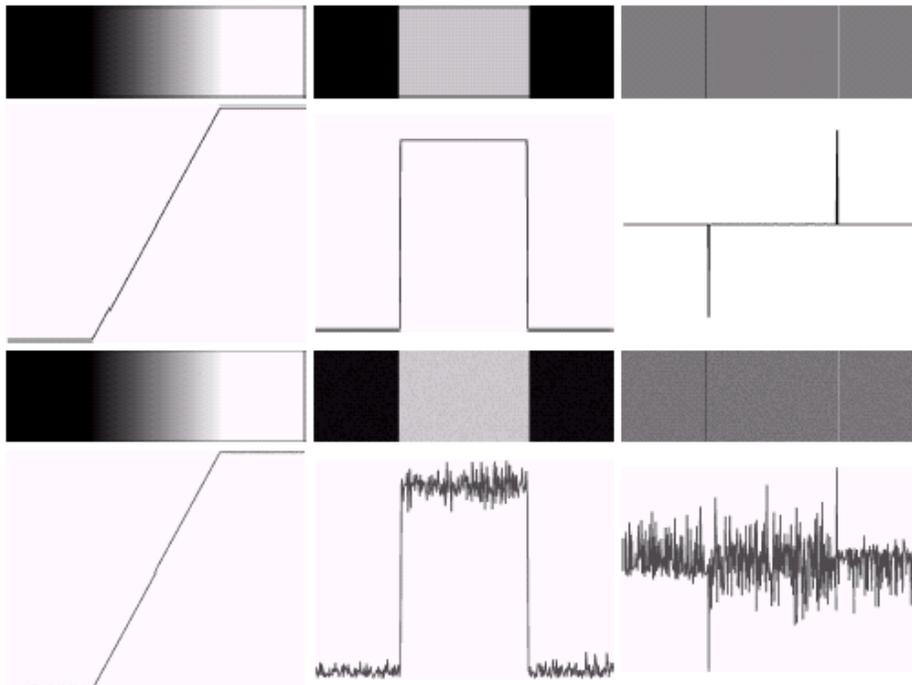
FIGURE 10.7 First column: images and gray-level profiles of a ramp edge corrupted by random Gaussian noise of mean 0 and $\sigma = 0.0, 0.1, 1.0,$ and $10.0,$ respectively. Second column: first-derivative images and gray-level profiles. Third column: second-derivative images and gray-level profiles.

a
b
c
d

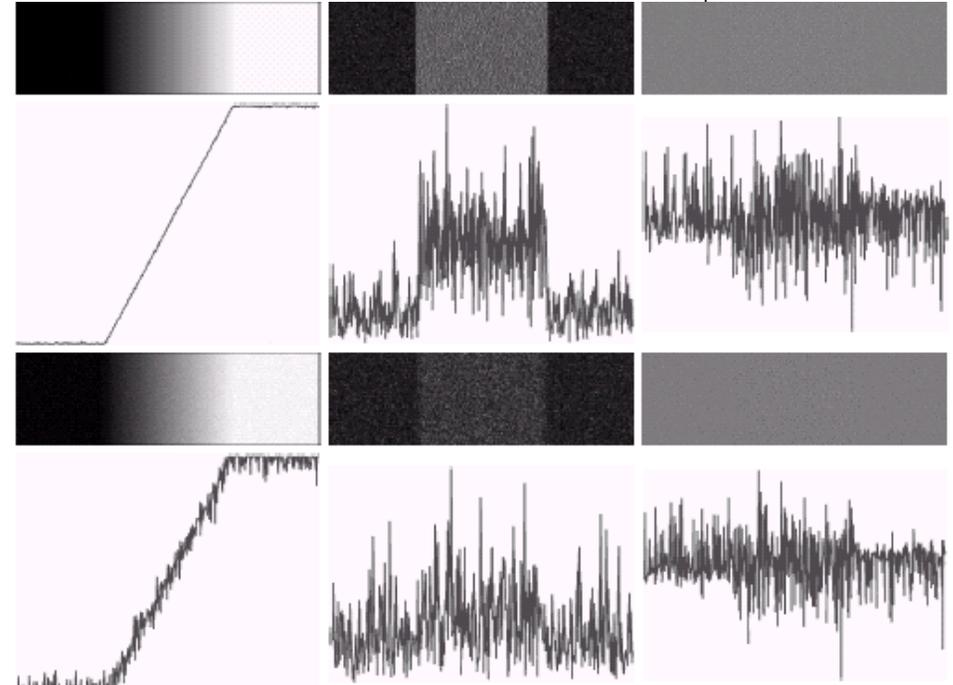


Detección de bordes “reales” ...

Ruido $s=0.0$



Ruido $s=1.0$



Ruido $s=0.1$

Ruido $s=10.0$

Una posible solución es filtrar con un “pasa bajos” ante de aplicar un “pasa altos”

Segmentación

Máscaras clásicas para detectar bordes...



a
b c
d e
f g

FIGURE 10.8

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

z_1	z_2	z_3
z_4	z_5	z_6
z_7	z_8	z_9

-1	0	0	-1
0	1	1	0

Roberts

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

Prewitt

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

Sobel

a b
c d

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

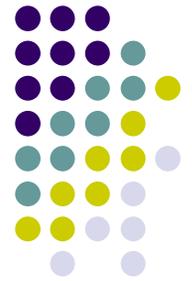
Prewitt

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

Sobel

FIGURE 10.9 Prewitt and Sobel masks for detecting diagonal edges.

Segmentación



Ejemplo: detección de Bordes sin aplicar “pasa bajos”

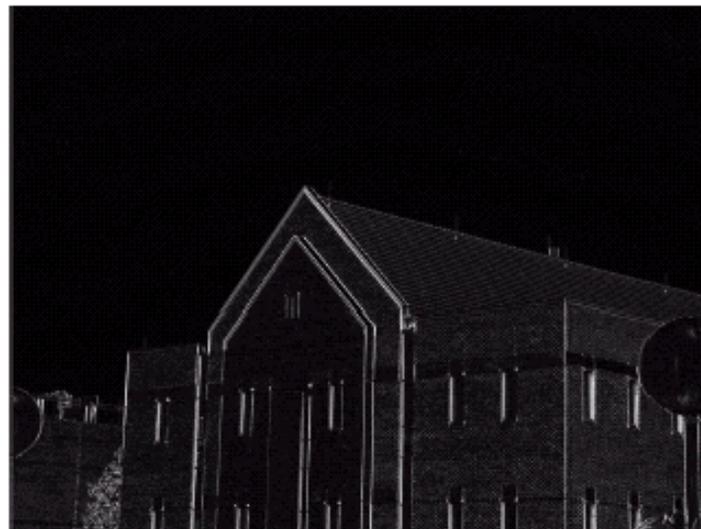
a b
c d

FIGURE 10.10

(a) Original image. (b) $|G_x|$, component of the gradient in the x -direction.

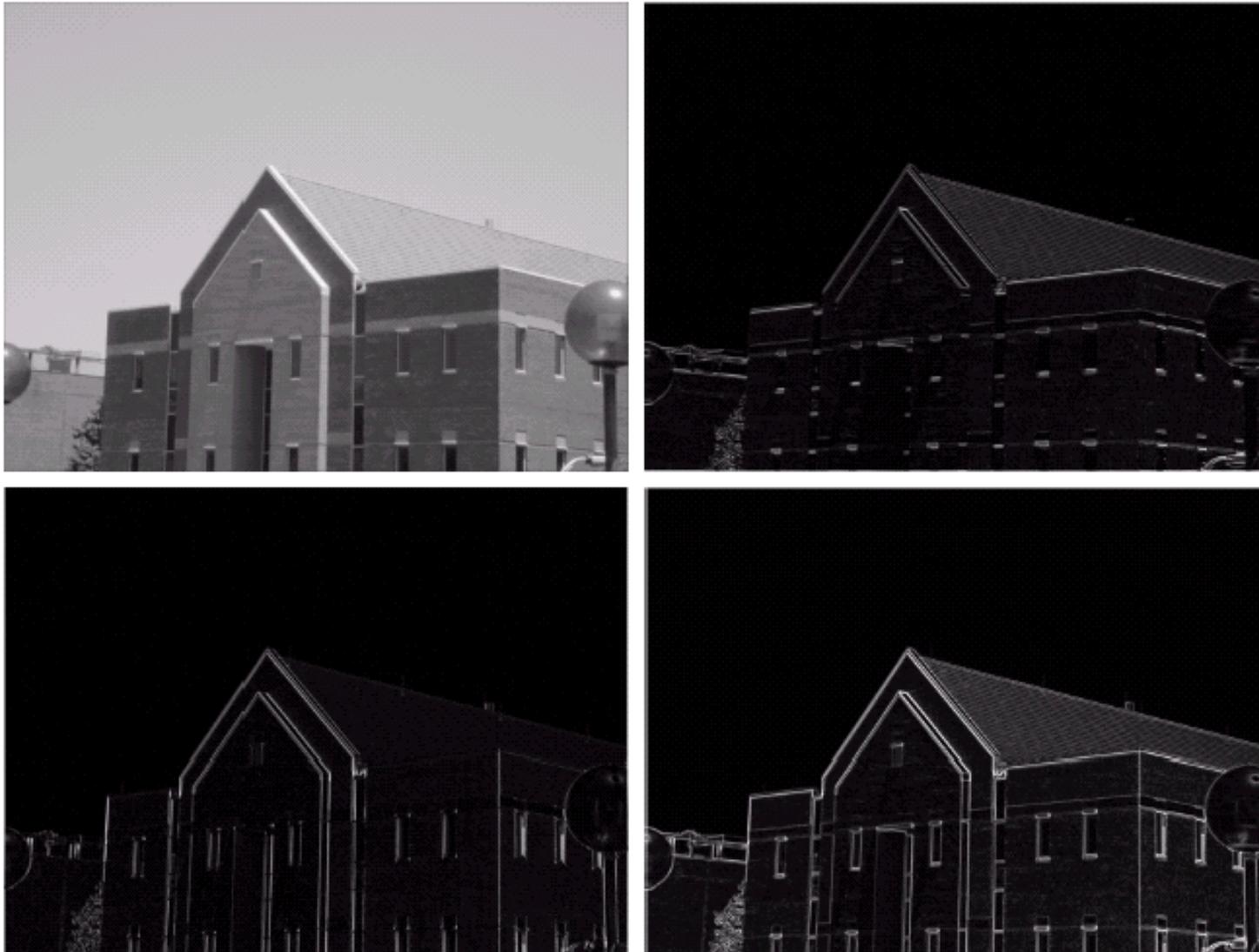
(c) $|G_y|$, component in the y -direction.

(d) Gradient image, $|G_x| + |G_y|$.



Segmentación

Ejemplo: detección de Bordes DESPUES DE aplicar “pasa bajos”



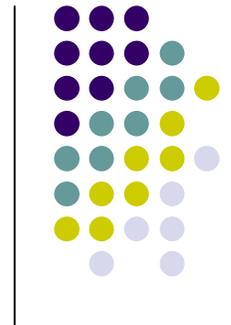
a	b
c	d

FIGURE 10.11
Same sequence as in Fig. 10.10, but with the original image smoothed with a 5×5 averaging filter.

Segmentación

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

Sobel



a b

FIGURE 10.12
Diagonal edge detection.
(a) Result of using the mask in Fig. 10.9(c).
(b) Result of using the mask in Fig. 10.9(d). The input in both cases was Fig. 10.11(a).

Para no aplicar 4 filtros se pueden aplicar sólo los filtros diagonales è 2 convoluciones en vez de 4

Segmentación

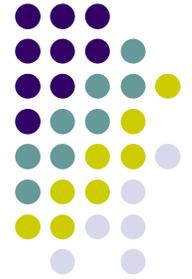
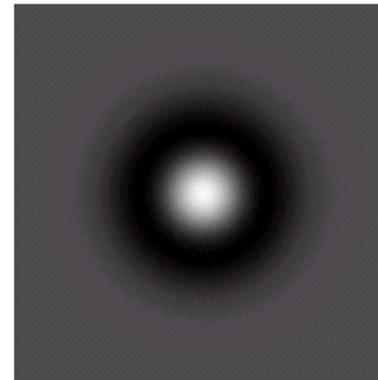
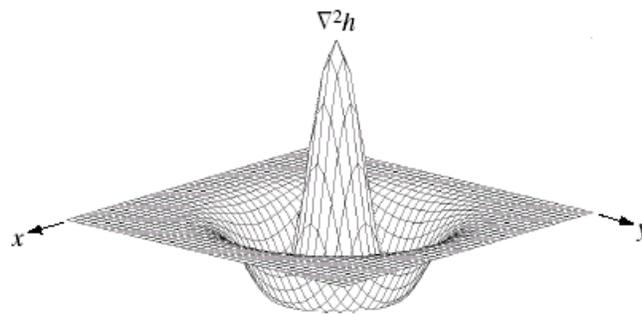


FIGURE 10.13
Laplacian masks
used to
implement
Eqs. (10.1-14) and
(10.1-15),
respectively.

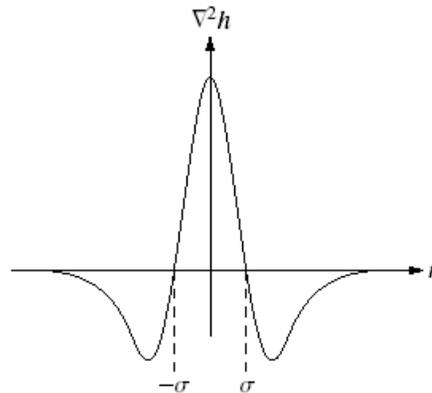
0	-1	0	-1	-1	-1
-1	4	-1	-1	8	-1
0	-1	0	-1	-1	-1

Segmentación



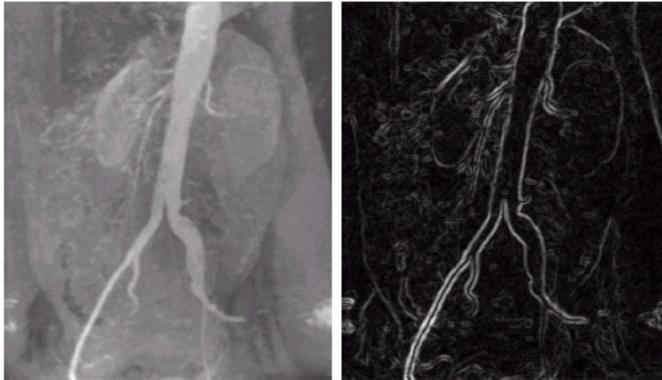
a b
c d

FIGURE 10.14
Laplacian of a Gaussian (LoG).
(a) 3-D plot.
(b) Image (black is negative, gray is the zero plane, and white is positive).
(c) Cross section showing zero crossings.
(d) 5×5 mask approximation to the shape of (a).



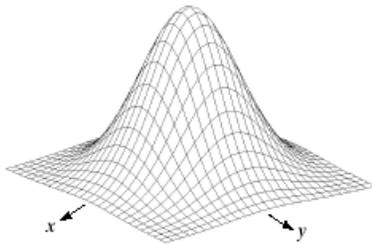
0	0	-1	0	0
0	-1	-2	-1	0
-1	-2	16	-2	-1
0	-1	-2	-1	0
0	0	-1	0	0

Segmentación



a b
c d
e f g

FIGURE 10.15 (a) Original image. (b) Sobel gradient (shown for comparison). (c) Spatial Gaussian smoothing function. (d) Laplacian mask. (e) LoG. (f) Thresholded LoG. (g) Zero crossings. (Original image courtesy of Dr. David R. Pickens, Department of Radiology and Radiological Sciences, Vanderbilt University Medical Center.)



-1	-1	-1
-1	8	-1
-1	-1	-1



Wood

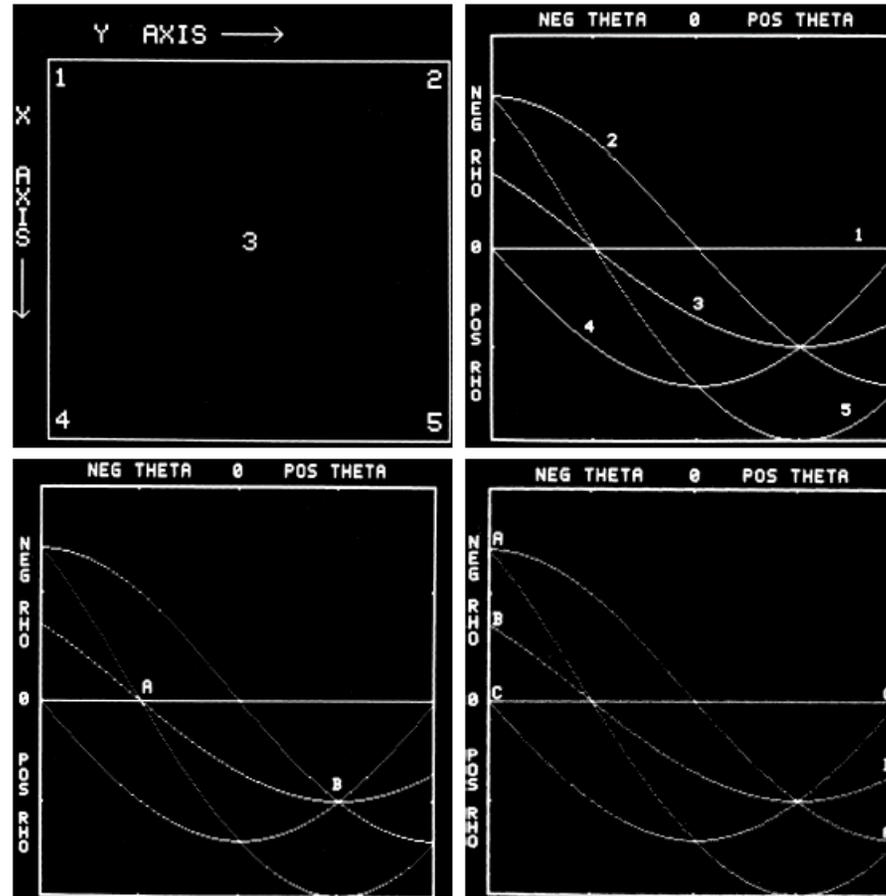
Segmentación

Transformada Hough



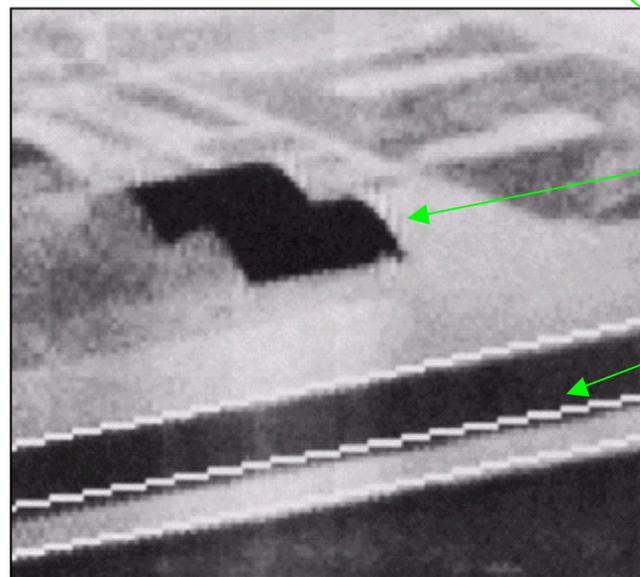
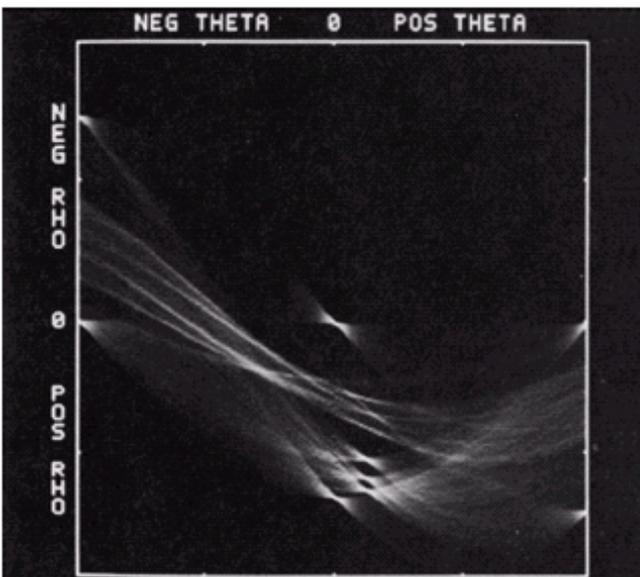
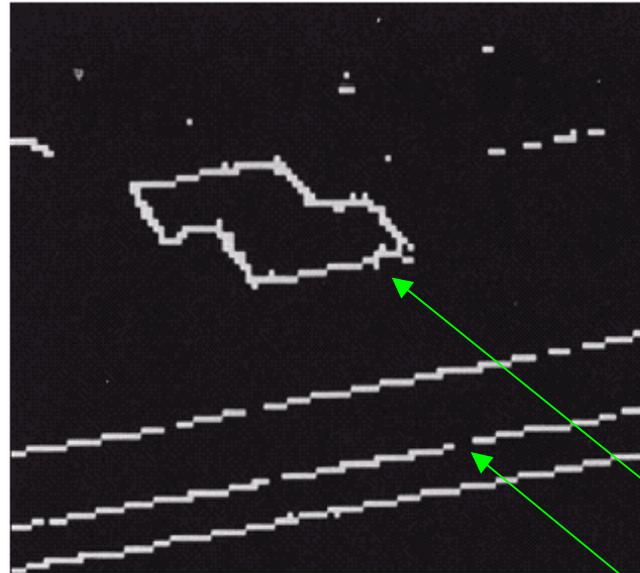
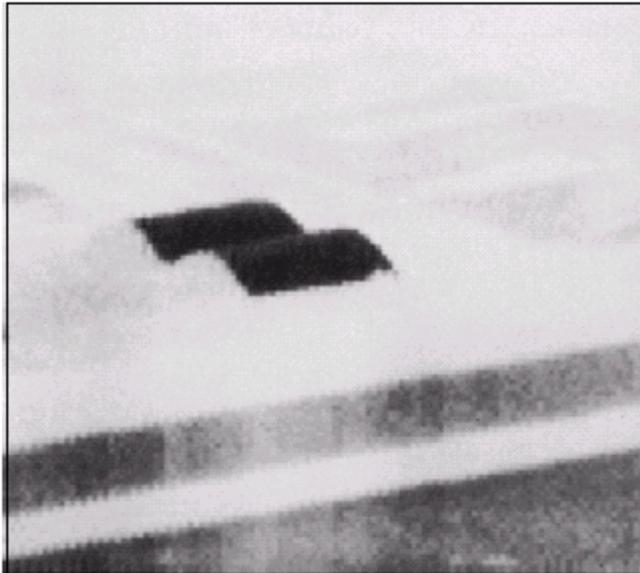
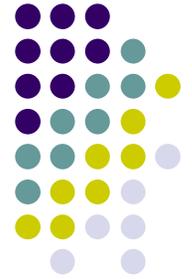
a b
c d

FIGURE 10.20
Illustration of the
Hough transform.
(Courtesy of Mr.
D. R. Cate, Texas
Instruments, Inc.)



Segmentación

Detección de bordes v/s Transformada Hough



a	b
c	d

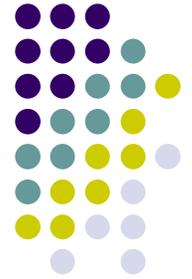
FIGURE 10.21

(a) Infrared image.
(b) Thresholded gradient image.
(c) Hough transform.
(d) Linked pixels.
(Courtesy of Mr. D. R. Cate, Texas Instruments, Inc.)

Detección sólo de líneas principales.

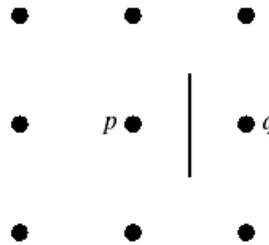
Se obtienen líneas continuas

Segmentación



Detección de bordes continuos utilizando técnicas de teoría de grafos.

FIGURE 10.22
Edge element
between pixels p
and q .

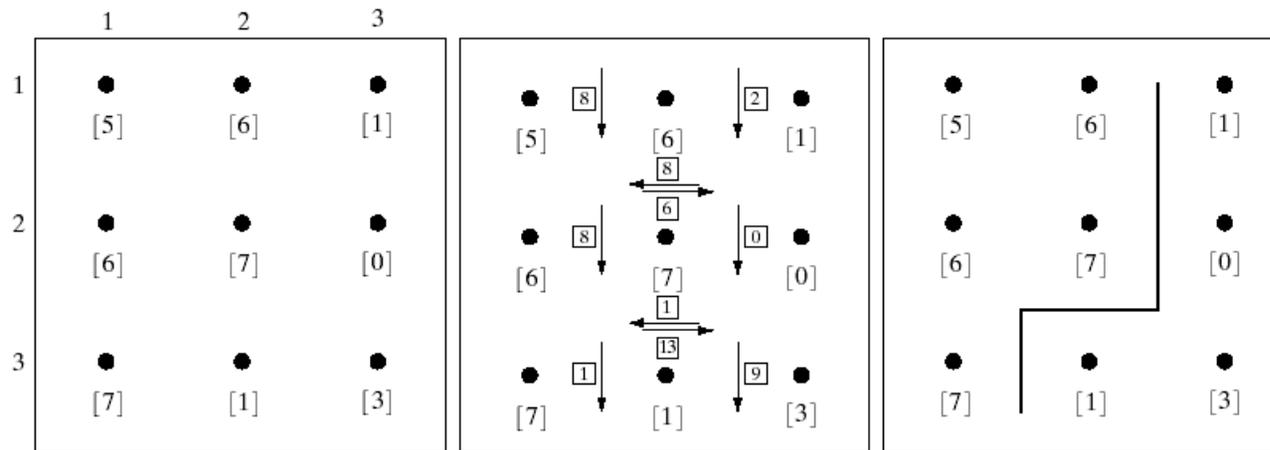


Se define el segmento que pasa entre p y q con un “costo” asociado:

$$C(p,q)=\text{GlobalMAX}-[\text{Gray}(p)-\text{Gray}(q)]$$

Es decir, el máximo nivel de gris de la imagen menos la diferencia de niveles de gris de los puntos p y q .

Segmentación



a b c

FIGURE 10.23 (a) A 3×3 image region. (b) Edge segments and their costs. (c) Edge corresponding to the lowest-cost path in the graph shown in Fig. 10.24.

Ej:

GlobalMAX=7

$C(p,q) = \text{GlobalMAX} - [\text{Gray}(p) - \text{Gray}(q)]$

$p=(1,1), q=(2,1) \Rightarrow C(p,q) = 7 - [5 - 6] = 8$

Por convención "p" es el punto a la "mano derecha" respecto de la dirección de la ruta.

Segmentación

El problema consiste en encontrar el “camino” de menor costo.

Importante: No es lo mismo que elegir siempre el segmento de menor costo.

Es un problema computacionalmente complejo dada la gran cantidad de caminos posibles

Se puede reducir buscando los caminos más cortos por tramos.

Por ejemplo caminos de 5 saltos.

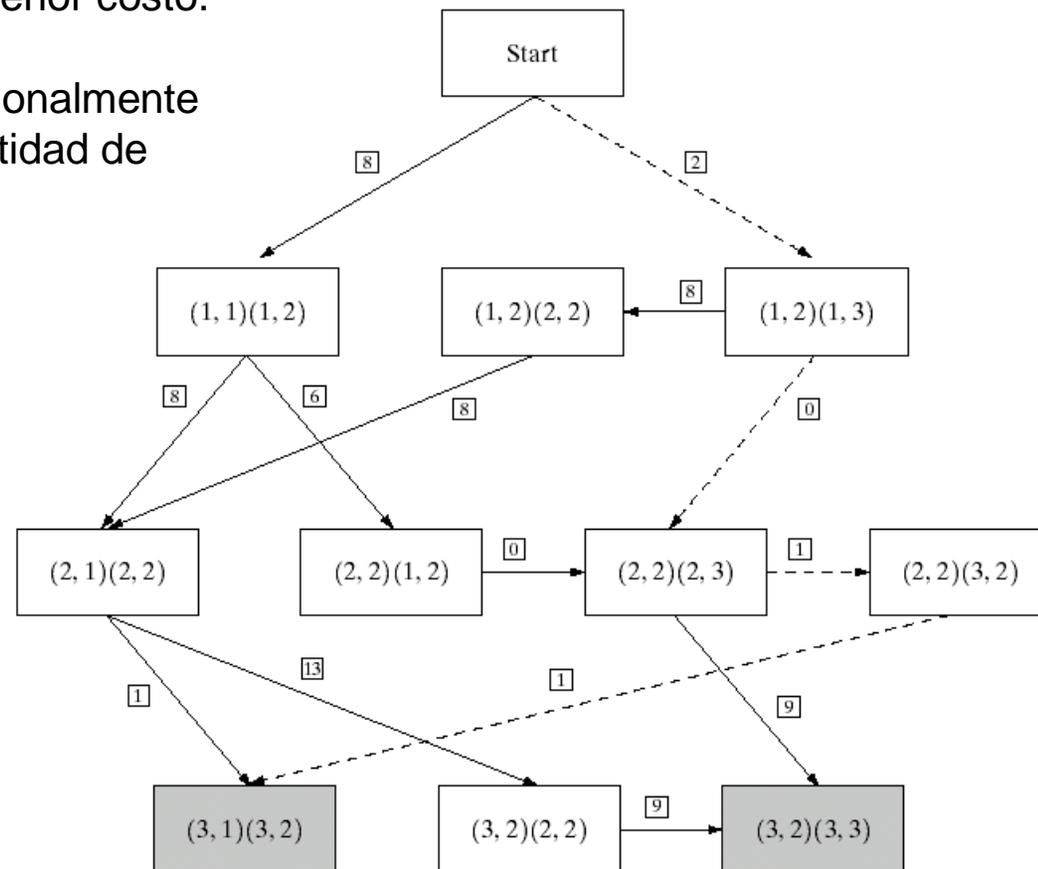
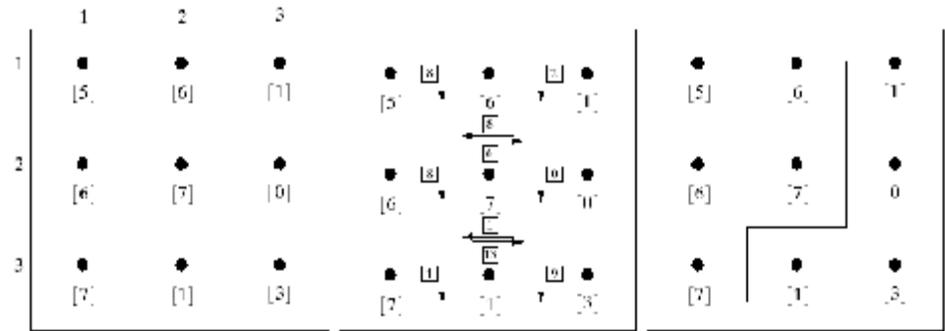


FIGURE 10.24
Graph for the image in Fig. 10.23(a). The lowest-cost path is shown dashed.

Segmentación

Borde de un cromosoma detectado utilizando algoritmo el algoritmo anterior.

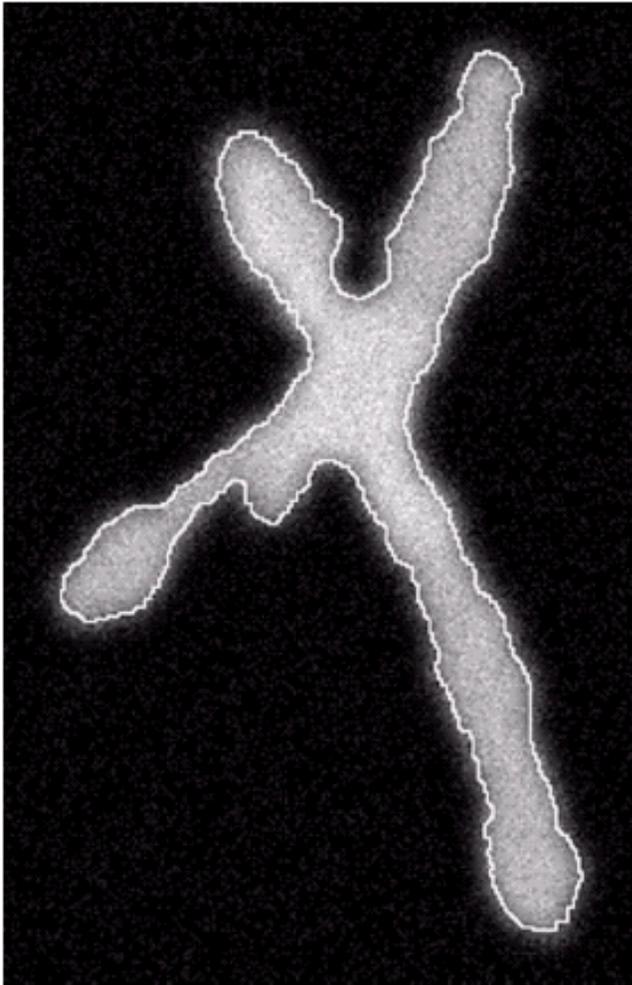
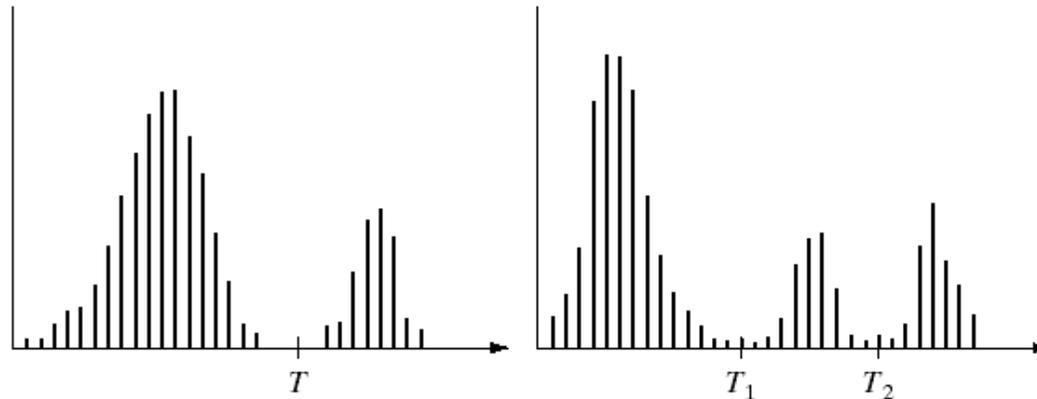
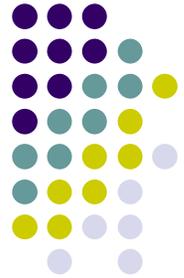


FIGURE 10.25
Image of noisy
chromosome
silhouette and
edge boundary
(in white)
determined by
graph search.



Segmentación

Umbrales Globales versus Umbrales Locales



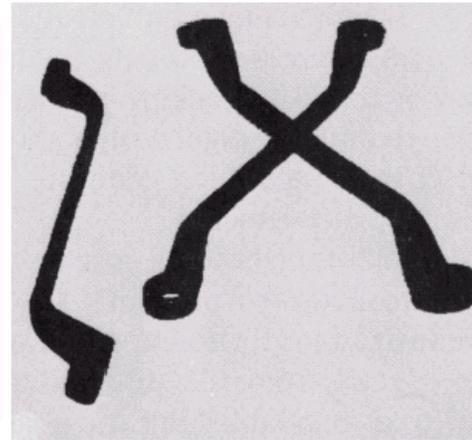
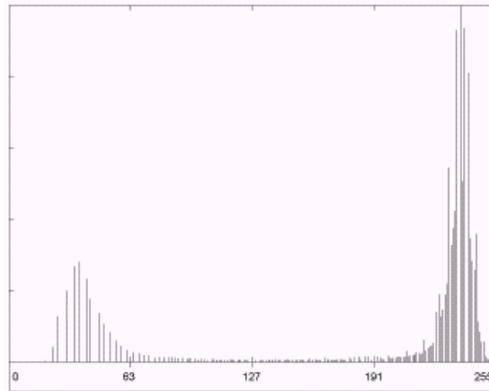
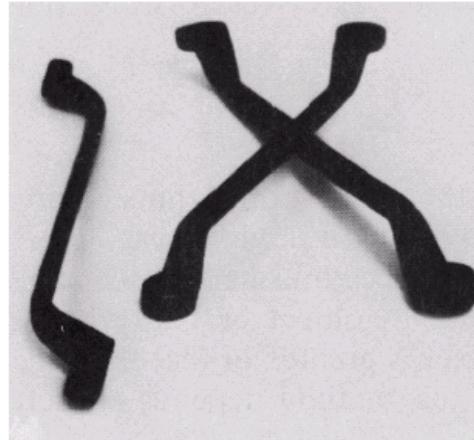
a b

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

Sólo funciona bien en imágenes con “iluminación” homogénea.

Segmentación

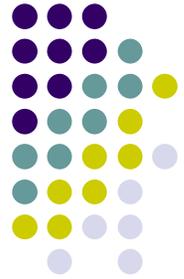
Ej. Umbral Global Básico: promedio entre máx. gris y min. gris. (o sea 127)



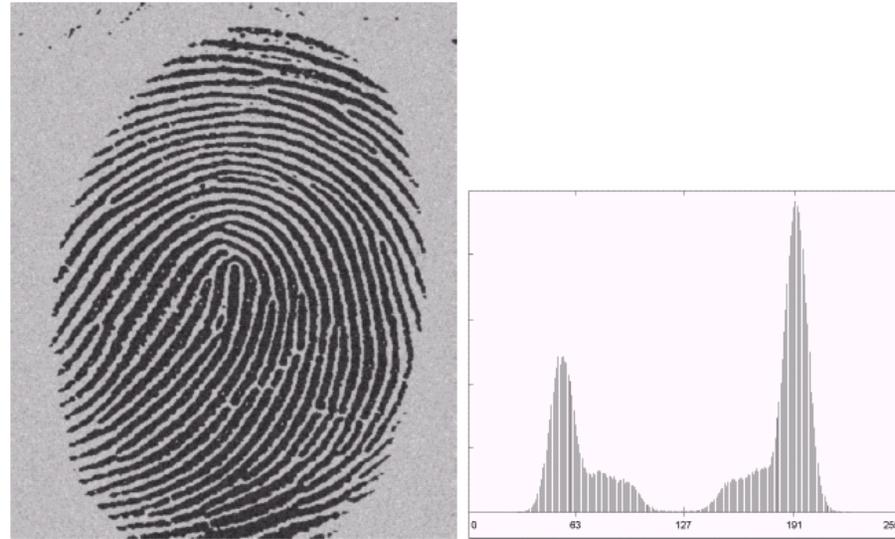
a
b c

FIGURE 10.28

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



Segmentación



a b
c
FIGURE 10.29
(a) Original image. (b) Image histogram. (c) Result of segmentation with the threshold estimated by iteration. (Original courtesy of the National Institute of Standards and Technology.)

Ej. Umbral Global Automático:

- 1.- Se estima un umbral T
- 2.- Se calcula el promedio p_1 de los píxeles $< T$ y el promedio p_2 de los píxeles $> T$
- 3.- Se actualiza $T = (p_1 + p_2) / 2$;
- 4.- Se repite 2 y 3 hasta ΔT sea menor que un parámetro E_0



Segmentación

Cuando la “iluminación” no es homogénea, no es posible definir claramente el umbral.

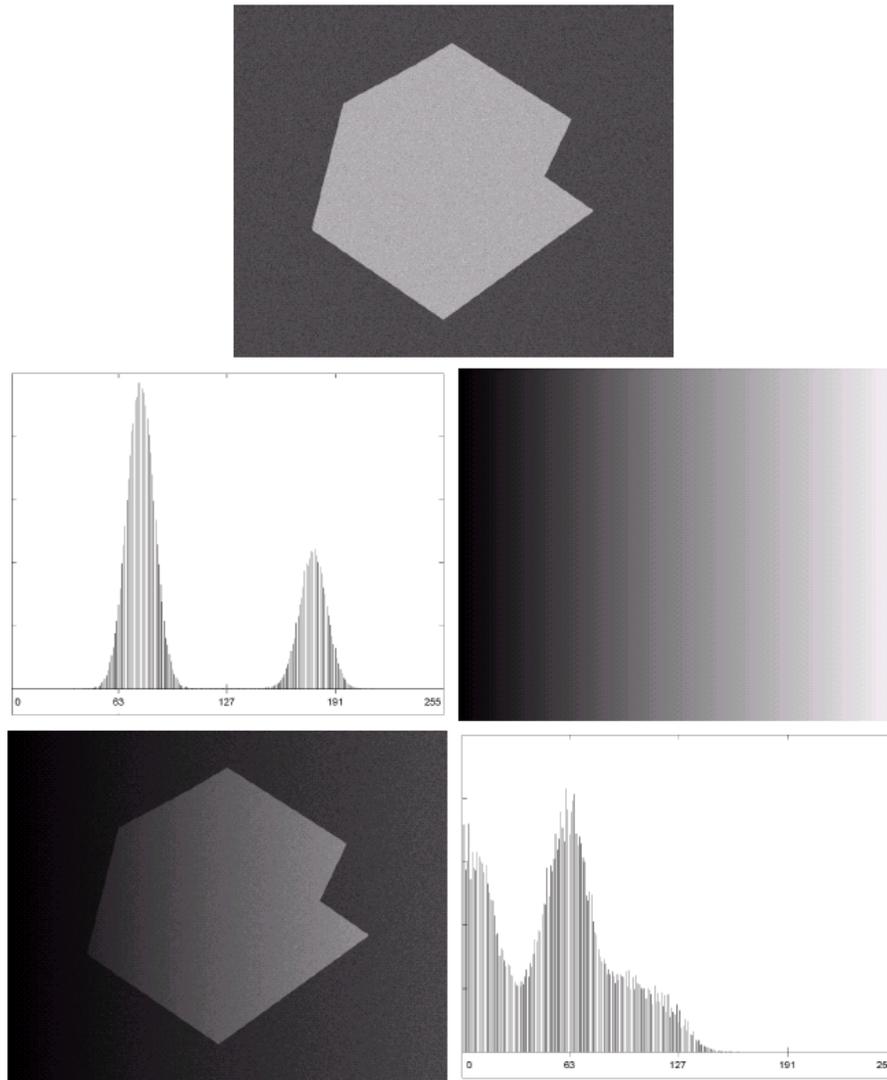


FIGURE 10.27
(a) Computer generated reflectance function.
(b) Histogram of reflectance function.
(c) Computer generated illumination function.
(d) Product of (a) and (c).
(e) Histogram of product image.



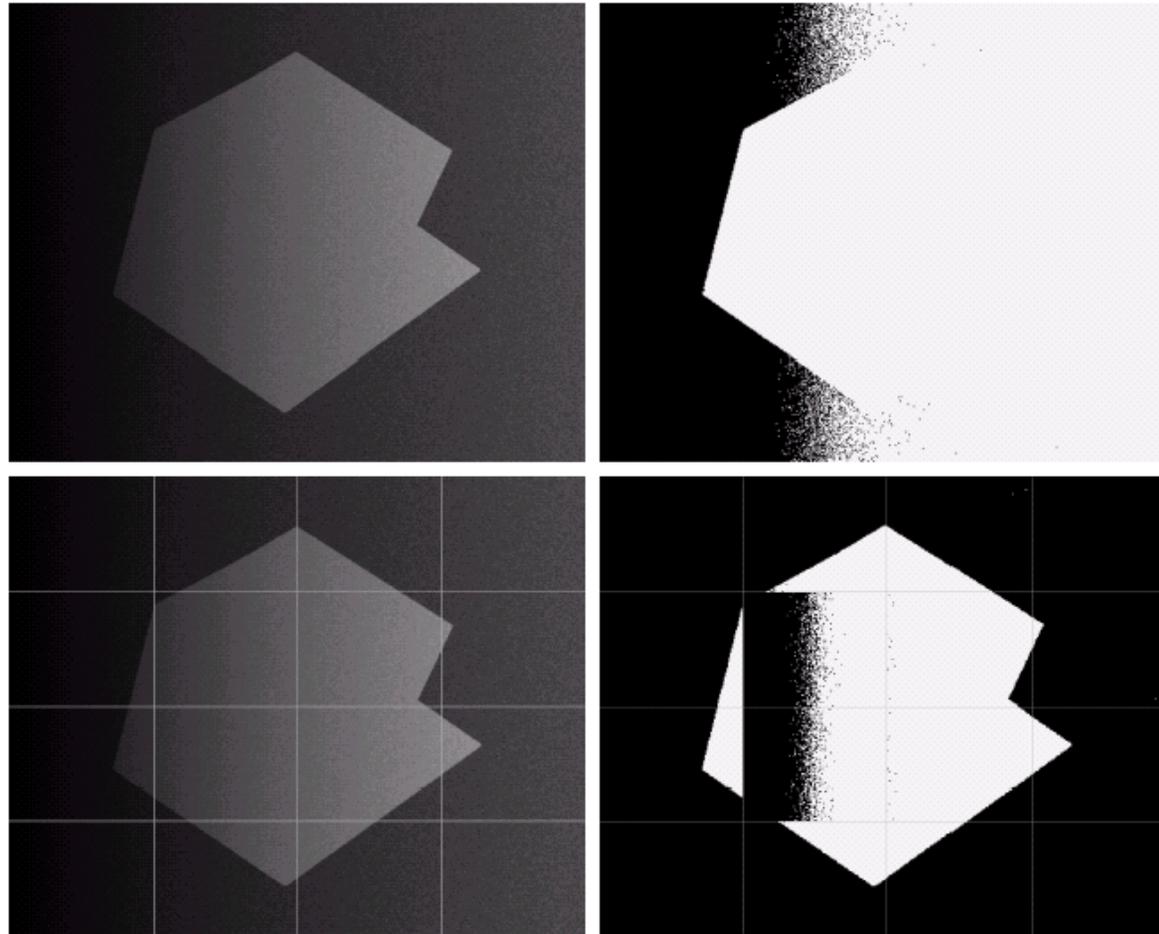
Segmentación



Solución umbrales locales (adaptivos) \Rightarrow cuidado con tamaño de las subimágenes

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.



Segmentación



a	b
c	d
e	f

FIGURE 10.31 (a) Properly and improperly segmented subimages from Fig. 10.30. (b)–(c) Corresponding histograms. (d) Further subdivision of the improperly segmented subimage. (e) Histogram of small subimage at top, left. (f) Result of adaptively segmenting (d).

