

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ



بینایی کامپیوتری

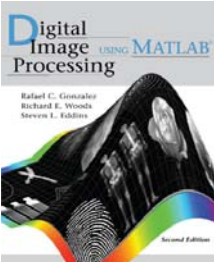
درس ۷ ب

پردازش تصویر رنگی در متلب

Color Image Processing in MATLAB®

کاظم فولادی
دانشکده مهندسی، پردیس فارابی
دانشگاه تهران

<http://courses.fouladi.ir/vision>



Chapter 7

Color Image Processing

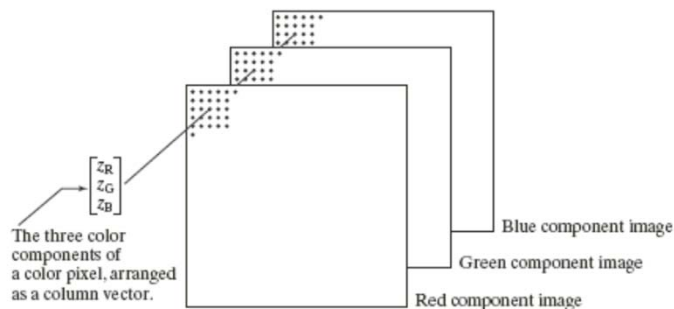


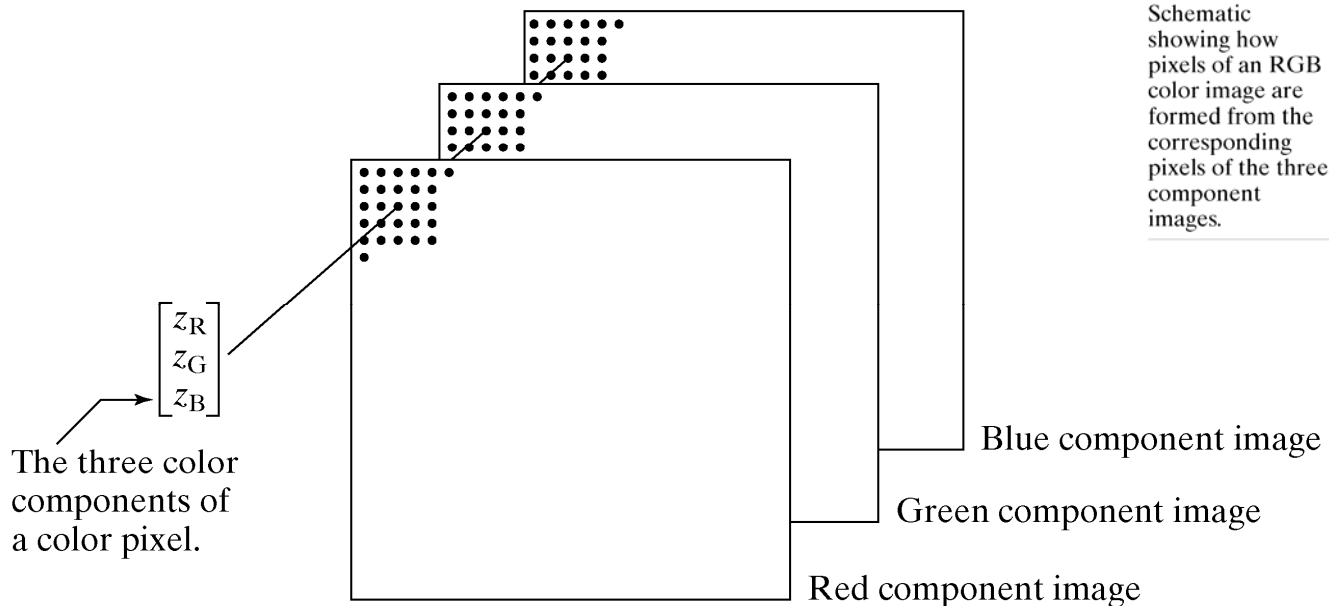
FIGURE 6.1

Schematic showing how pixels of an RGB color image are formed from the corresponding pixels of the three component images.

بازنمایی تصاویر رنگی در متلب

تصاویر RGB

```
rgb_image = cat(3,fR,fG,fB)
```



Schematic showing how pixels of an RGB color image are formed from the corresponding pixels of the three component images.

```
fR = rgb_image(:,:,1)
fG = rgb_image(:,:,2)
fB = rgb_image(:,:,3)
```

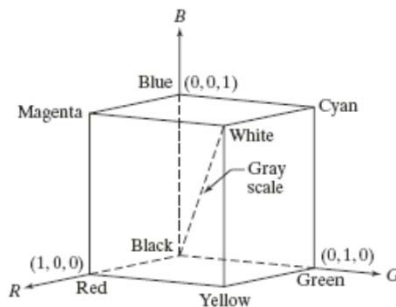
Chapter 7

Color Image Processing

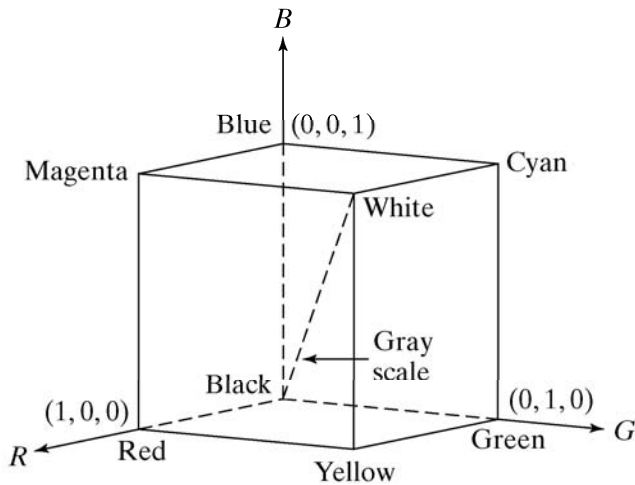
a b

FIGURE 6.2

(a) Schematic of the RGB color cube showing the primary and secondary colors of light at the vertices. Points along the main diagonal have gray values from black at the origin to white at point (1, 1, 1). (b) The RGB color cube.



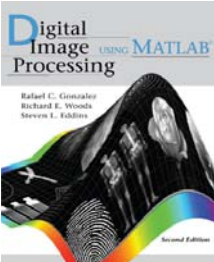
مکعب رنگ RGB



a b

(a) Schematic of the RGB color cube showing the primary and secondary colors of light at the vertices. Points along the main diagonal have gray values from black at the origin to white at point $(1, 1, 1)$. (b) The RGB color cube.

`rgbcube(xv,vy,vz)`



Chapter 7

Color Image Processing

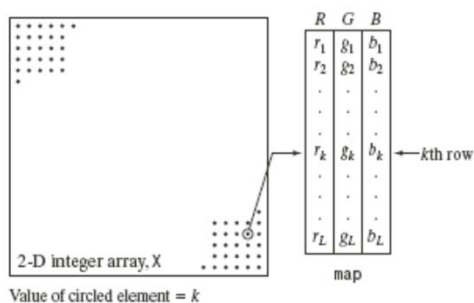
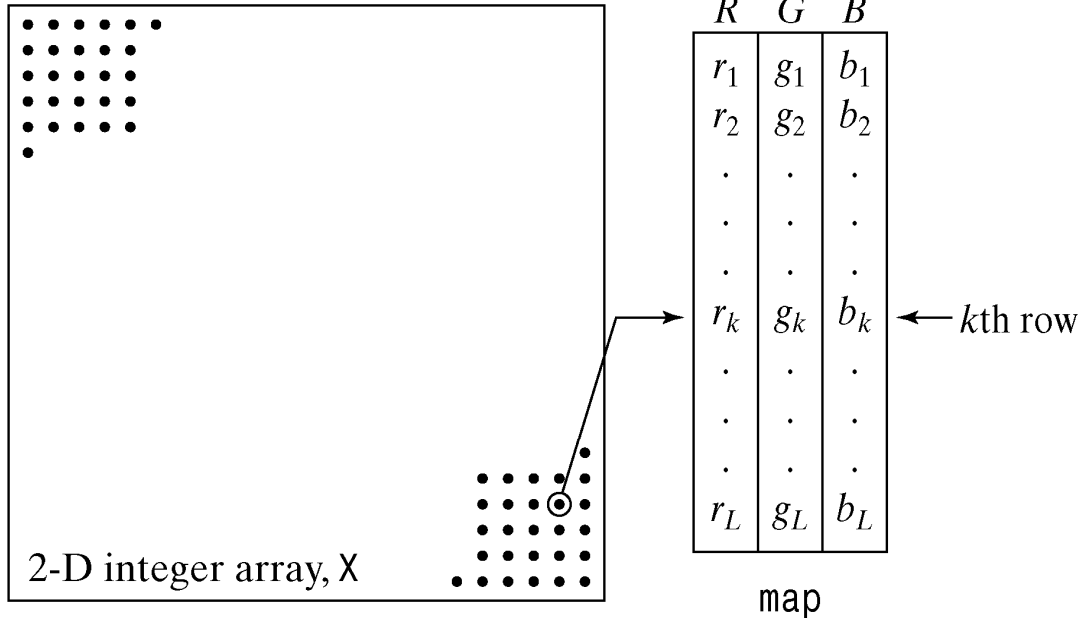


FIGURE 6.3

Elements of an indexed image. The value of an element of integer array X determines the row number in the color map. Each row contains an RGB triplet, and L is the total number of rows.

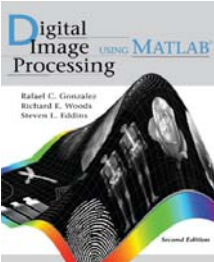
تصاویر شاخص گذاری شده

INDEXED IMAGES

Elements of an indexed image. Note that the value of an element of integer array X determines the row number in the colormap. Each row contains an RGB triplet, and L is the total number of rows.

Value of circled element = k

`imshow(X, map)`



Chapter 7

Color Image Processing

TABLE 6.1

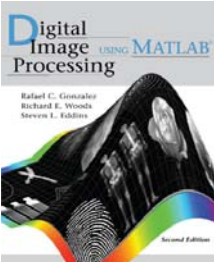
RGB values of some basic colors. The long or short names (enclosed by single quotes) can be used instead of a numerical triplet to specify an RGB color.

Long name	Short name	RGB values
Black	k	[0 0 0]
Blue	b	[0 0 1]
Green	g	[0 1 0]
Cyan	c	[0 1 1]
Red	r	[1 0 0]
Magenta	m	[1 0 1]
Yellow	y	[1 1 0]
White	w	[1 1 1]

رنگ‌های پایه در متلب

Long name	Short name	RGB values
Black	k	[0 0 0]
Blue	b	[0 0 1]
Green	g	[0 1 0]
Cyan	c	[0 1 1]
Red	r	[1 0 0]
Magenta	m	[1 0 1]
Yellow	y	[1 1 0]
White	w	[1 1 1]

RGB values of some basic colors. The long or short names (enclosed by quotes) can be used instead of the numerical triplet to specify an RGB color.



Chapter 7 Color Image Processing

TABLE 6.2 MATLAB predefined color maps.

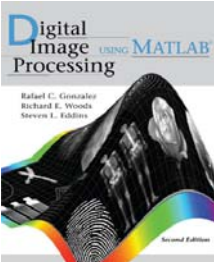
Function	Description
autumn	Varies smoothly from red, through orange, to yellow.
bone	A gray-scale color map with a higher value for the blue component. This color map is useful for adding an “electronic” look to gray-scale images.
colorcube	Contains as many regularly spaced colors in RGB color space as possible, while attempting to provide more steps of gray, pure red, pure green, and pure blue.
cool	Consists of colors that are smoothly-varying shades from cyan to magenta.
copper	Varies smoothly from black to bright copper.
flag	Consists of the colors red, white, blue, and black. This color map completely changes color with each index increment.
gray	Returns a linear gray-scale color map.
hot	Varies smoothly from black, through shades of red, orange, and yellow, to white.
hsv	Varies the hue component of the hue-saturation-value color model. The colors begin with red, pass through yellow, green, cyan, blue, magenta, and return to red. The color map is particularly appropriate for displaying periodic functions.
jet	Ranges from blue to red, and passes through the colors cyan, yellow, and orange.
lines	Produces a color map of colors specified by the axes <code>ColorOrder</code> property and a shade of gray. Consult the help page for function <code>ColorOrder</code> for details on this function.
pink	Contains pastel shades of pink. The pink color map provides sepia tone colorization of gray-scale photographs.
prism	Repeats the six colors red, orange, yellow, green, blue, and violet.
spring	Consists of colors that are shades of magenta and yellow.
summer	Consists of colors that are shades of green and yellow.
winter	Consists of colors that are shades of blue and green.
white	This is an all white monochrome color map.

نقشه‌های رنگ از پیش تعریف شده در متلب

Name	Description
autumn	Varies smoothly from red, through orange, to yellow.
bone	A gray-scale colormap with a higher value for the blue component. This colormap is useful for adding an “electronic” look to gray-scale images.
colorcube	Contains as many regularly spaced colors in RGB color space as possible, while attempting to provide more steps of gray, pure red, pure green, and pure blue.
cool	Consists of colors that are shades of cyan and magenta. It varies smoothly from cyan to magenta.
copper	Varies smoothly from black to bright copper.
flag	Consists of the colors red, white, blue, and black. This colormap completely changes color with each index increment.
gray	Returns a linear gray-scale colormap.
hot	Varies smoothly from black, through shades of red, orange, and yellow, to white.
hsv	Varies the hue component of the hue-saturation-value color model. The colors begin with red, pass through yellow, green, cyan, blue, magenta, and return to red. The colormap is particularly appropriate for displaying periodic functions.
jet	Ranges from blue to red, and passes through the colors cyan, yellow, and orange.
lines	Produces a colormap of colors specified by the ColorOrder property and a shade of gray. Consult online help regarding function ColorOrder.
pink	Contains pastel shades of pink. The pink colormap provides sepia tone colorization of grayscale photographs.
prism	Repeats the six colors red, orange, yellow, green, blue, and violet.
spring	Consists of colors that are shades of magenta and yellow.
summer	Consists of colors that are shades of green and yellow.
white	This is an all white monochrome colormap.
winter	Consists of colors that are shades of blue and green.

Some of the MATLAB predefined colormaps.





Chapter 7

Color Image Processing

TABLE 6.3 Toolbox functions for converting between RGB, indexed, and gray-scale images.

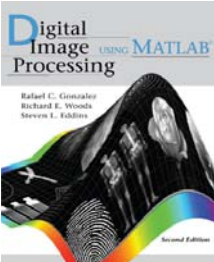
Function	Description
dither	Creates an indexed image from an RGB image by dithering.
grayslice	Creates an indexed image from a gray-scale intensity image by thresholding.
gray2ind	Creates an indexed image from a gray-scale intensity image.
ind2gray	Creates a gray-scale image from an indexed image.
rgb2ind	Creates an indexed image from an RGB image.
ind2rgb	Creates an RGB image from an indexed image.
rgb2gray	Creates a gray-scale image from an RGB image.

توابع تبدیل فضای رنگ در متلب

Function	Purpose
dither	Creates an indexed image from an RGB image by dithering.
grayslice	Creates an indexed image from a gray-scale intensity image by multilevel thresholding.
gray2ind	Creates an indexed image from a gray-scale intensity image.
ind2gray	Creates a gray-scale intensity image from an indexed image.
rgb2ind	Creates an indexed image from an RGB image.
ind2rgb	Creates an RGB image from an indexed image.
rgb2gray	Creates a gray-scale image from an RGB image.

IPT functions for converting between RGB, indexed, and gray-scale intensity images.





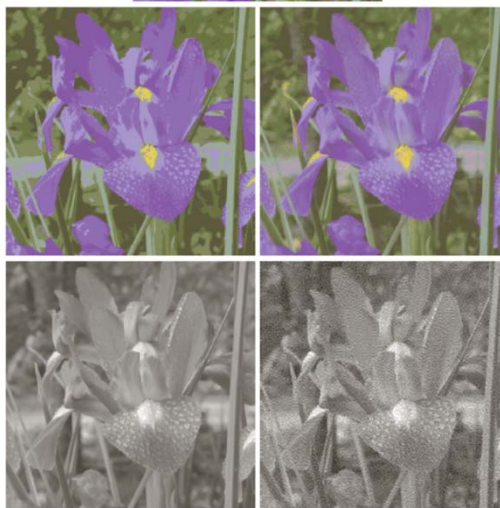
Chapter 7 Color Image Processing



a
b c
d e

FIGURE 6.4

(a) RGB image.
(b) Number of colors reduced to 8, with no dithering.
(c) Number of colors reduced to 8, with dithering.
(d) Gray-scale version of (a) obtained using function `rgb2gray`.
(e) Dithered gray-scale image (this is a binary image).



توابع تبدیل فضای رنگ در متلب

مثال

f



```
[X1,map1] = rgb2ind(f,8, 'nodither');
imshow(X1,map1)
```

```
[X2,map2] = rgb2ind(f,8, 'dither');
imshow(X1,map2)
```



```
g = rgb2gray(f)
```



```
g = rgb2gray(X2)
```

a
b c
d e

(a) RGB image.

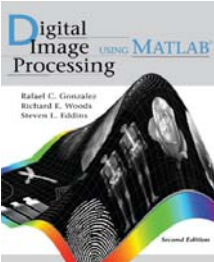
(b) Number of colors reduced to 8 without dithering.

(c) Number of colors reduced to 8 with dithering.

(d) Gray-scale version of (a) obtained using function

rgb2gray.

(e) Dithered gray-scale image (this is a binary image).



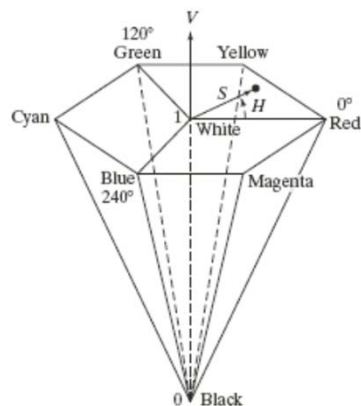
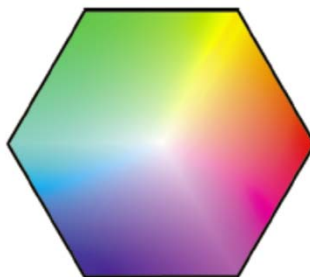
Chapter 7 Color Image Processing

a b

FIGURE 6.5

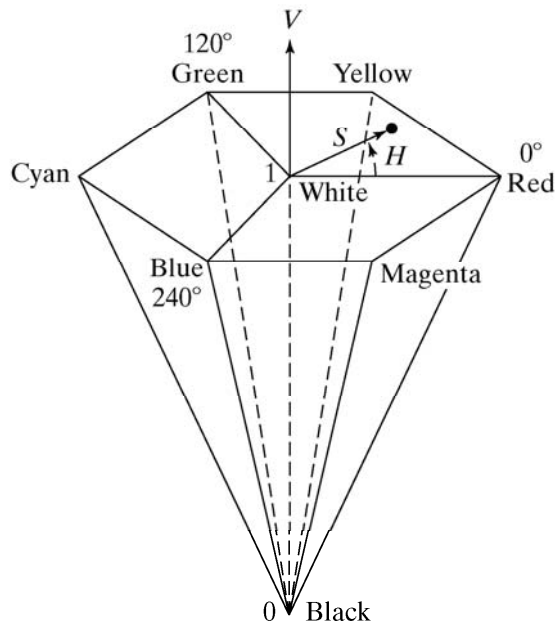
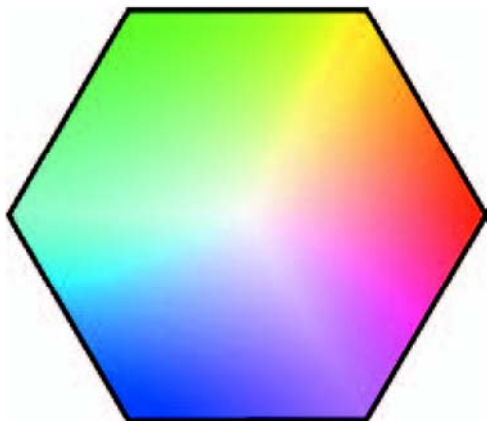
(a) The HSV
color hexagon.

(b) The HSV
hexagonal cone.



فضای رنگ HSV

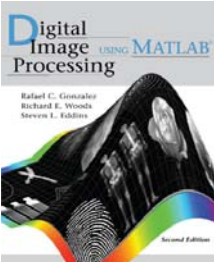
شش وجهی رنگ HSV و مخروط شش وجهی HSV



a b

(a) The HSV color hexagon.

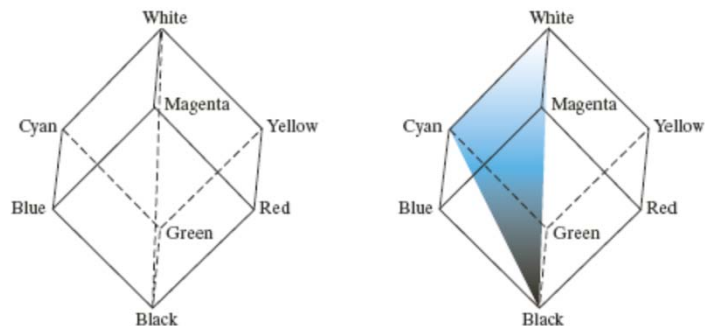
(b) The HSV hexagonal cone.



Chapter 7 Color Image Processing

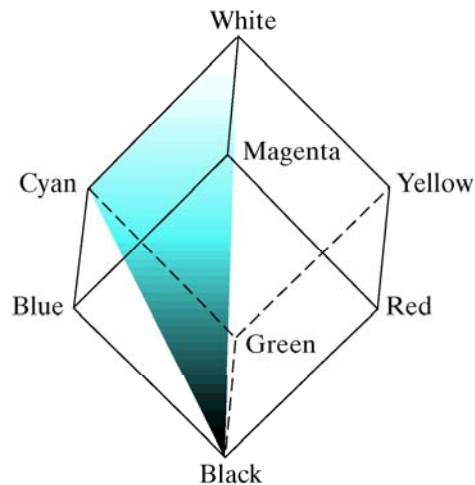
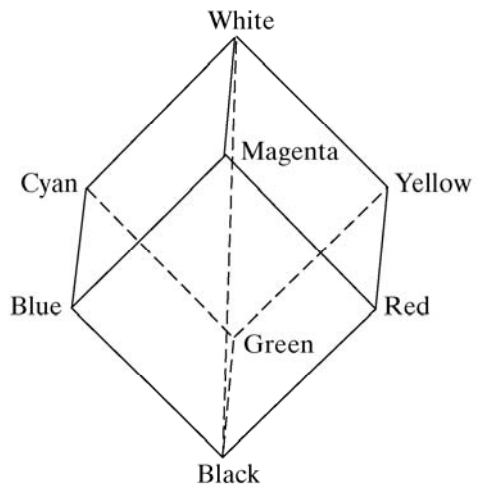
a b

FIGURE 6.6
Relationship
between the RGB
and HSI color
models.



مدل رنگ HSI

ارتباط میان مدل‌های رنگ RGB و HSI



a b

Relationship
between the RGB
and HSI color
models.

Chapter 7

Color Image Processing

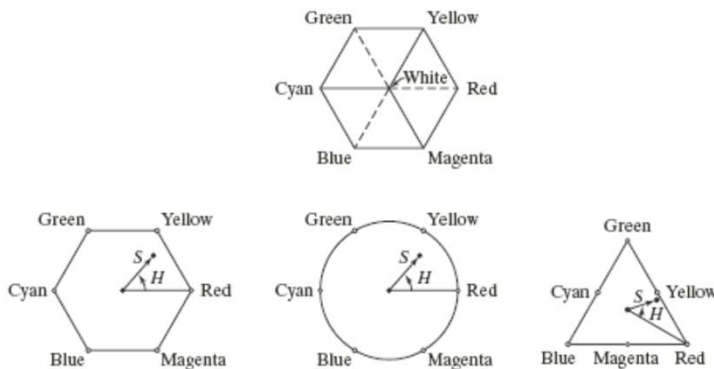
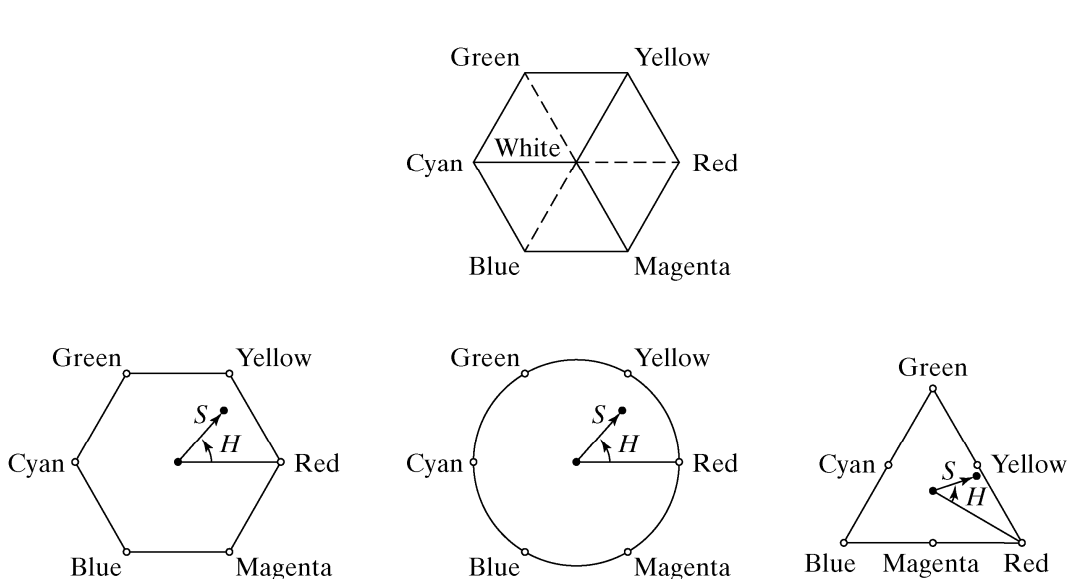


FIGURE 6.7
Hue and saturation in the HSI color model. The dot is an arbitrary color point. The angle from the red axis gives the hue, and the length of the vector is the saturation. The intensity of all colors in any of these planes is given by the position of the plane on the vertical intensity axis.

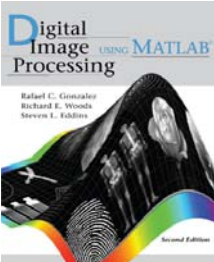
مدل رنگ HSI

فام و اشباع در مدل رنگ HSI

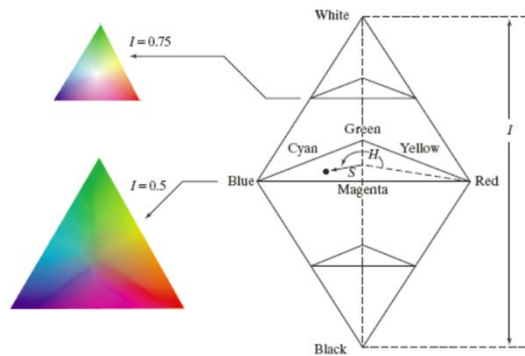


a
b c d

FIGURE Hue and saturation in the HSI color model. The dot is an arbitrary color point. The angle from the red axis gives the hue, and the length of the vector is the saturation. The intensity of all colors in any of these planes is given by the position of the plane on the vertical intensity axis.



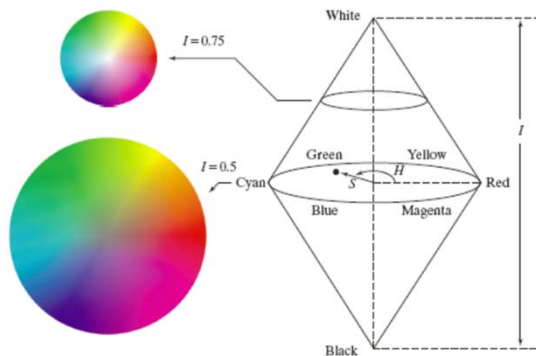
Chapter 7 Color Image Processing



a
b

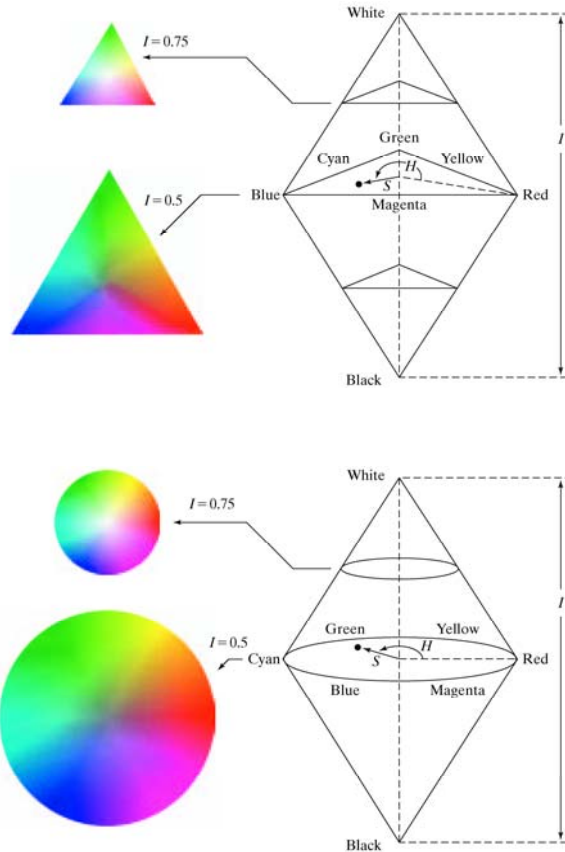
FIGURE 6.8

The HSI color model based on (a) triangular and (b) circular color planes. The triangles and circles are perpendicular to the vertical intensity axis.



مدل رنگ HSI

صفحه‌ی رنگ مثلثی و دایره‌ای



a
b

FIGURE The HSI color model based on (a) triangular and (b) circular color planes. The triangles and circles are perpendicular to the vertical intensity axis.

Chapter 7

Color Image Processing

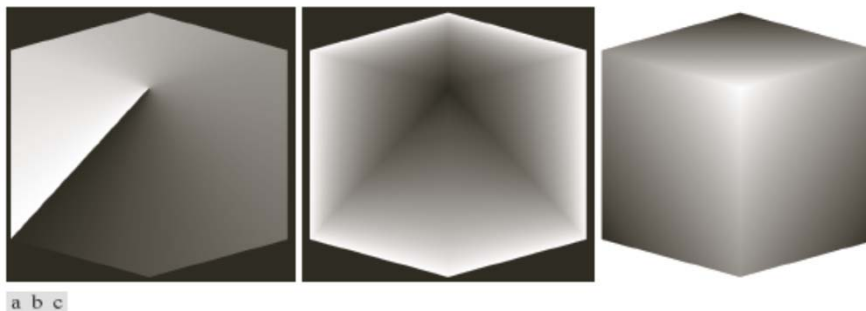
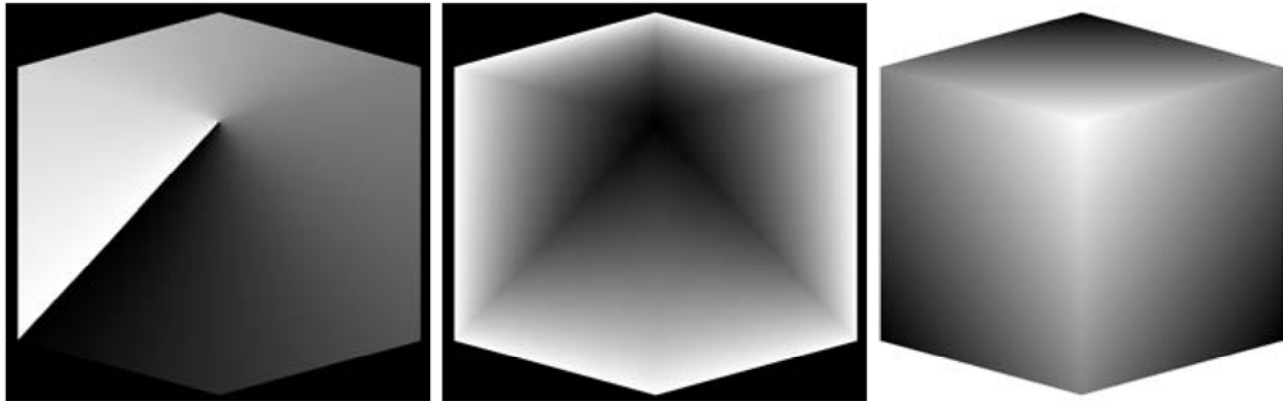


FIGURE 6.9 HSI component images of an image of an RGB color cube. (a) Hue, (b) saturation, and (c) intensity images.

مدل رنگ HSI

مؤلفه‌های HSI مکعب رنگ RGB



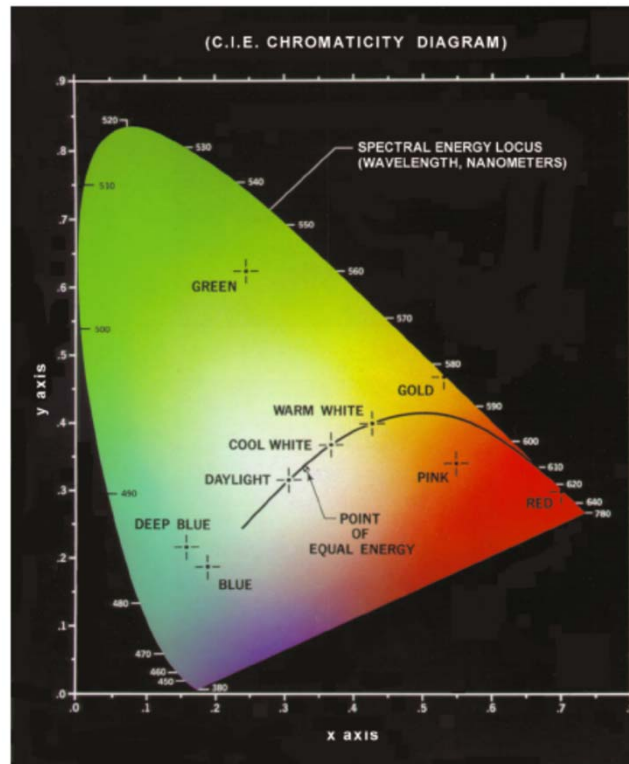
a b c

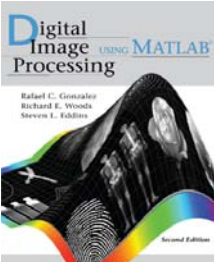
FIGURE HSI component images of an image of an RGB color cube. (a) Hue, (b) saturation, and (c) intensity images.



Chapter 7 Color Image Processing

FIGURE 6.10
 CIE chromaticity diagram.
 (Courtesy of the
 General Electric
 Co. Lamp
 Business
 Division.)





Chapter 7

Color Image Processing

TABLE 6.4 Device-independent CIE color spaces supported by the Image Processing Toolbox.

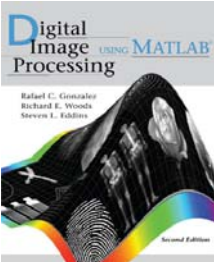
Color space	Description
XYZ	The original, 1931 CIE color space specification.
xyY	CIE specification that provides normalized chromaticity values. The capital Y value represents luminance and is the same as in XYZ.
uvL	CIE specification that attempts to make the chromaticity plane more visually uniform. L is luminance and is the same as Y in XYZ.
u'v'L	CIE specification in which u and v are re-scaled to improve uniformity.
$L^*a^*b^*$	CIE specification that attempts to make the luminance scale more perceptually uniform. L^* is a nonlinear scaling of L , normalized to a reference white point.
L^*ch	CIE specification where c is chroma and h is hue. These values are a polar coordinate conversion of a^* and b^* in $L^*a^*b^*$.

فضاهای رنگ مستقل از دستگاه

DEVICE-INDEPENDENT COLOR SPACES

Device-independent CIE color spaces supported by the Image Processing Toolbox.

Color space	Description
XYZ	The original, 1931 CIE color space specification.
$x\ y\ Y$	CIE specification that provides normalized chromaticity values. The capital Y value represents luminance and is the same as in XYZ.
$u\ v\ L$	CIE specification that attempts to make the chromaticity plane more visually uniform. L is luminance and is the same as Y in XYZ.
$u'\ v'\ L$	CIE specification in which u and v are re-scaled to improve uniformity.
$L^*a^*b^*$	CIE specification that attempts to make the luminance scale more perceptually uniform. L^* is a nonlinear scaling of L , normalized to a reference white point.
L^*ch	CIE specification where c is chroma and h is hue. These values are a polar coordinate conversion of a^* and b^* in $L^*a^*b^*$.



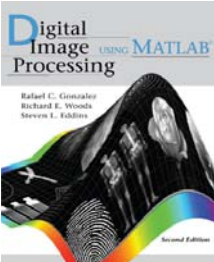
Chapter 7

Color Image Processing

types used in makecform	Color spaces
'lab2lch', 'lch2lab'	$L^*a^*b^*$ and L^*ch
'lab2srgb', 'srgb2lab'	$L^*a^*b^*$ and sRGB
'lab2xyz', 'xyz2lab'	$L^*a^*b^*$ and XYZ
'srgb2xyz', 'xyz2srgb'	sRGB and XYZ
'upvp12xyz', 'xyz2upvp1'	u^*v^*L and XYZ
'uvl2xyz', 'xyz2uvl'	uvL and XYZ
'xy12xyz', 'xyz2xy1'	xyY and XYZ

TABLE 6.5

Device-independent color-space conversions supported by the Image Processing Toolbox.



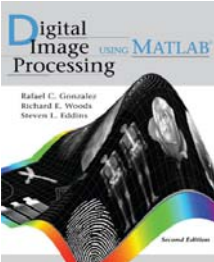
Chapter 7

Color Image Processing

FIGURE 6.11

A perceptually uniform color scale based on the $L^*a^*b^*$ color space.



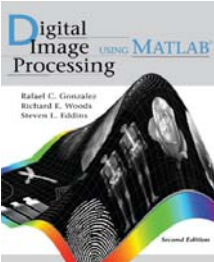


Chapter 7

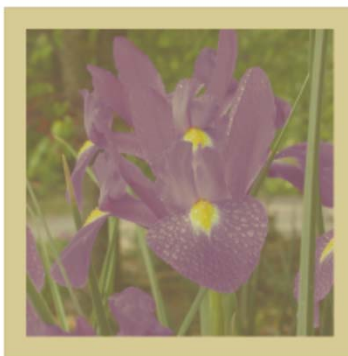
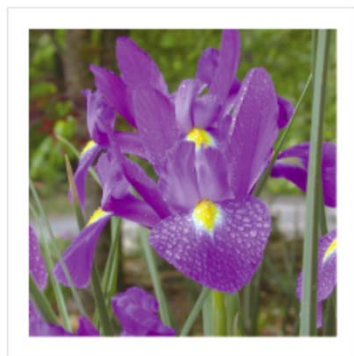
Color Image Processing

TABLE 6.6
ICC profile
rendering intents.

Rendering intent	Description
Perceptual	Optimizes gamut mapping to achieve the most aesthetically pleasing result. In-gamut colors might not be maintained.
Absolute colorimetric	Maps out-of-gamut colors to the nearest gamut surface. Maintains relationship of in-gamut colors. Renders colors with respect to a perfect diffuser.
Relative colorimetric	Maps out-of-gamut colors to the nearest gamut surface. Maintains relationship of in-gamut colors. Renders colors with respect to the white point of the device or output media.
Saturation	Maximizes saturation of device colors, possibly at the expense of shifting hue. Intended for simple graphic charts and graphs, rather than images.



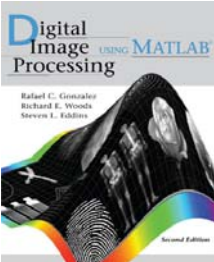
Chapter 7 Color Image Processing



a b

FIGURE 6.12

Soft proofing example. (a) Original image with white border. (b) Simulation of image appearance when printed on newsprint.



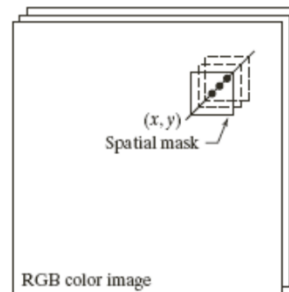
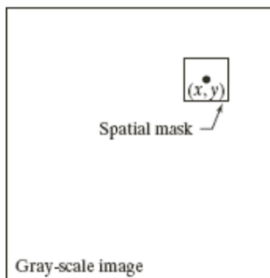
Chapter 7

Color Image Processing

a b

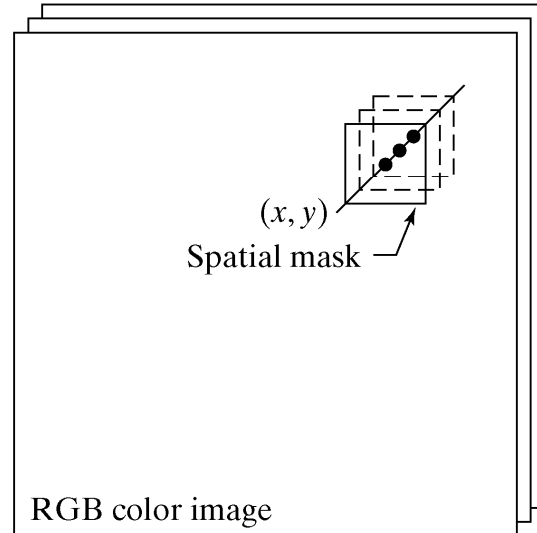
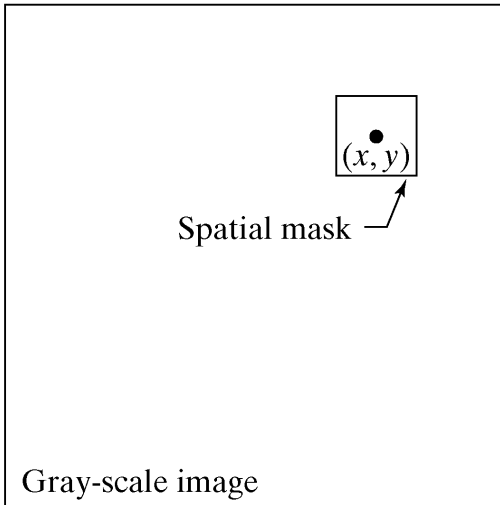
FIGURE 6.13

Spatial masks for
(a) gray-scale and
(b) RGB color
images.



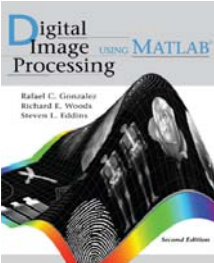
پردازش تصویر رنگی

ماسک‌های مکانی



a b

Spatial masks for
gray-scale and
RGB color
images.



Chapter 7 Color Image Processing

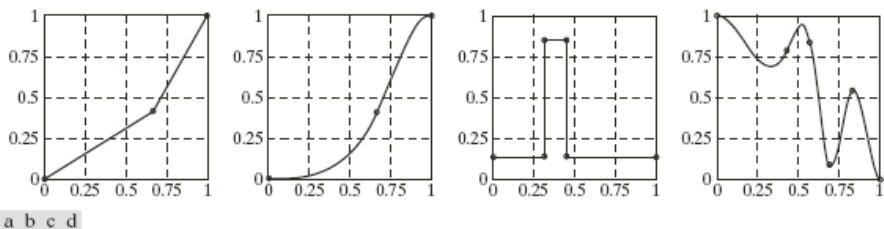
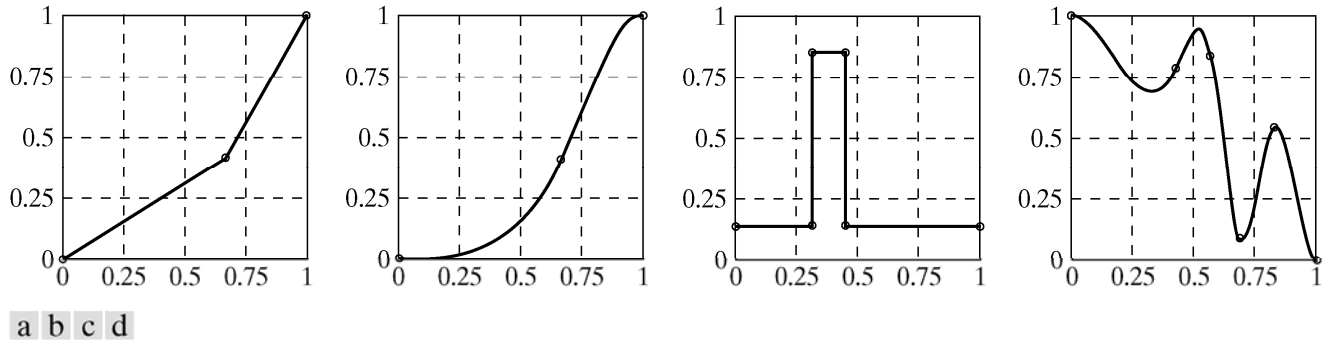


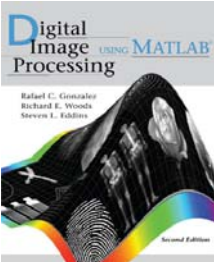
FIGURE 6.14 Specifying mapping functions using control points: (a) and (c) linear interpolation and (b) and (d) cubic spline interpolation.

پردازش تصویر رنگی

توابع نگاشت



Specifying mapping functions using control points: (a) and (c) linear interpolation, and (b) and (d) cubic spline interpolation.



Chapter 7 Color Image Processing

Property Name	Property Value
'image'	An RGB or monochrome input image, <i>f</i> , to be transformed by interactively-specified mappings.
'space'	The color space of the components to be modified. Possible values are 'rgb', 'cmy', 'hsi', 'hsv', 'ntsc' (or 'yiq'), and 'ycbcr'. The default is 'rgb'.
'wait'	If 'on' (the default), <i>g</i> is the mapped input image. If 'off', <i>g</i> is the handle of the mapped input image.

TABLE 6.7

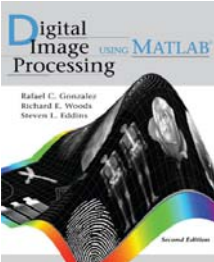
Valid inputs for function *ice*.

تابع ICE

```
g = ice('Property Name', 'Property Value', ...)
```

Property Name	Property Value
'image'	An RGB or monochrome input image, f, to be transformed by interactively specified mappings.
'space'	The color space of the components to be modified. Possible values are 'rgb', 'cmy', 'hsi', 'hsv', 'ntsc' (or 'yiq'), and 'ycbcr'. The default is 'rgb'.
'wait'	If 'on' (the default), g is the mapped input image. If 'off', g is the handle of the mapped input image.

Valid inputs for function ice.



Chapter 7

Color Image Processing

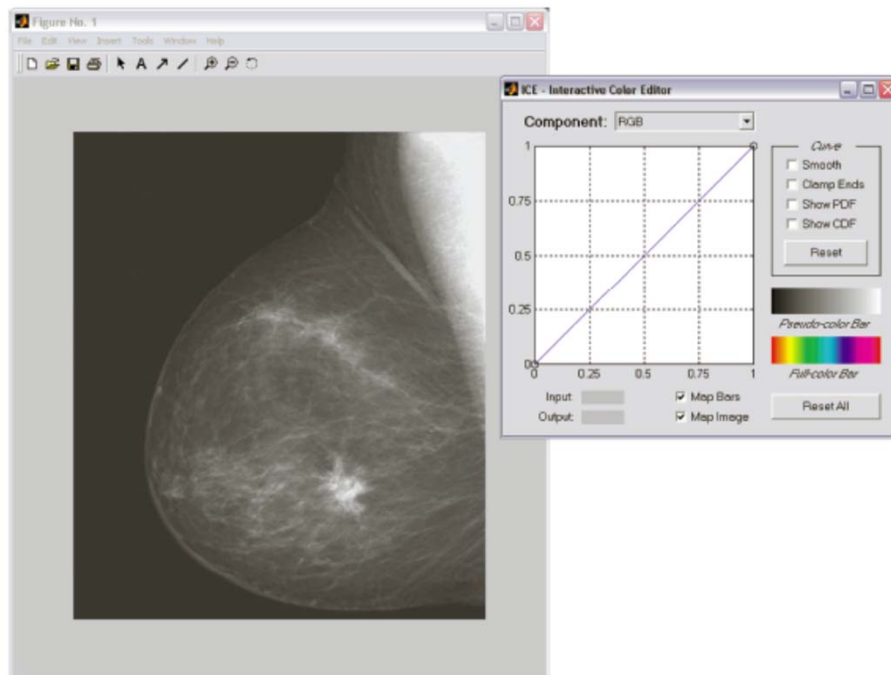
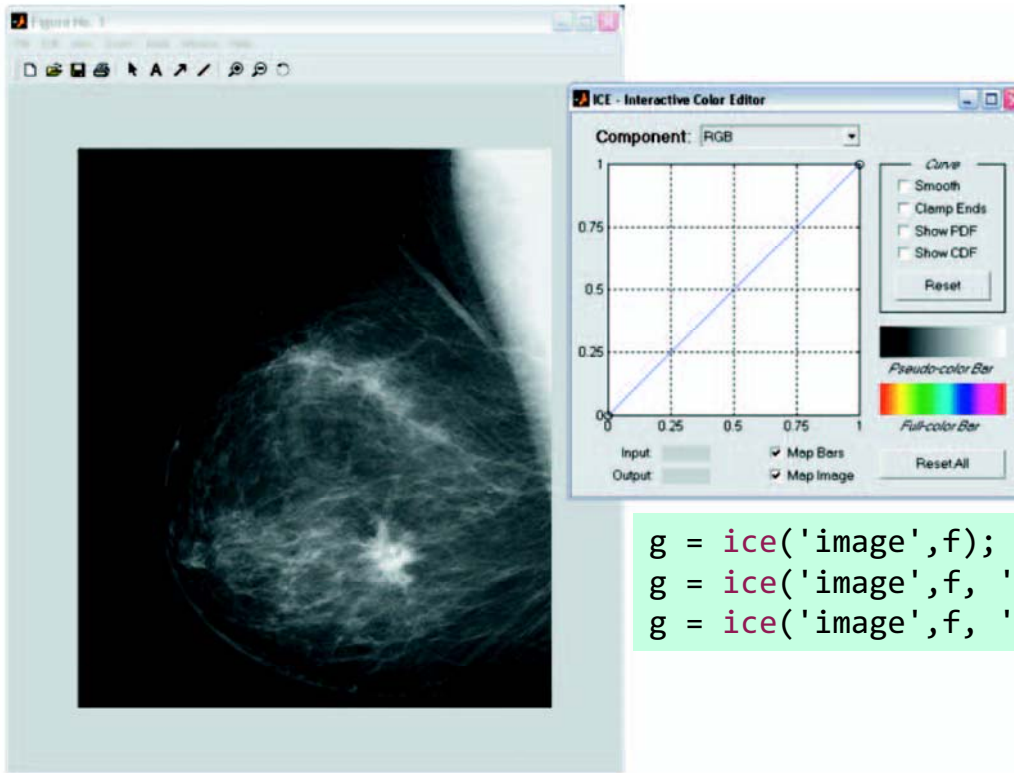


FIGURE 6.15 The typical opening windows of function `ice`. (Image courtesy of G.E. Medical Systems.)

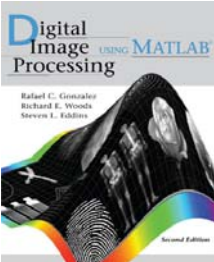
تابع ICE

مثال



```
g = ice('image',f);
g = ice('image',f, 'wait', 'off');
g = ice('image',f, 'space', 'his');
```

FIGURE The typical opening windows of function ice.



Chapter 7

Color Image Processing

TABLE 6.8 Manipulating control points with the mouse.

Mouse action [†]	Result
Left Button	Move control point by pressing and dragging..
Left Button + Shift Key	Add control point. The location of the control point can be changed by dragging (while still pressing the Shift Key).
Left Button + Control Key	Delete control point.

[†]For three button mice, the left, middle, and right buttons correspond to the move, add, and delete operations in the table.

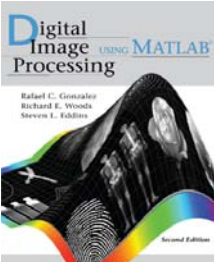
تابع ICE

تغییر تابع نگاشت با ماوس

Manipulating
control points
with the mouse.

Mouse Action [†]	Result
Left Button	Move control point by pressing and dragging.
Left Button + Shift Key	Add control point. The location of the control point can be changed by dragging (while still pressing the Shift Key).
Left Button + Control Key	Delete control point.

[†] For three button mice, the left, middle, and right buttons correspond to the move, add, and delete operations in the table.



Chapter 7 Color Image Processing

TABLE 6.9 Function of the checkboxes and pushbuttons in the *ice* GUI.

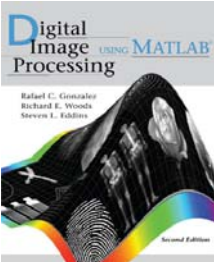
GUI Element	Description
Smooth	Checked for cubic spline (smooth curve) interpolation. If unchecked, piecewise linear interpolation is used.
Clamp Ends	Checked to force the starting and ending curve slopes in cubic spline interpolation to 0. Piecewise linear interpolation is not affected.
Show PDF	Display probability density function(s) [i.e., histogram(s)] of the image components affected by the mapping function.
Show CDF	Display cumulative distribution function(s) instead of PDFs. (Note: PDFs and CDFs cannot be displayed simultaneously.)
Map Image	If checked, image mapping is enabled; otherwise it is not.
Map Bars	If checked, pseudo- and full-color bar mapping is enabled; otherwise the unmapped bars (a gray wedge and hue wedge, respectively) are displayed.
Reset	Initialize the currently displayed mapping function and uncheck all curve parameters.
Reset All	Initialize all mapping functions.
Input/Output	Show the coordinates of a selected control point on the transformation curve. Input refers to the horizontal axis, and Output to the vertical axis.
Component	Select a mapping function for interactive manipulation. In RGB space, possible selections include R, G, B, and RGB (which maps all three color components). In HSI space, the options are H, S, I, and HSI, and so on.

تابع ICE

کارکردهای مربوط به واسط گرافیکی کاربر

GUI Element	Function
Smooth	Checked for cubic spline (smooth curve) interpolation. If unchecked, piecewise linear interpolation is used.
Clamp Ends	Checked to force the starting and ending curve slopes in cubic spline interpolation to 0. Piecewise linear interpolation is not affected.
Show PDF	Display probability density function(s) [i.e., histogram(s)] of the image components affected by the mapping function.
Show CDF	Display cumulative distribution function(s) instead of PDFs. (Note: PDFs and CDFs cannot be displayed simultaneously.)
Map Image	If checked, image mapping is enabled; otherwise it is not.
Map Bars	If checked, pseudo- and full-color bar mapping is enabled; otherwise the unmapped bars (a gray wedge and hue wedge, respectively) are displayed.
Reset	Initialize the currently displayed mapping function and uncheck all curve parameters.
Reset All	Initialize all mapping functions.
Input/Output	Shows the coordinates of a <i>selected</i> control point on the transformation curve. Input refers to the horizontal axis, and Output to the vertical axis.
Component	Select a mapping function for interactive manipulation. In RGB space, possible selections include R, G, B, and RGB (which maps all three color components). In HSI space, the options are H, S, I, and HSI, and so on.

Function of the checkboxes and pushbuttons in the ice GUI.



Chapter 7 Color Image Processing

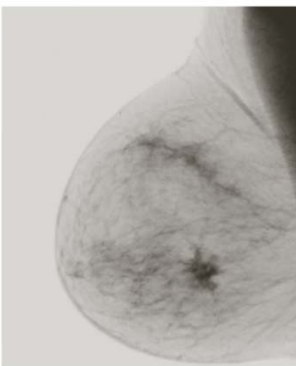
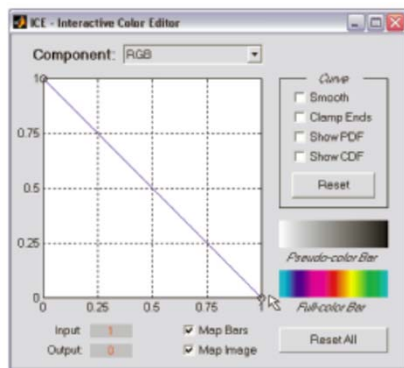
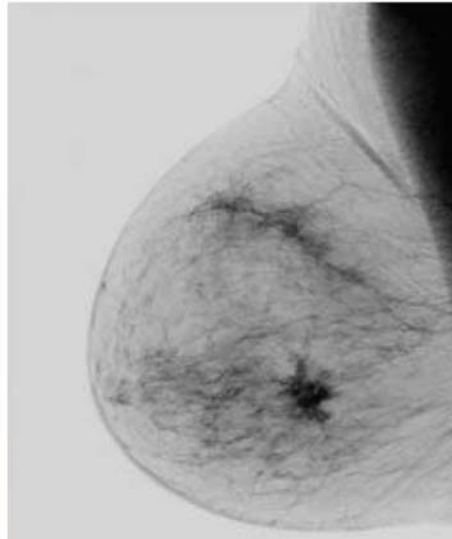
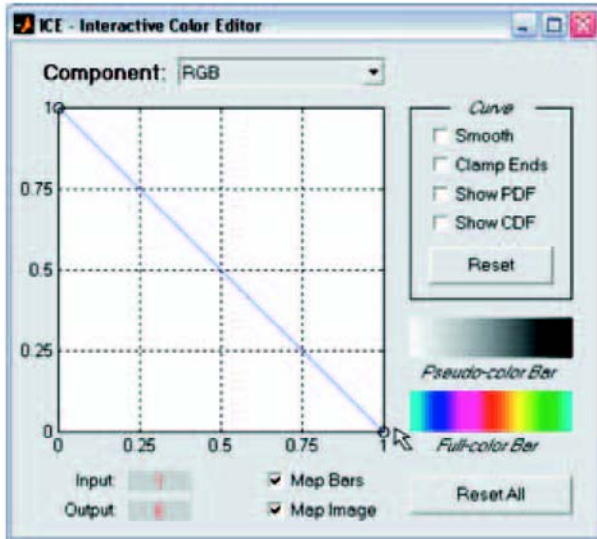


FIGURE 6.16
(a) A negative mapping function, and (b) its effect on the monochrome image of Fig. 6.15.

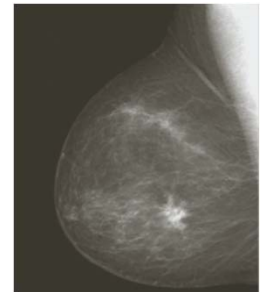
تابع ICE

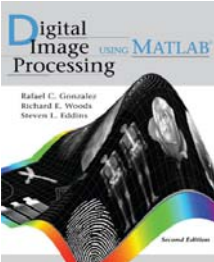
تابع نگاشت نکاتیو



a b

(a) A negative mapping function, and (b) its effect on the monochrome image of Fig. 6.12.





Chapter 7 Color Image Processing

a b
FIGURE 6.17
(a) A full color
image, and (b) its
negative (color
complement).



پردازش تصویر رنگی

نگاتیو کردن تصویر رنگی



a b

(a) A full color image, and (b) its negative (color complement).

Chapter 7

Color Image Processing

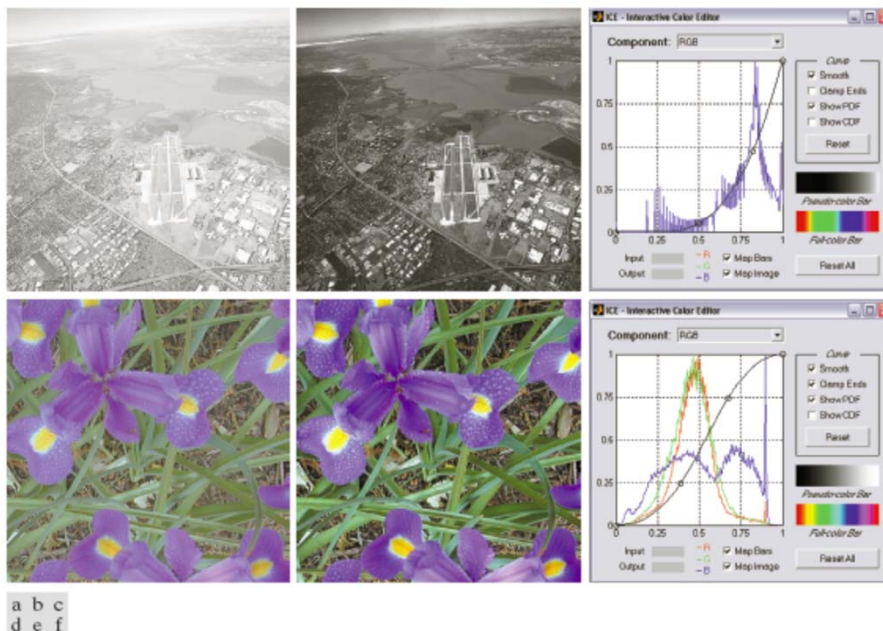


FIGURE 6.18 Using function `ice` for monochrome and full color contrast enhancement: (a) and (d) are the input images, both of which have a “washed-out” appearance; (b) and (e) show the processed results; (c) and (f) are the `ice` displays. (Original monochrome image for this example courtesy of NASA.)

تابع ICE

کاربرد در به سازی کنتراست تکرنگ و تمام رنگی

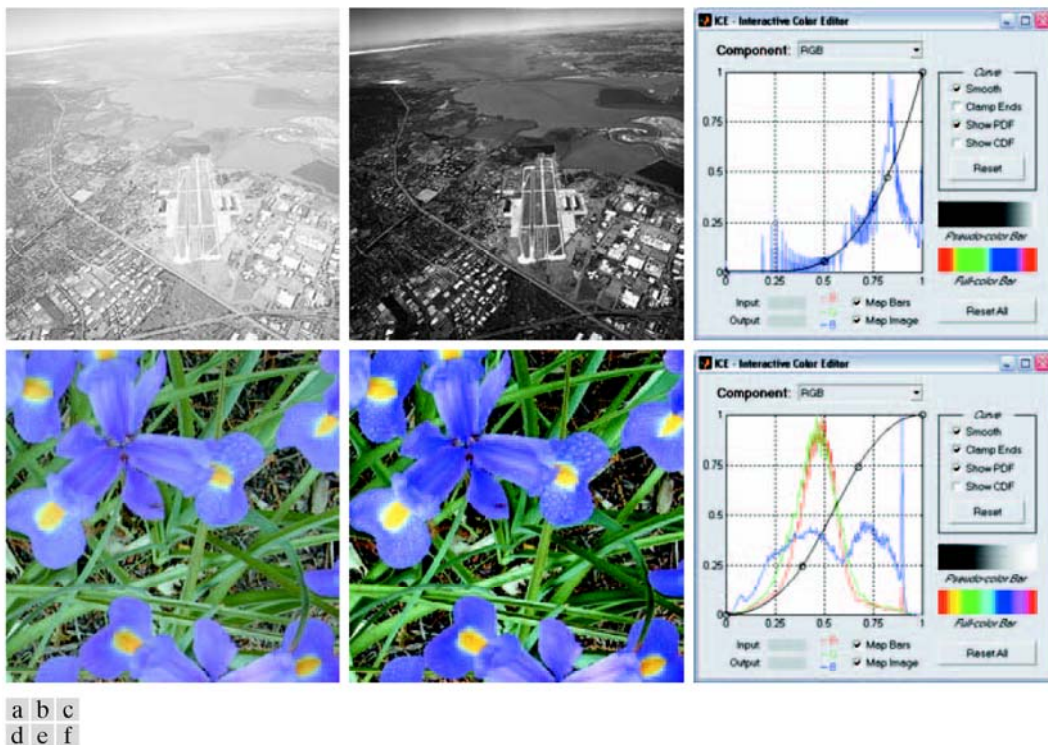


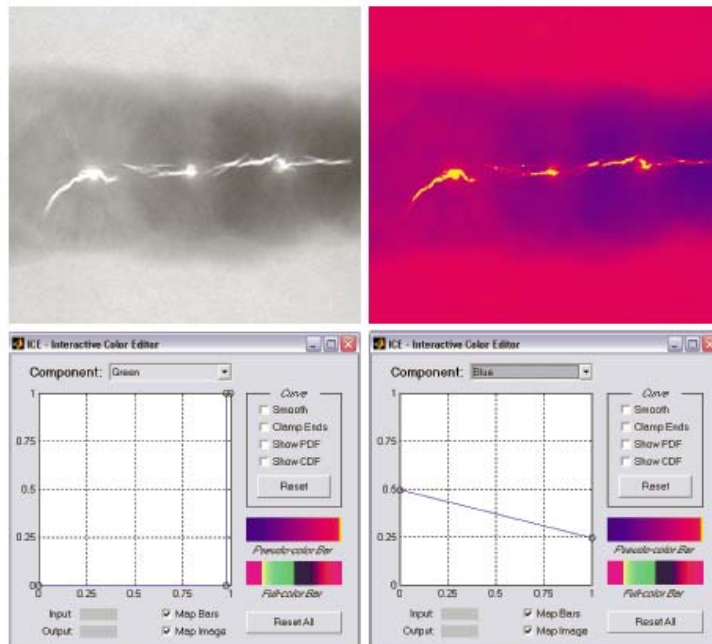
FIGURE Using function `ice` for monochrome and full color contrast enhancement: (a) and (d) are the input images, both of which have a “washed-out” appearance; (b) and (e) show the processed results; (c) and (f) are the ice displays.

Chapter 7 Color Image Processing

a b
c d

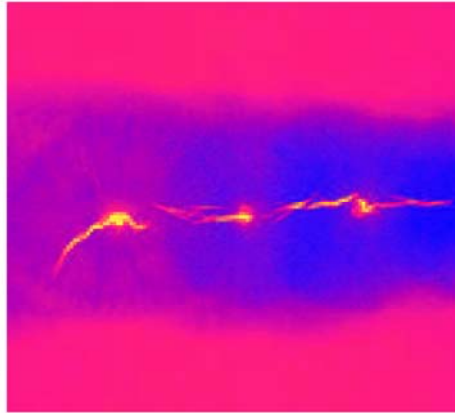
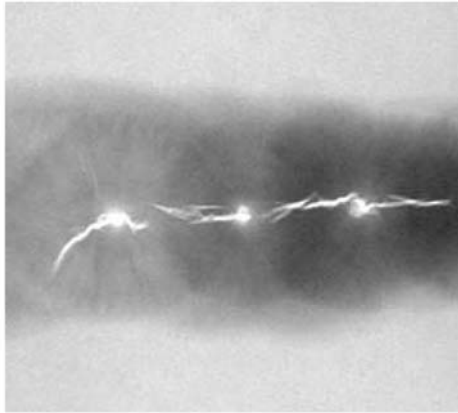
FIGURE 6.19

(a) X-ray of a defective weld; (b) a pseudo-color version of the weld; (c) and (d) mapping functions for the green and blue components. (Original image courtesy of X-TEK Systems, Ltd.)



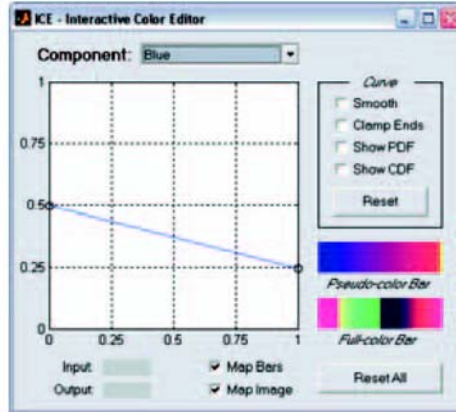
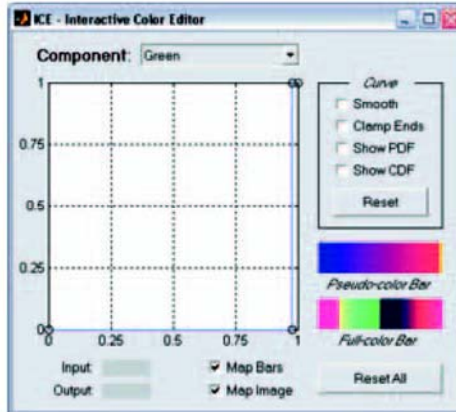
تابع ICE

کاربرد در نگاشت شبه‌رنگی



a	b
c	d

(a) X-ray of a defective weld;
 (b) a pseudo-color version of the weld; (c) and (d) mapping functions for the green and blue components.



Chapter 7

Color Image Processing

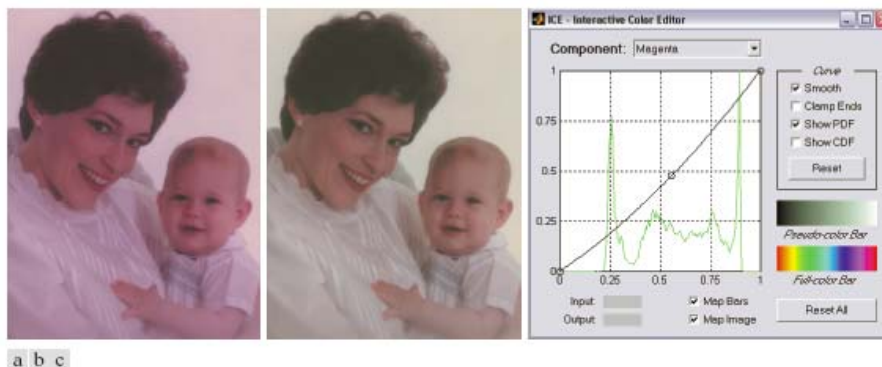
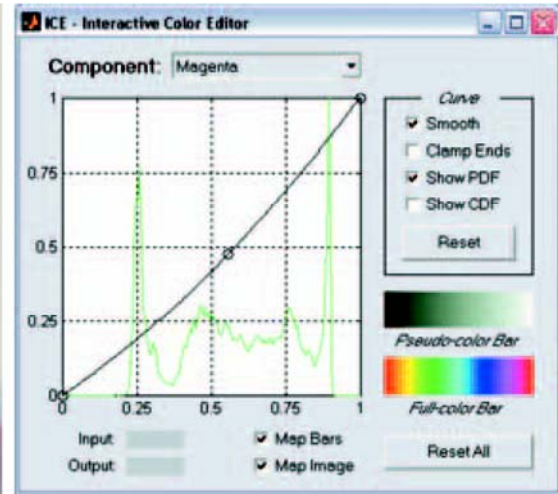


FIGURE 6.20 Using function `ice` for color balancing: (a) an image heavy in magenta; (b) the corrected image; and (c) the mapping function used to correct the imbalance.

تابع ICE

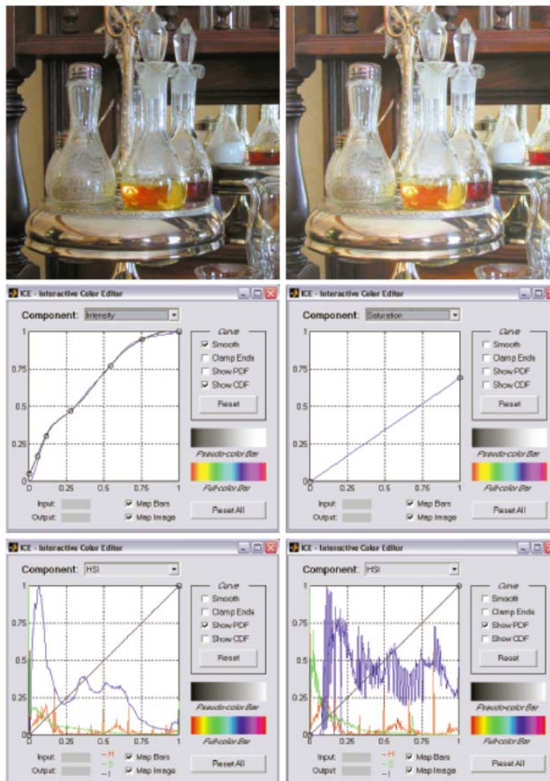
کاربرد در متوازن سازی رنگ



a b c

FIGURE Using function ice for color balancing: (a) an image heavy in magenta; (b) the corrected image; and (c) the mapping function used to correct the imbalance.

Chapter 7 Color Image Processing

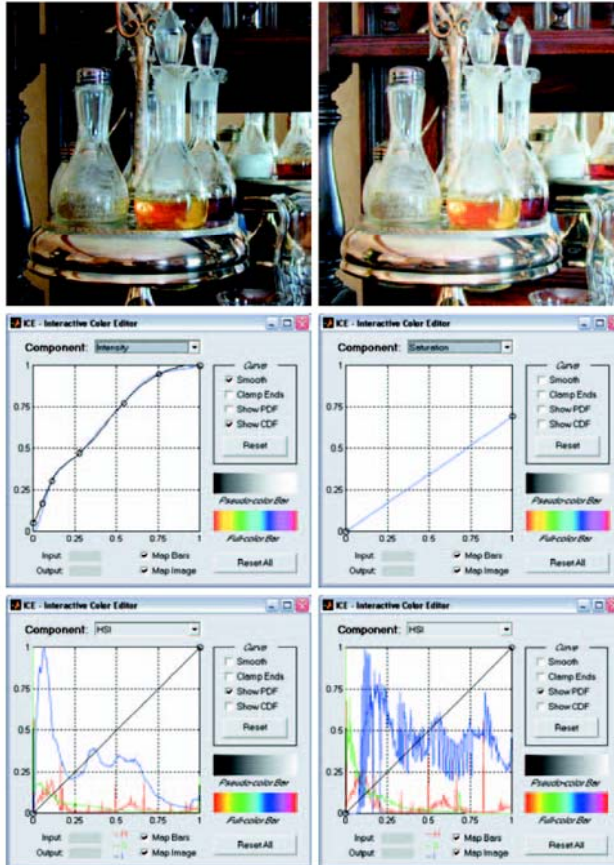


a
b
c
d
e
f

FIGURE 6.21
 Histogram equalization followed by saturation adjustment in the HSI color space: (a) input image; (b) mapped result; (c) intensity component mapping function and cumulative distribution function; (d) saturation component mapping function; (e) input image's component histograms; and (f) mapped result's component histograms.

تابع ICE

کاربرد در تعدیل هیستوگرام



a	b
c	d
e	f

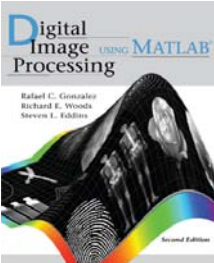
Histogram equalization followed by saturation adjustment in the HSI color space:
 (a) input image;
 (b) mapped result;
 (c) intensity component mapping function and cumulative distribution function;
 (d) saturation component mapping function;
 (e) input image's component histograms; and
 (f) mapped result's component histograms.

فیلتر کردن تصویر رنگی در حوزه‌ی مکان

مراحل

```
% Extract image components
fR = fc(:,:,1);
fG = fc(:,:,2);
fB = fc(:,:,3);
% Filter each component separately
% for example:
fR_filtered = imfilter(fR, w, 'replicate');
% Reconstruct filtered RGB image:
fc_filtered = cat(3,fR_filtered,fG_filtered,fB_filtered);
```

```
fc_filtered = imfilter(fc, w);
```



Chapter 7 Color Image Processing



a b
c d

FIGURE 6.22

(a) RGB image. (b) through (d) The red, green and blue component images, respectively.

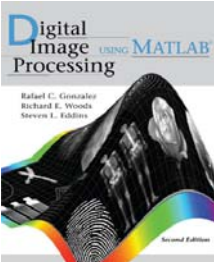
فیلتر کردن تصویر رنگی در حوزه‌ی مکان

یک تصویر رنگی و مؤلفه‌های RGB آن



a	b
c	d

(a) RGB image;
(b) through
(d) are the red,
green and blue
component
images,
respectively.



Chapter 7

Color Image Processing



FIGURE 6.23 From left to right: hue, saturation, and intensity components of Fig. 6.22(a).

فیلتر کردن تصویر رنگی در حوزه‌ی مکان

یک تصویر رنگی و مؤلفه‌های HSI آن



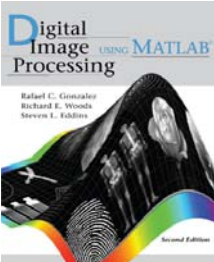
```
h = rgb2hsl(fc);
H = h(:, :, 1);
S = h(:, :, 2);
I = h(:, :, 3);
```



a b c

FIGURE

From left to right: hue, saturation, and intensity components



Chapter 7

Color Image Processing



a b c

FIGURE 6.24 (a) Smoothed RGB image obtained by smoothing the R , G , and B image planes separately. (b) Result of smoothing only the intensity component of the HSI equivalent image. (c) Result of smoothing all three HSI components equally.

فیلتر کردن تصویر رنگی در حوزه‌ی مکان

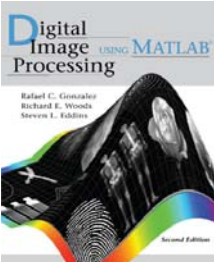
هموارسازی



a b c

FIGURE (a) Smoothed RGB image obtained by smoothing the R , G , and B image planes separately. (b) Result of smoothing only the intensity component of the HSI equivalent image. (c) Result of smoothing all three HSI components equally.

```
w = fspecial('average', 25);
I_filtered = imfilter(I, w, 'replicate');
h = cat(3, H, S, I_filtered);
f = hsi2rgb(h); % Back to RGB for comparison.
imshow(f);
```



Chapter 7 Color Image Processing

a b

FIGURE 6.25
(a) Blurred image. (b) Image
enhanced using
the Laplacian.



فیلتر کردن تصویر رنگی در حوزه‌ی مکان

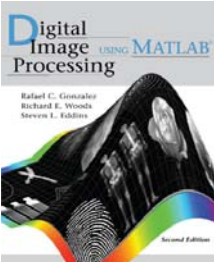
تیزسازی تصویر رنگی با استفاده از لاپلاسیان



a b

(a) Blurred image.
(b) Image enhanced using the Laplacian, followed by contrast enhancement

```
lapmask = [1 1 1; 1 -8 1; 1 1 1] ;  
fb = tofloat(fb);  
fen = fb - imfilter(fb, lapmask, 'replicate');  
imshow(fen)
```



Chapter 7

Color Image Processing

z_1	z_2	z_3	-1	-2	-1	-1	0	1
z_4	z_5	z_6	0	0	0	-2	0	2
z_7	z_8	z_9	1	2	1	-1	0	1

a b c

FIGURE 6.26 (a) A small neighborhood. (b) and (c) Sobel masks used to compute the gradient in the x (vertical) and y (horizontal) directions, respectively, with respect to the center point of the neighborhood.

عمل مستقیم در فضای برداری RGB

آشکارسازی لبه توسط گرادیان: ماسک‌های سوبل

z_1	z_2	z_3	-1	-2	-1	-1	0	1
z_4	z_5	z_6	0	0	0	-2	0	2
z_7	z_8	z_9	1	2	1	-1	0	1

a b c

FIGURE (a) A small neighborhood. (b) and (c) Sobel masks used to compute the gradient in the x (vertical) and y (horizontal) directions, respectively, with respect to the center point of the neighborhood.

$$[VG, A, PPG] = \text{colorgrad}(f, T)$$

Chapter 7

Color Image Processing

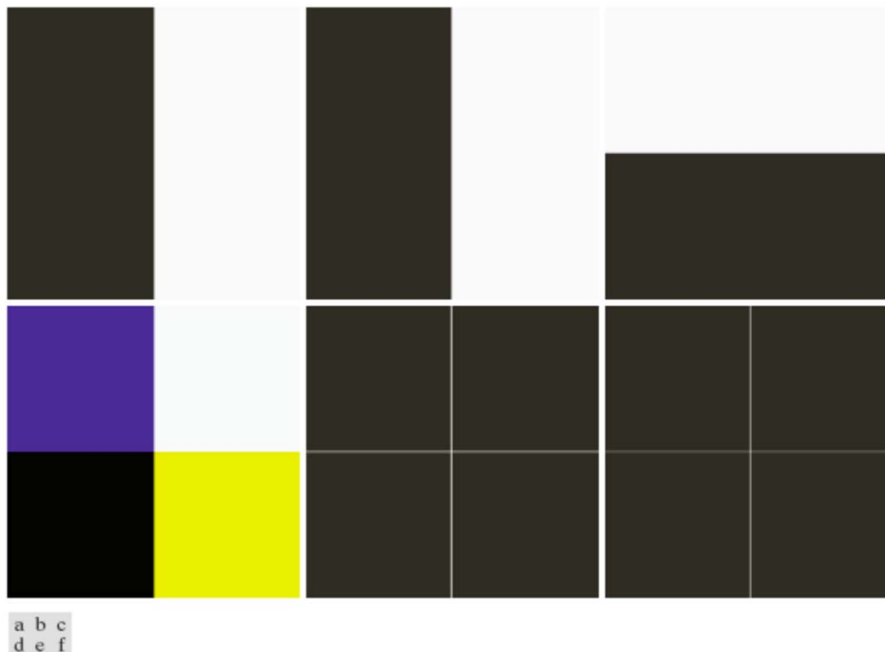


FIGURE 6.27 (a) through (c) RGB component images. (d) Corresponding color image. (e) Gradient computed directly in RGB vector space. (f) Composite gradient obtained by computing the 2-D gradient of each RGB component image separately and adding the results.

عمل مستقیم در فضای برداری RGB

آشکارسازی لبه توسط گرادیان

$$[VG, A, PPG] = \text{colorgrad}(f, T)$$

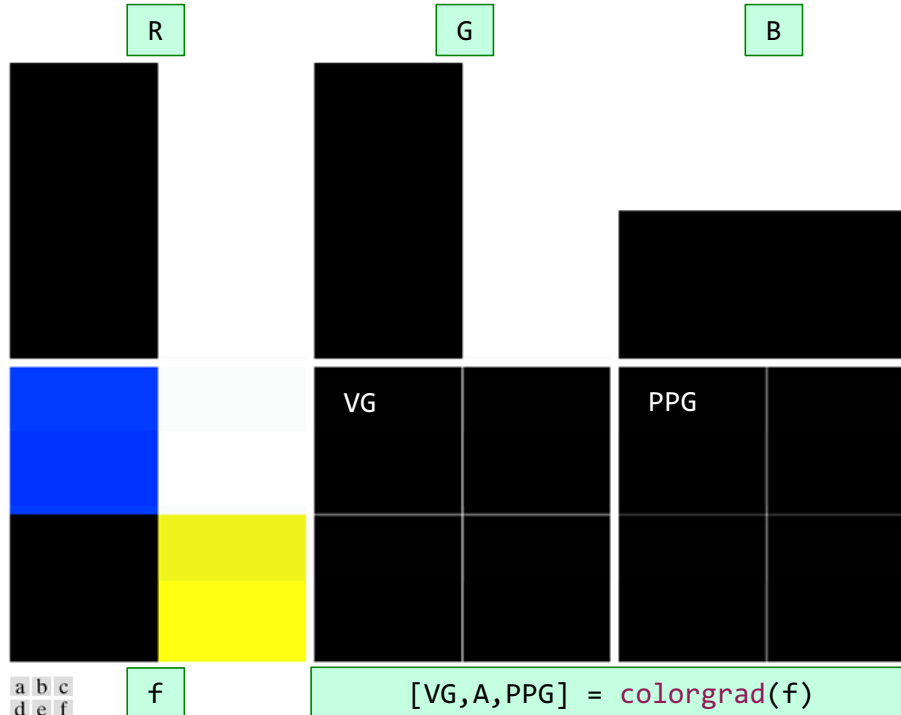
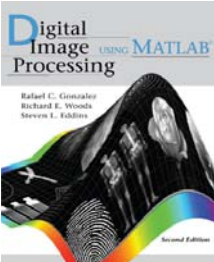


FIGURE (a) through (c) RGB component images (black is 0 and white is 255). (d) Corresponding color image. (e) Gradient computed directly in RGB vector space. (f) Composite gradient obtained by computing the 2-D gradient of each RGB component image separately and adding the results.



Chapter 7 Color Image Processing



عمل مستقیم در فضای برداری RGB

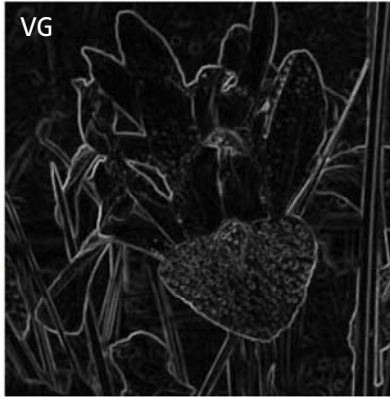
آشکارسازی لبه توسط گرادیان

$$[VG, A, PPG] = \text{colorgrad}(f, T)$$

f



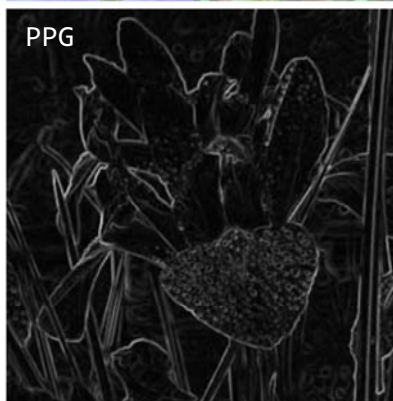
VG



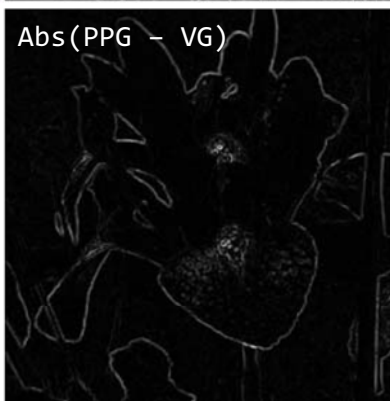
a	b
c	d

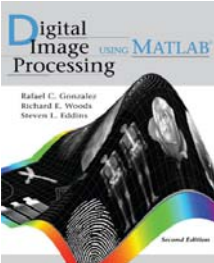
(a) RGB image.
 (b) Gradient computed in RGB vector space.
 (c) Gradient computed as in Fig. 6.24(f).
 (d) Absolute difference between (b) and (c), scaled to the range [0, 1].

PPG



Abs (PPG - VG)





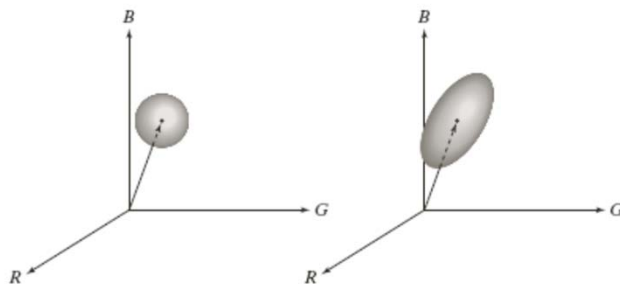
Chapter 7

Color Image Processing

a b

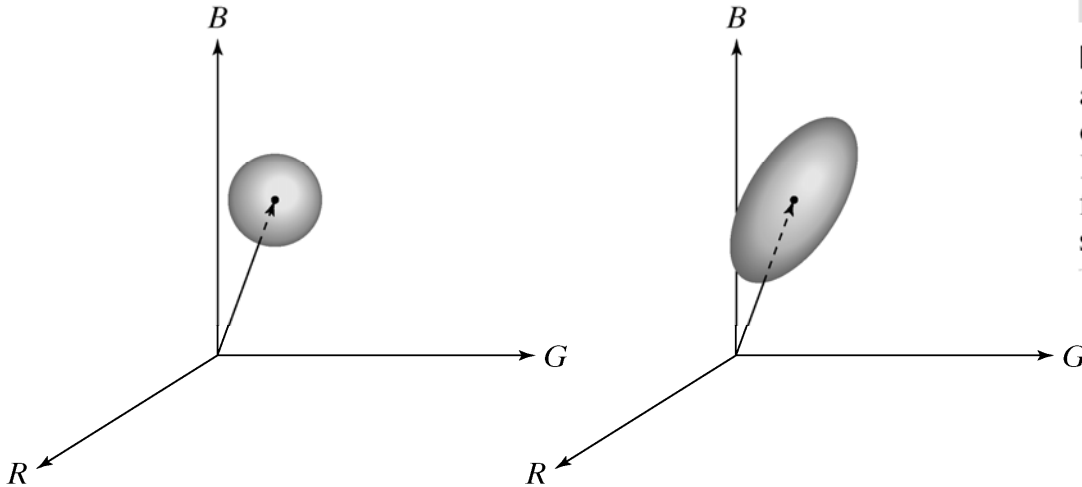
FIGURE 6.29

Two approaches
for enclosing data
in RGB vector
space for the
purpose of
segmentation.



عمل مستقیم در فضای برداری RGB

بخش‌بندی تصویر در فضای برداری RGB

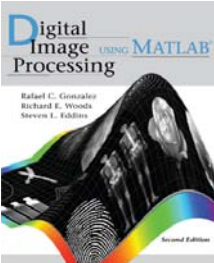


a b

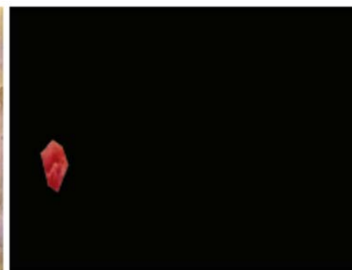
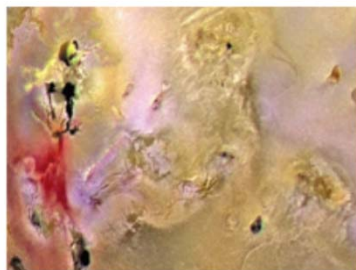
FIGURE Two approaches for enclosing data in RGB vector space for the purpose of segmentation.

$S = \text{colorseg}(\text{method}, f, T, \text{parameters})$

'euclidean'
'mahalanobis'



Chapter 7 Color Image Processing



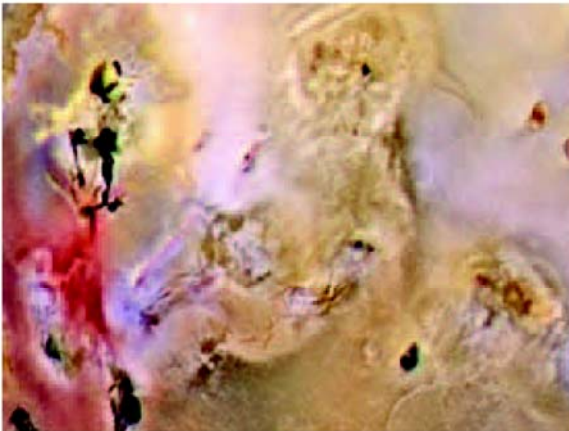
a b

FIGURE 6.30

(a) Pseudocolor of the surface of Jupiter's Moon Io. (b) Region of interest extracted interactively using function `roipoly`. (Original image courtesy of NASA.)

عمل مستقیم در فضای برداری RGB

بخش‌بندی تصویر در فضای برداری RGB : مثال



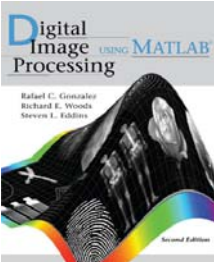
a b

(a) Pseudocolor of the surface of Jupiter's Moon Io.
(b) Region of interest extracted interactively using function `roipoly`.

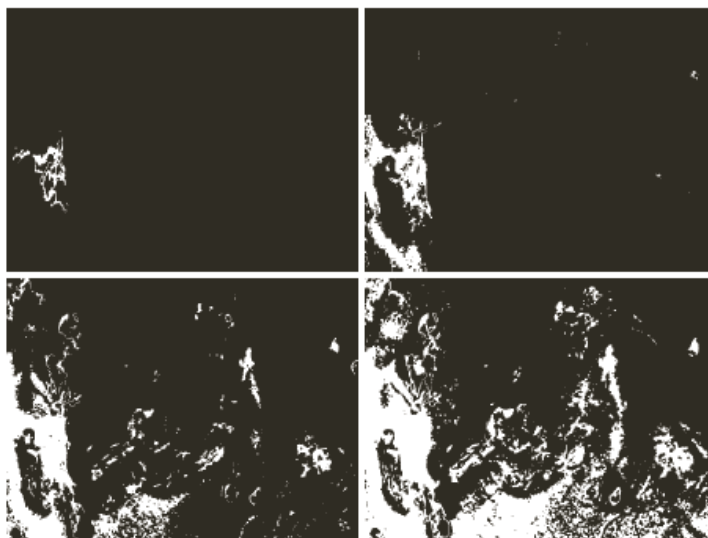
```
mask = roipoly(f); % Select region interactively.
red = immultiply(mask, f(:, :, 1));
green = immultiply(mask, f(:, :, 2));
blue = immultiply(mask, f(:, :, 3));
g = cat(3, red, green, blue);
figure, imshow(g);
```

```
[M,N,k] = size(g);
I = reshape(g, M*N, 3);
idx = find(mask);
I = double(I(idx, 1:3));
[C,m] = covmatrix(I);
d = diag(C);
sd = sqrt(d)'
```

22.0643 **24.2442** 16.1806



Chapter 7 Color Image Processing



a b
c d

FIGURE 6.31
(a) through
(d) Segmentation
of Fig. 6.30(a)
using option
'euclidean' in
function
colorseg with
 $T = 25, 50, 75$, and
100, respectively.

عمل مستقیم در فضای برداری RGB

بخش‌بندی تصویر در فضای برداری RGB : مثال

```
E25 = colorseg(method,f,25,'euclidean', m)
```

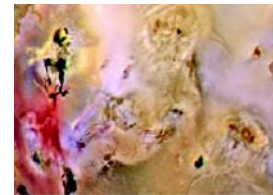
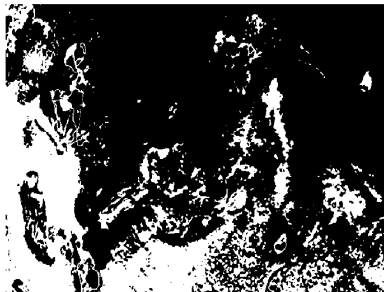
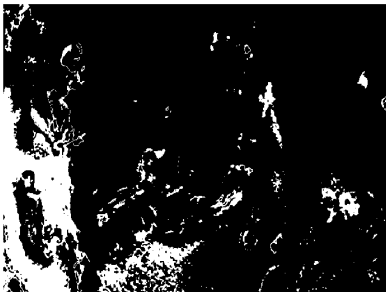


```
E50 = colorseg(method,f,50,'euclidean', m)
```



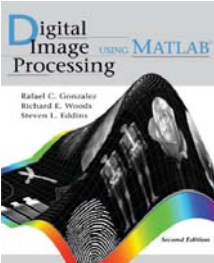
a b
c d

(a) through
(d) Segmentation
of Fig. 6.27(a)
using option
'euclidean' in
function
colorseg with
 $T = 25, 50, 75,$
and 100,
respectively.



```
E75 = colorseg(method,f,25,'euclidean', m)
```

```
E100 = colorseg(method,f,50,'euclidean', m)
```



Chapter 7 Color Image Processing



a b
c d

FIGURE 6.32

(a) through (d)
Segmentation of
Fig. 6.30(a)
using option
'mahalanobis' in
function
colorseg with
 $T = 25, 50, 75$, and
100, respectively.
Compare with
Fig. 6.31.

عمل مستقیم در فضای برداری RGB

بخش‌بندی تصویر در فضای برداری RGB: مثال

```
E25 = colorseg(method,f,25,'mahalanobis', m)
```

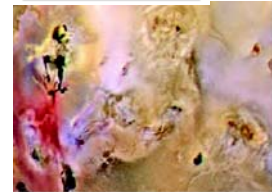


```
E50 = colorseg(method,f,50,'mahalanobis', m)
```



a b
c d

(a) through (d) Segmentation of Fig. 6.27(a) using option 'mahalanobis' in function colorseg with $T = 25, 50, 75,$ and 100 , respectively. Compare with Fig. 6.28.

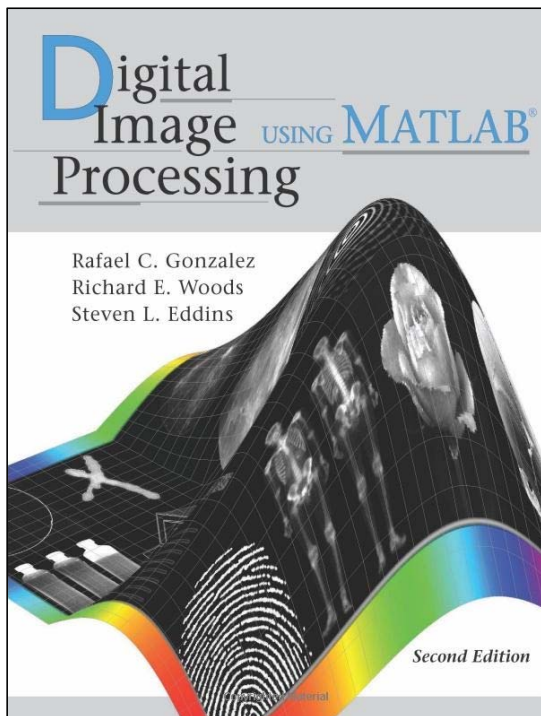


```
E75 = colorseg(method,f,25,'mahalanobis', m)
```



```
E100 = colorseg(method,f,50,'mahalanobis', m)
```





Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins,
Digital Image Processing Using MATLAB®,
Second Edition, Pearson Prentice Hall, 2008.
Chapter 7