مبانی بینایی کامپیوتری

درس ۷ب

پردازش تصویر رنگی در متلب

Color Image Processing in MATLAB®

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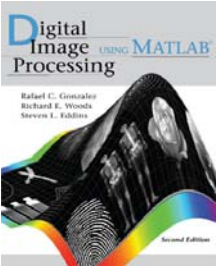
دانشگاه تهران

http://courses.fouladi.ir/fcvision



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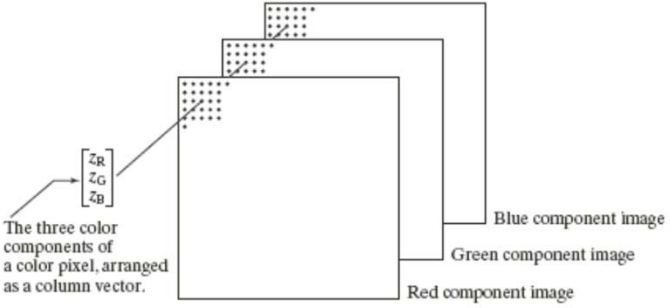
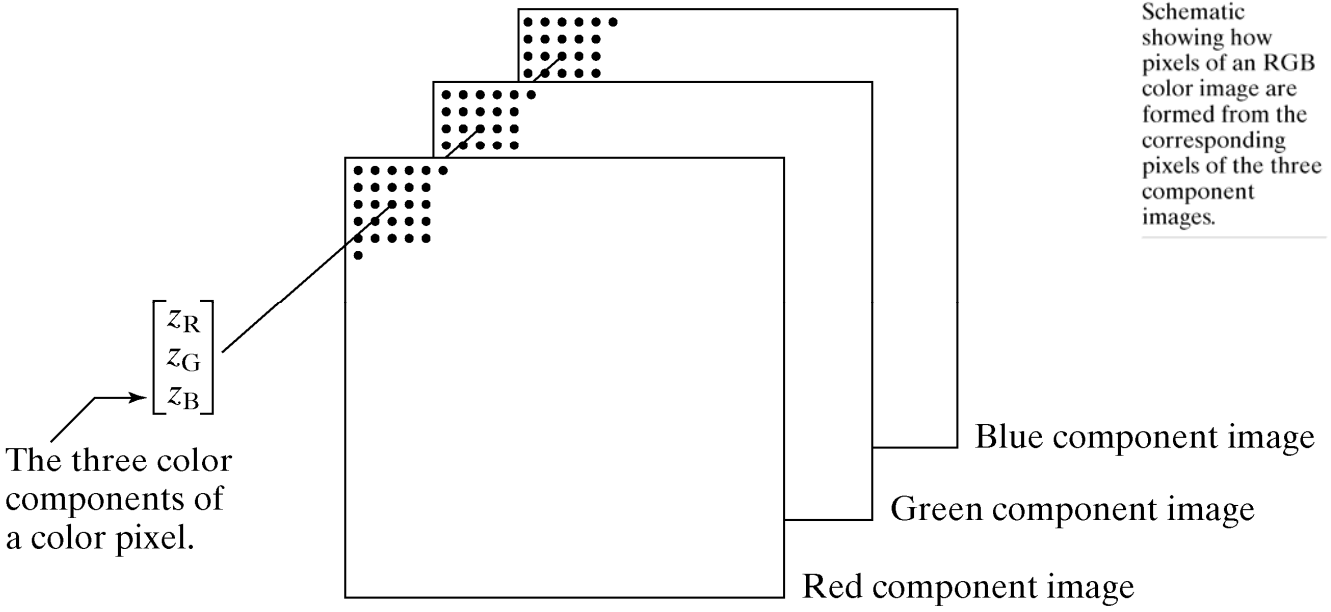


FIGURE 6.1 Schematic showing how pixels of an RGB color image are formed from the corresponding pixels of the three component images.

بازنمایی تصاویر رنگی در متلب

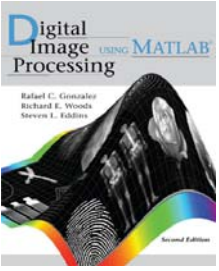
تصاویر RGB

```
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)
```



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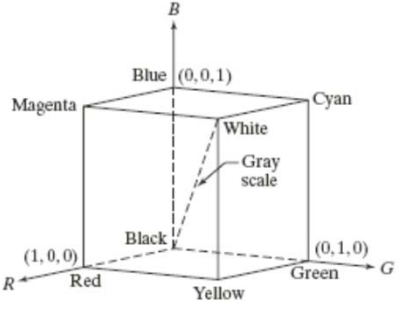
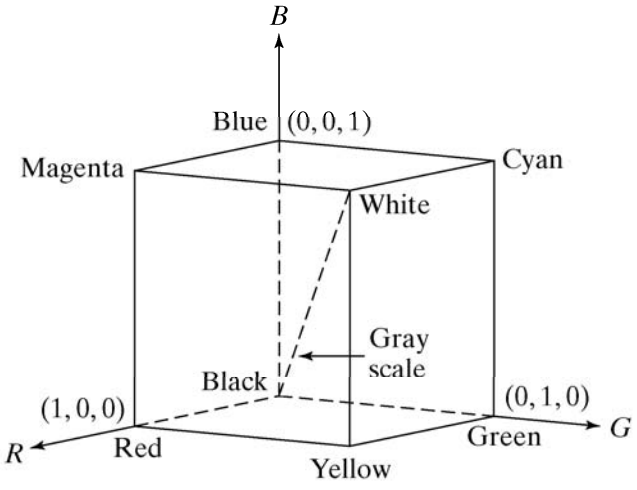
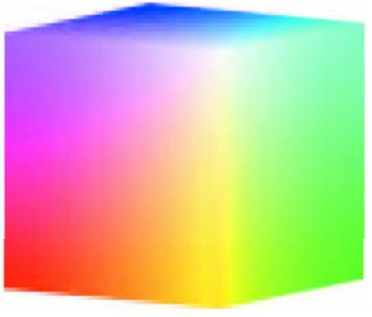
a b
FIGURE 6.2
(a) Schematic of the RGB color cube showing the primary and secondary colors of light at the vertices. Points along the main diagonal have gray values from black at the origin to white at point (1, 1, 1). (b) The RGB color cube.



مکعب رنگ RGB

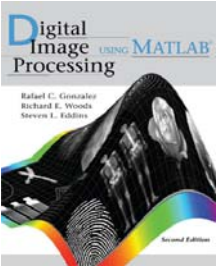




a b

(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)
```



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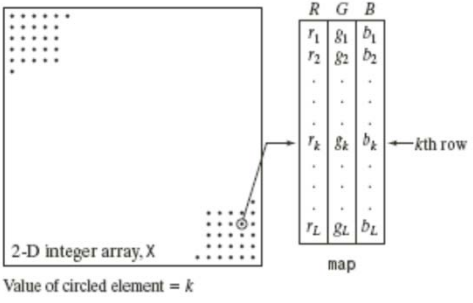
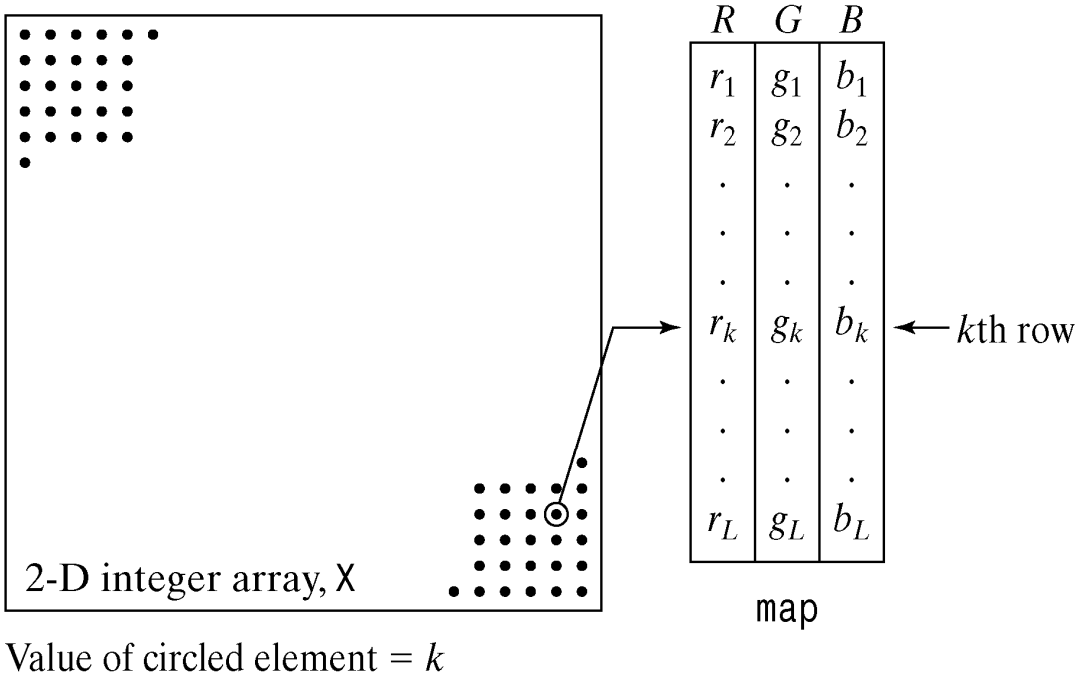


FIGURE 6.3 Elements of an indexed image. The value of an element of integer array X determines the row number in the color map. Each row contains an RGB triplet, and L is the total number of rows.

تصاویر شاخص‌گذاری‌شده

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.

```
imshow(X, map)
```


MATLAB

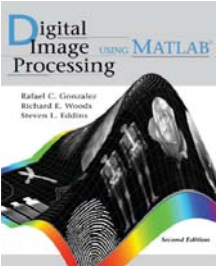


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TABLE 6.1
RGB values of some basic colors. The long or short names (enclosed by single quotes) can be used instead of a numerical triplet to specify an RGB color.

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.

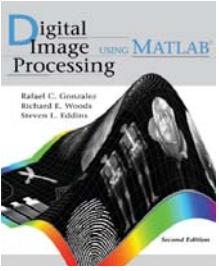

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TABLE 6.2 MATLAB predefined color maps.

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 `ColorOrder` property and a shade of gray. Consult the help page for function `ColorOrder` 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.

MATLAB

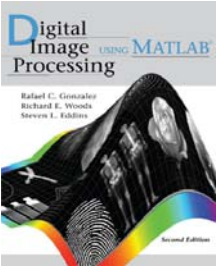

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TABLE 6.3 Toolbox functions for converting between RGB, indexed, and gray-scale images.

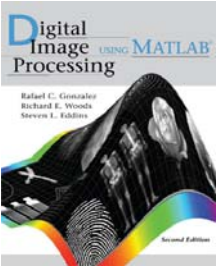
Function	Description
`dither`	Creates an indexed image from an RGB image by dithering.
`grayslice`	Creates an indexed image from a gray-scale intensity image by thresholding.
`gray2ind`	Creates and indexed image from a gray-scale intensity image.
`ind2gray`	Creates a gray-scale image from an indexed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

MATLAB



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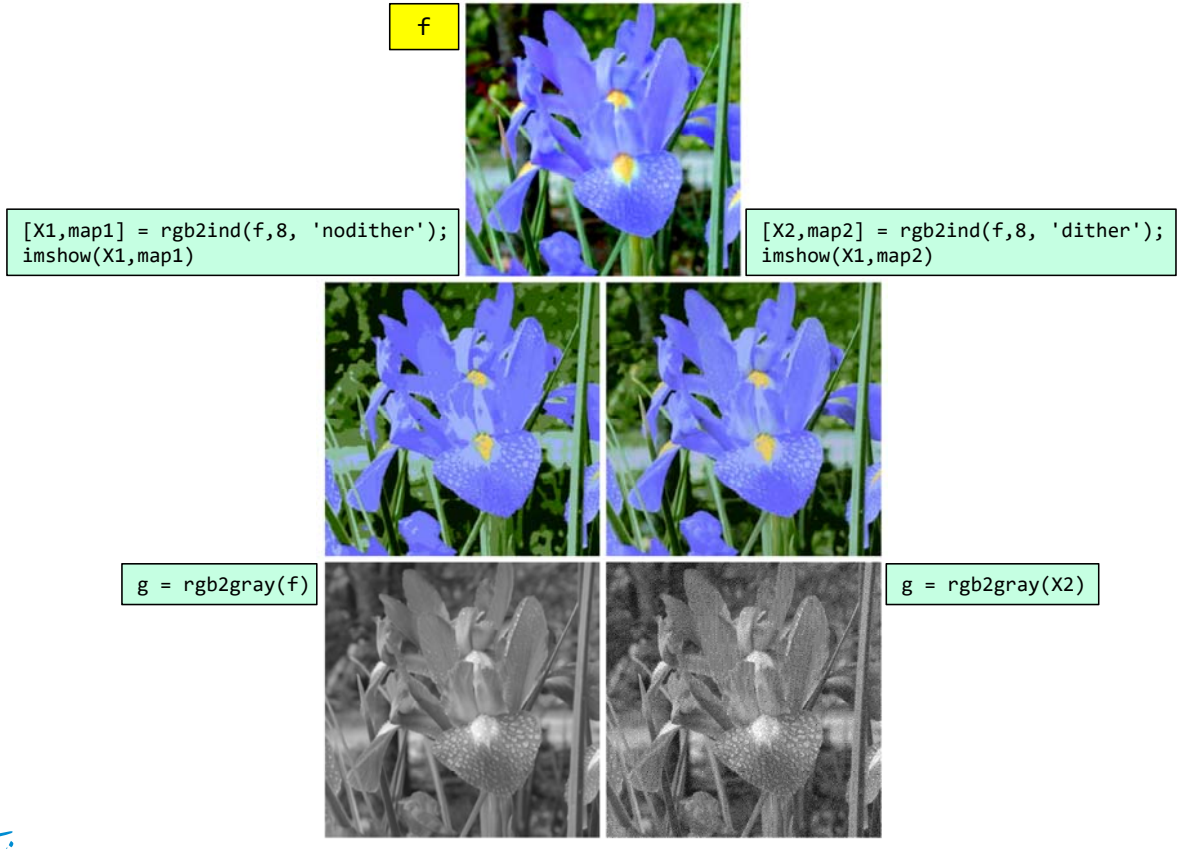
a
b c
d e
FIGURE 6.4
(a) RGB image. (b) Number of colors reduced to 8, with no dithering. (c) Number of colors reduced to 8, with dithering. (d) Gray-scale version of (a) obtained using function `rgb2gray`. (e) Dithered gray-scale image (this is a binary image).

توابع تبدیل فضای رنگ در متلب

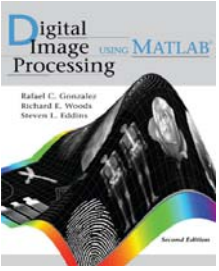
مثال



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).

MATLAB



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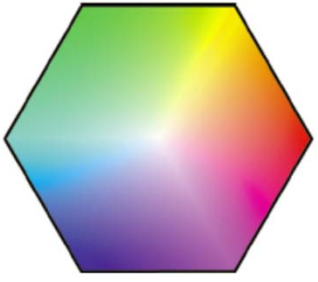
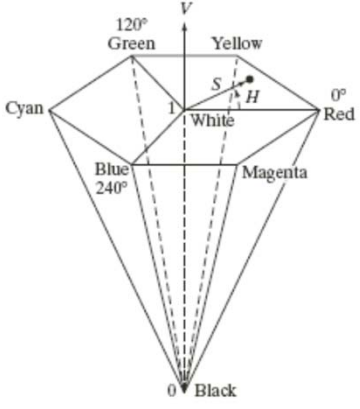
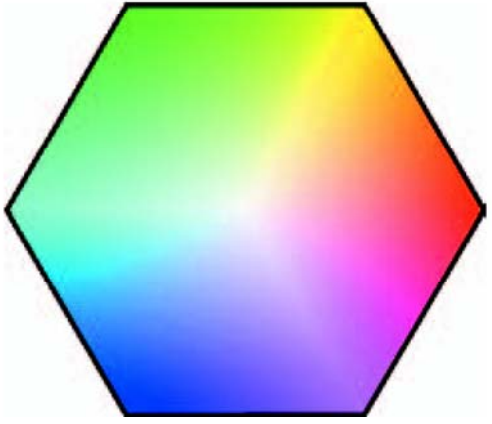
a b
FIGURE 6.5
(a) The HSV color hexagon. (b) The HSV hexagonal cone.

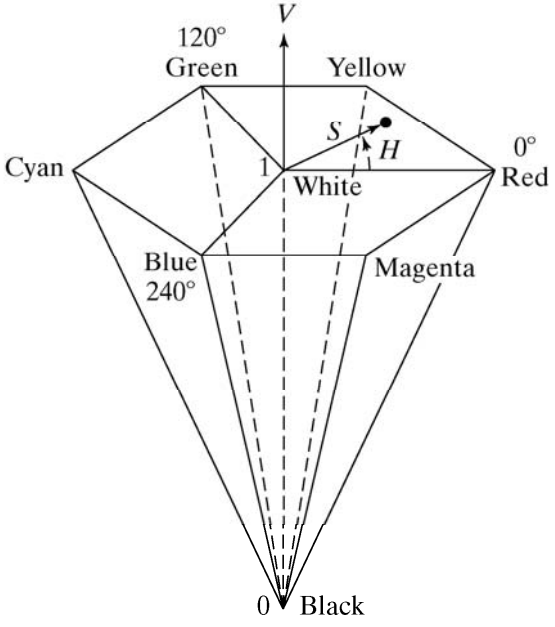




فضای رنگ HSV

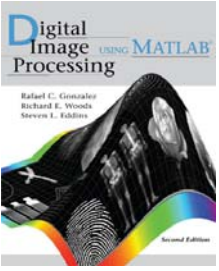
شش‌وجهی رنگ HSV و مخروط شش‌وجهی HSV





a b

(a) The HSV color hexagon. (b) The HSV hexagonal cone.



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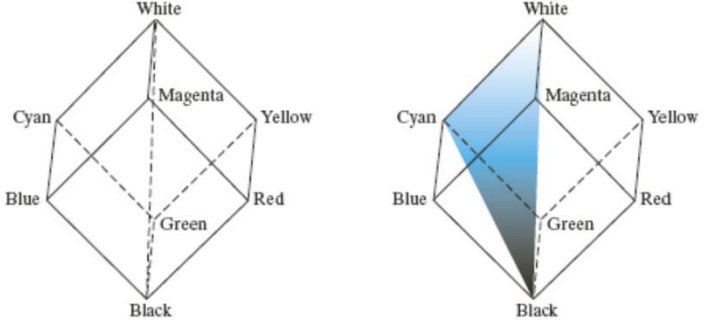
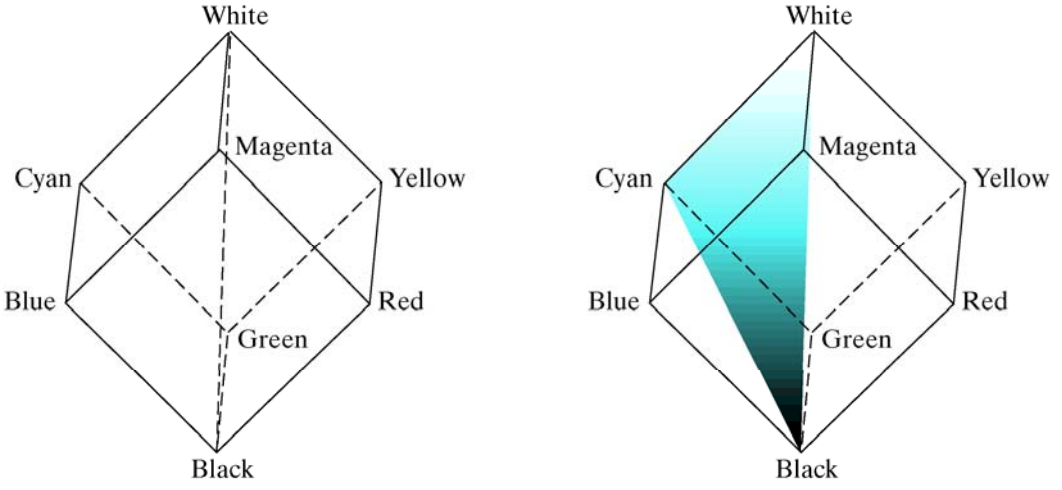
a b

FIGURE 6.6 Relationship between the RGB and HSI color models.



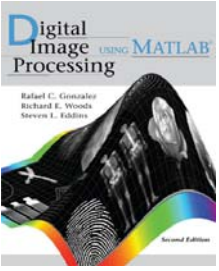
مدل رنگ HSI

ارتباط میان مدل‌های رنگ RGB و HSI



a b

Relationship between the RGB and HSI color models.



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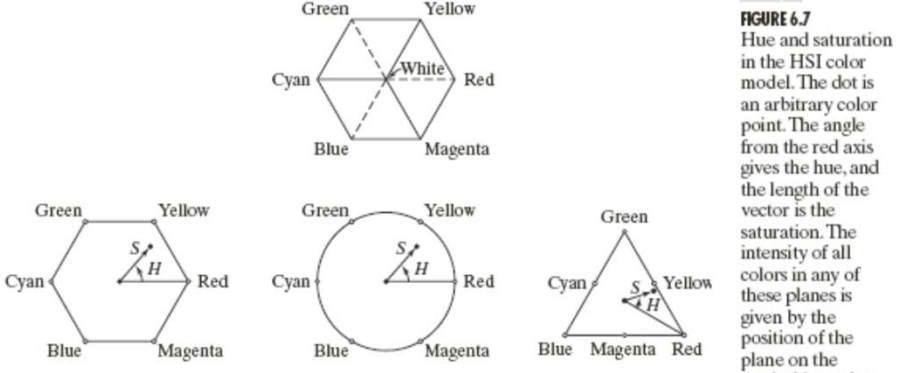
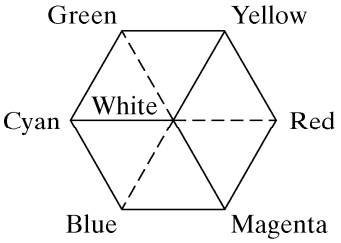


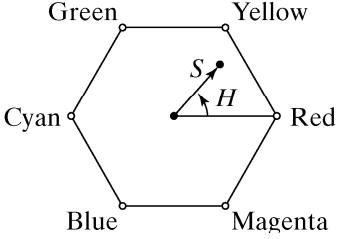
a
b c d

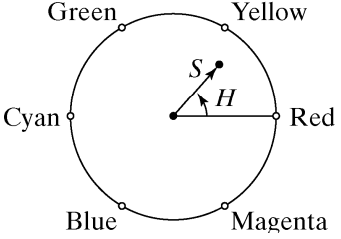
FIGURE 6.7
Hue and saturation in the HSI color model. The dot is an arbitrary color point. The angle from the red axis gives the hue, and the length of the vector is the saturation. The intensity of all colors in any of these planes is given by the position of the plane on the vertical intensity axis.

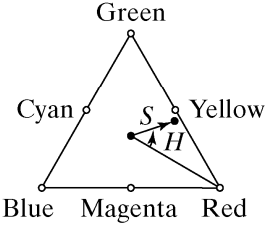
مدل رنگ HSI

فام و اشباع در مدل رنگ HSI



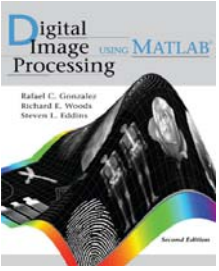






a
b c d

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.



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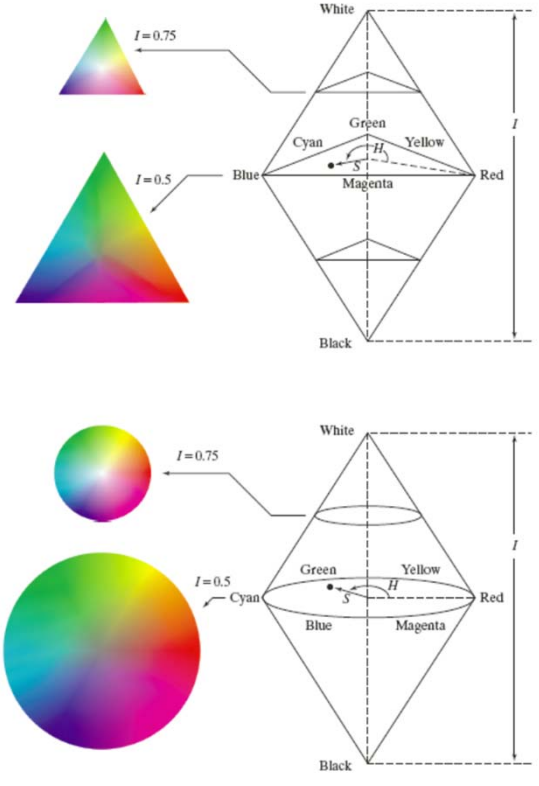
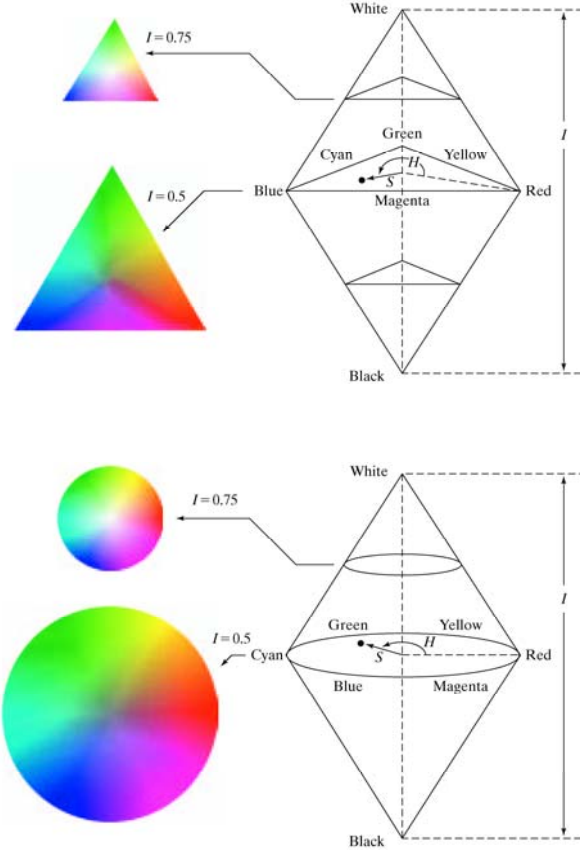


a
b

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.

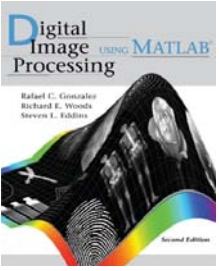
مدل رنگ HSI

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.



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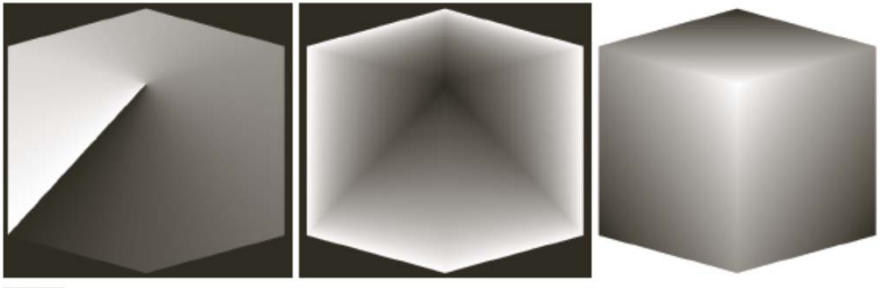
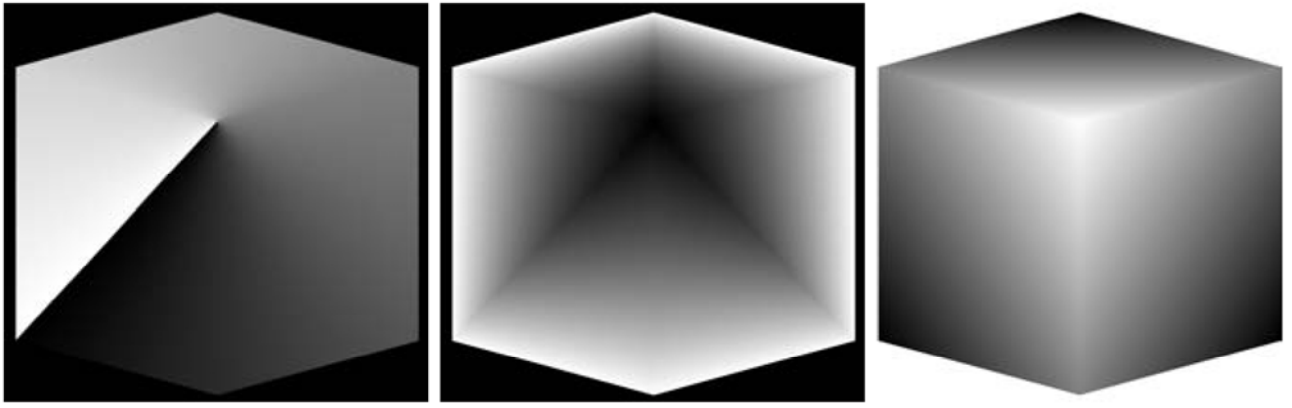


a b c

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.

MATLAB

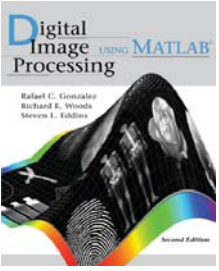


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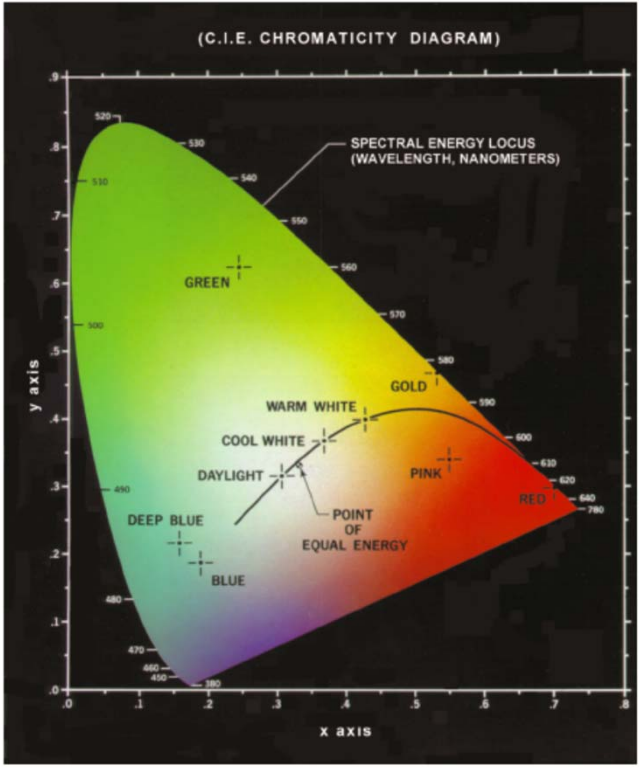
FIGURE 6.10 CIE chromaticity diagram. (Courtesy of the General Electric Co. Lamp Business Division.)



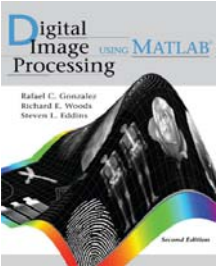


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TABLE 6.4 Device-independent CIE color spaces supported by the Image Processing Toolbox.

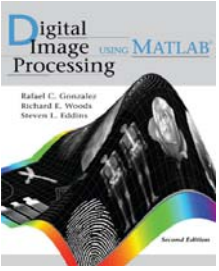
Color space	Description
XYZ	The original, 1931 CIE color space specification.
xyY	CIE specification that provides normalized chromaticity values. The capital Y value represents luminance and is the same as in XYZ.
uvL	CIE specification that attempts to make the chromaticity plane more visually uniform. 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.
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**.



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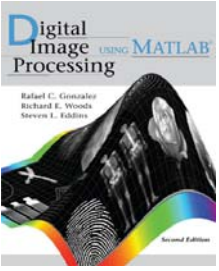
types used in makecform	Color spaces
'lab2lch', 'lch2lab'	L*a*b* and L*ch
'lab2srgb', 'srgb2lab'	L*a*b* and sRGB
'lab2xyz', 'xyz2lab'	L*a*b* and XYZ
'srgb2xyz', 'xyz2srgb'	sRGB and XYZ
'upvpl2xyz', 'xyz2upvpl'	u´v´L and XYZ
'uvl2xyz', 'xyz2uvl'	uvL and XYZ
'xyl2xyz', 'xyz2xyl'	xyY and XYZ

TABLE 6.5
Device-independent color-space conversions supported by the Image Processing Toolbox.



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Color Image Processing

FIGURE 6.11
A perceptually uniform color scale based on the L*a*b* color space.

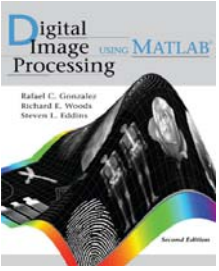

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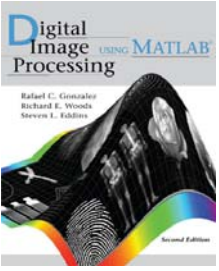
TABLE 6.6
ICC profile rendering intents.

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.



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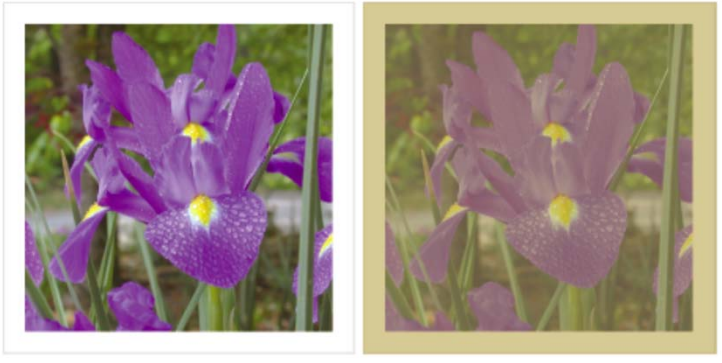
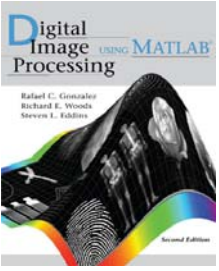


a b
FIGURE 6.12
Soft proofing example. (a) Original image with white border. (b) Simulation of image appearance when printed on newsprint.



Chapter 7
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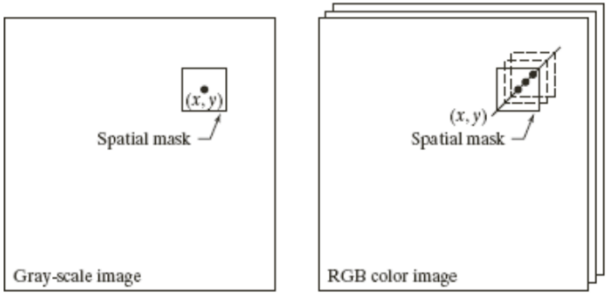
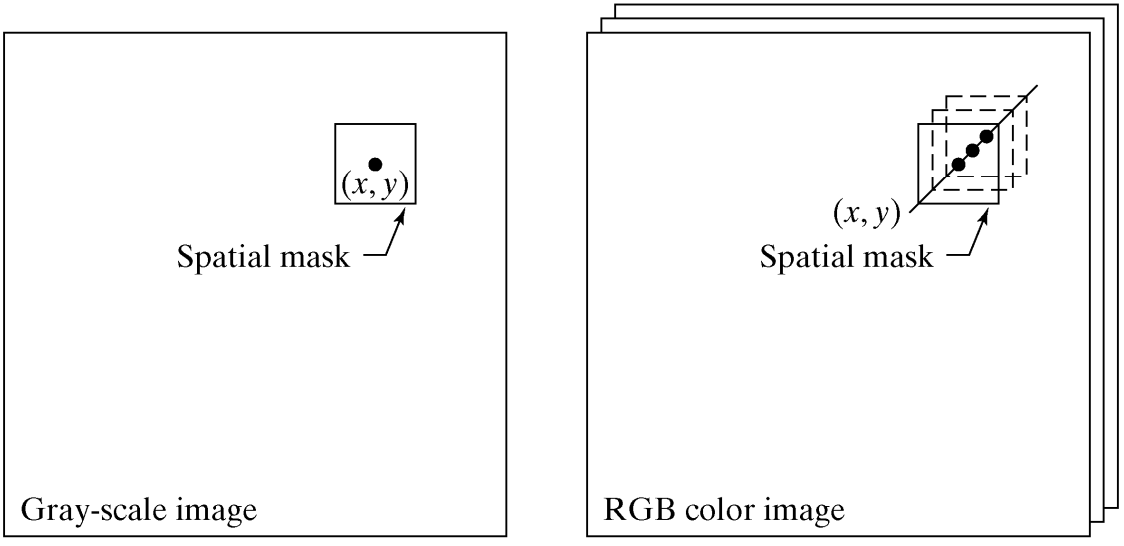
a b

FIGURE 6.13
Spatial masks for (a) gray-scale and (b) RGB color images.



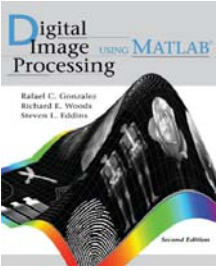
پردازش تصویر رنگی

ماسک‌های مکانی



a b

Spatial masks for gray-scale and RGB color images.



Chapter 7
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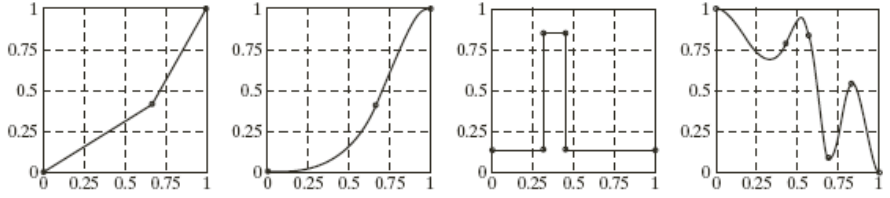
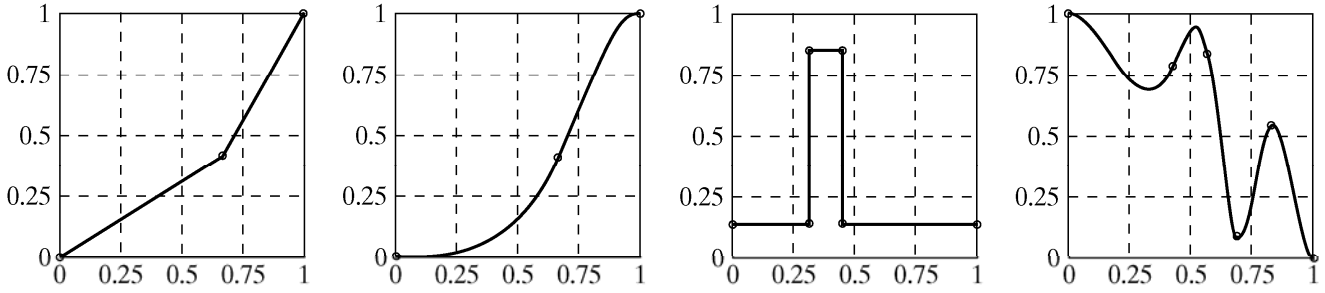


a b c d

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

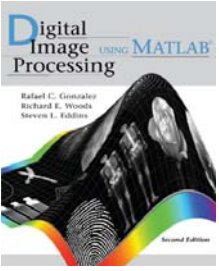
پردازش تصویر رنگی

توابع نگاشت



a b c d

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



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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.

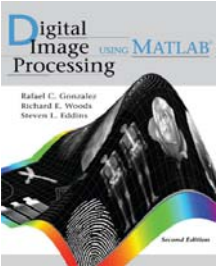
TABLE 6.7
Valid inputs for function `ice`.

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`.



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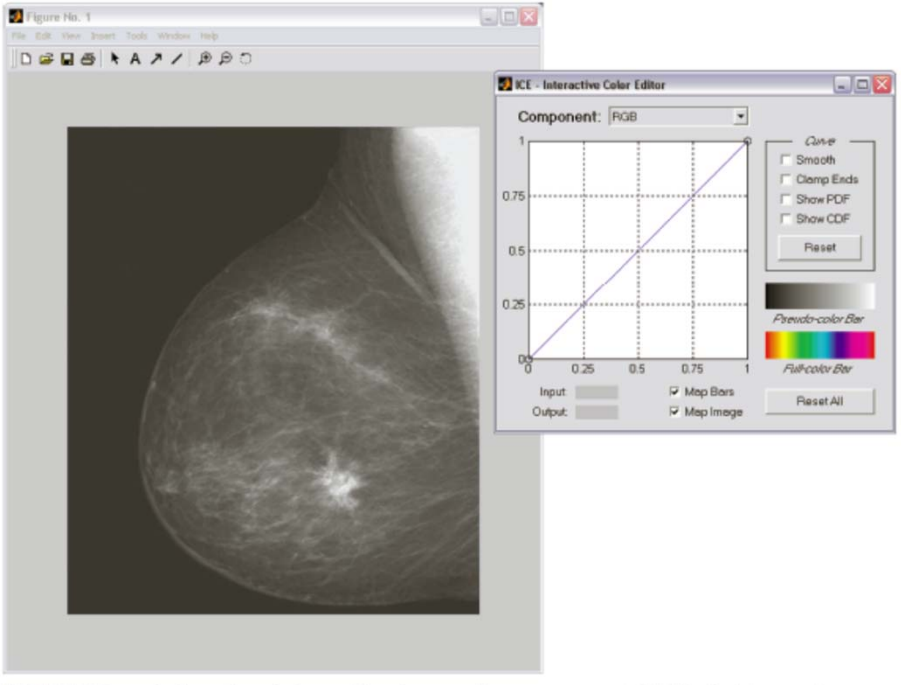
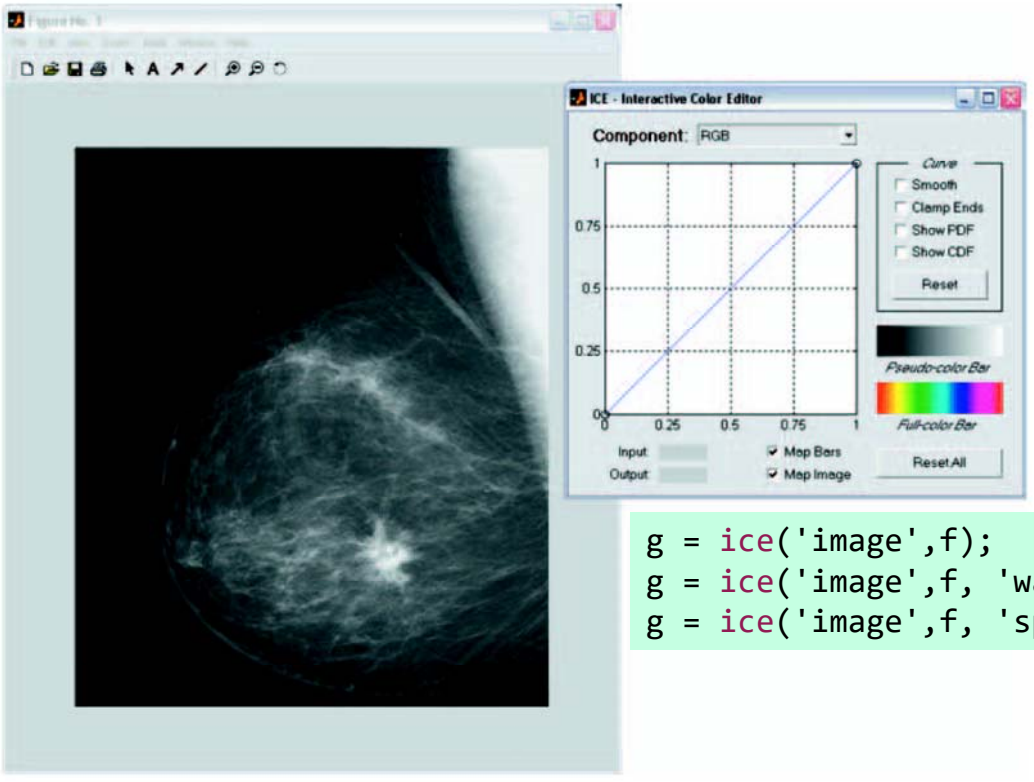


FIGURE 6.15 The typical opening windows of function `ice`. (Image courtesy of G.E. Medical Systems.)

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.

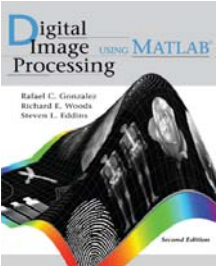


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TABLE 6.8 Manipulating control points with the mouse.

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.

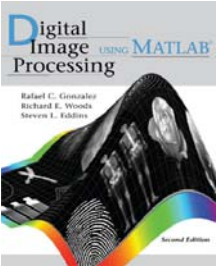

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TABLE 6.9 Function of the checkboxes and pushbuttons in the `ice` GUI.

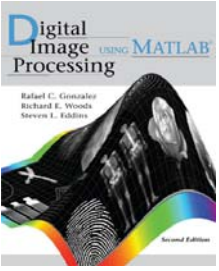
GUI Element	Description
Smooth	Checked for cubic spline (smooth curve) interpolation. If unchecked, piecewise linear interpolation is used.
Clamp Ends	Checked to force the starting and ending curve slopes in cubic spline interpolation to 0. Piecewise linear interpolation is not affected.
Show PDF	Display 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 *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.

Function of the checkboxes and pushbuttons in the `ice` GUI.



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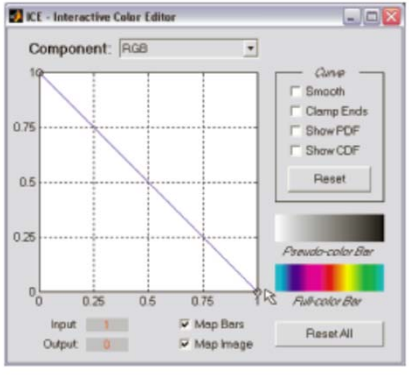
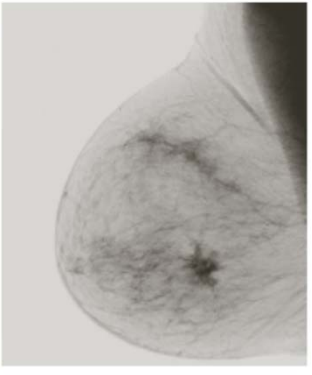
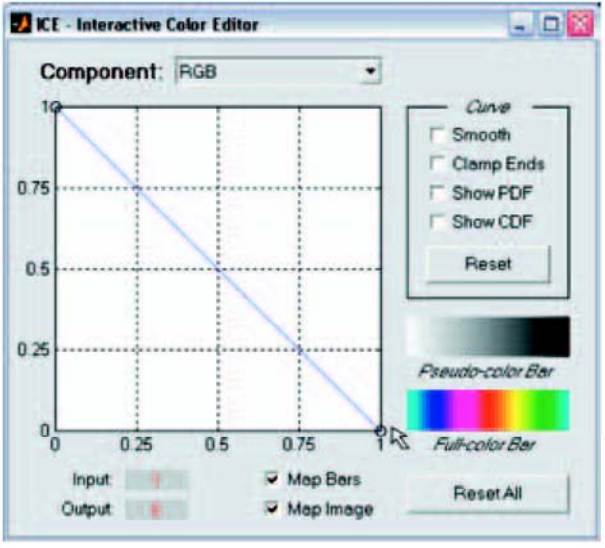


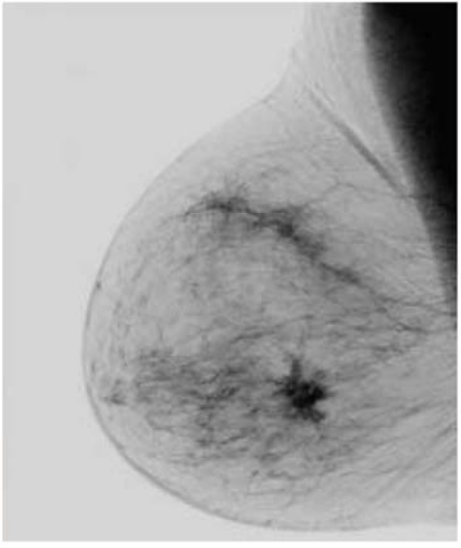


a b
FIGURE 6.16
(a) A negative mapping function, and (b) its effect on the monochrome image of Fig. 6.15.

تابع ICE

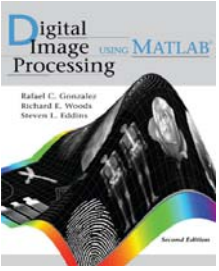
تابع نگاشت نگاتیو





a b

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



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a b

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

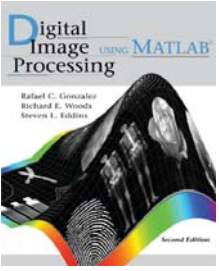
پردازش تصویر رنگی

نگاتیو کردن تصویر رنگی

a b

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

MATLAB



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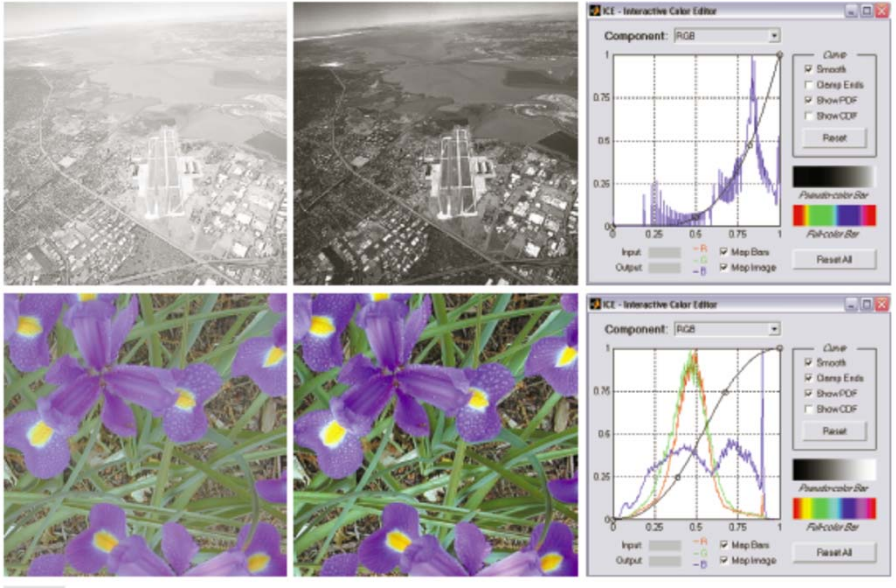
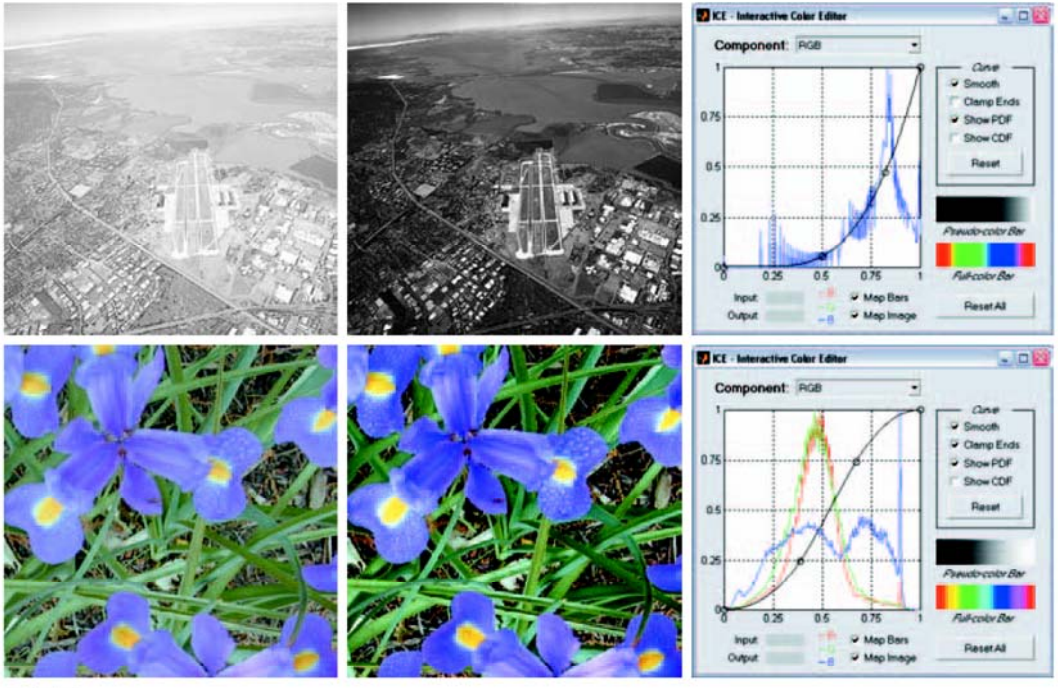


a b c
d e f

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.)

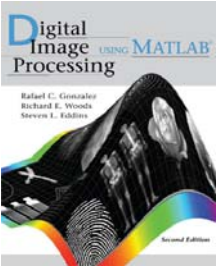
تابع ICE

کاربرد در به‌سازی کنتراست تک‌رنگ و تمام‌رنگی



a b c
d e f

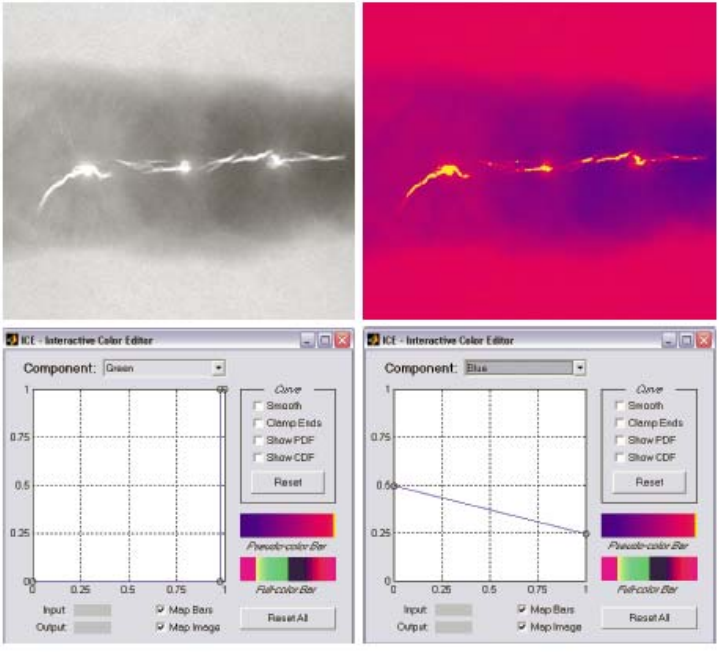
FIGURE Using function `ice` for monochrome and full color contrast enhancement: (a) and (d) are the input images, both of which have a "washed-out" appearance; (b) and (e) show the processed results; (c) and (f) are the `ice` displays.



Chapter 7
Color Image Processing

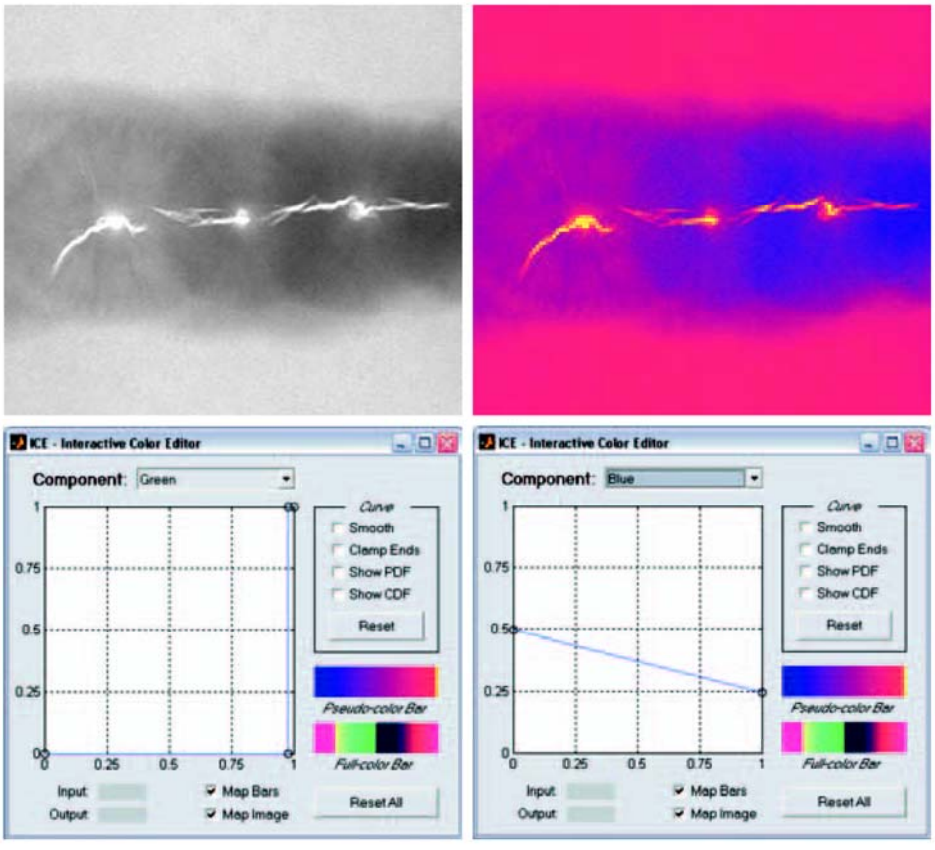
a b
c d

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

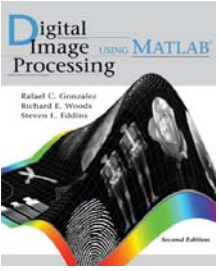
کاربرد در نگاشت شبه‌رنگی



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.

MATLAB



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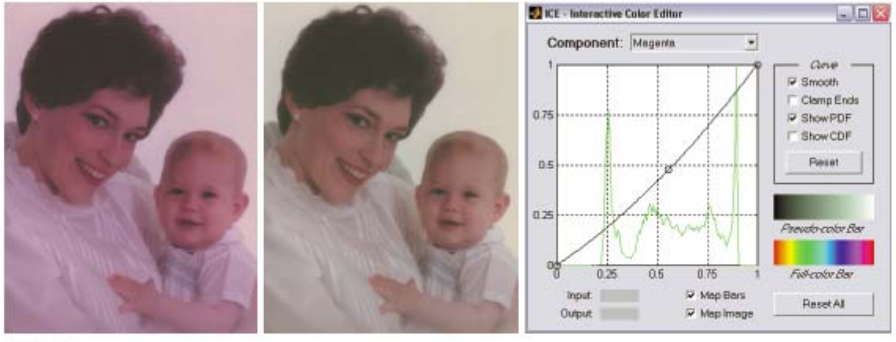
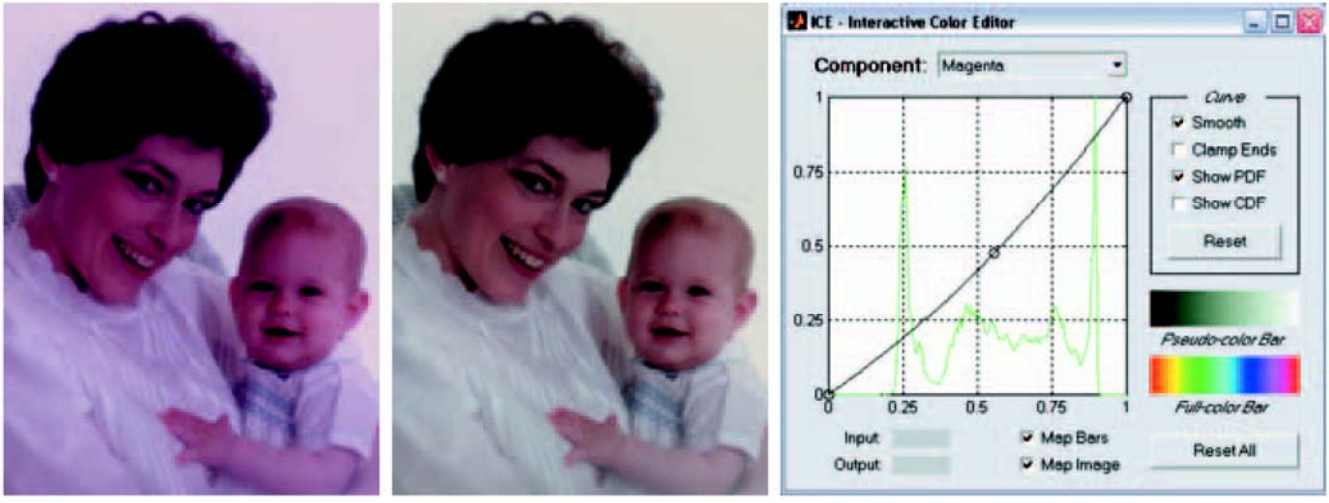


a b c

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.

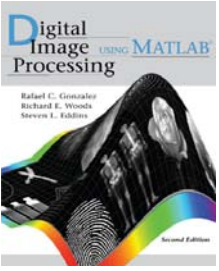
تابع ICE

کاربرد در متوازن‌سازی 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.



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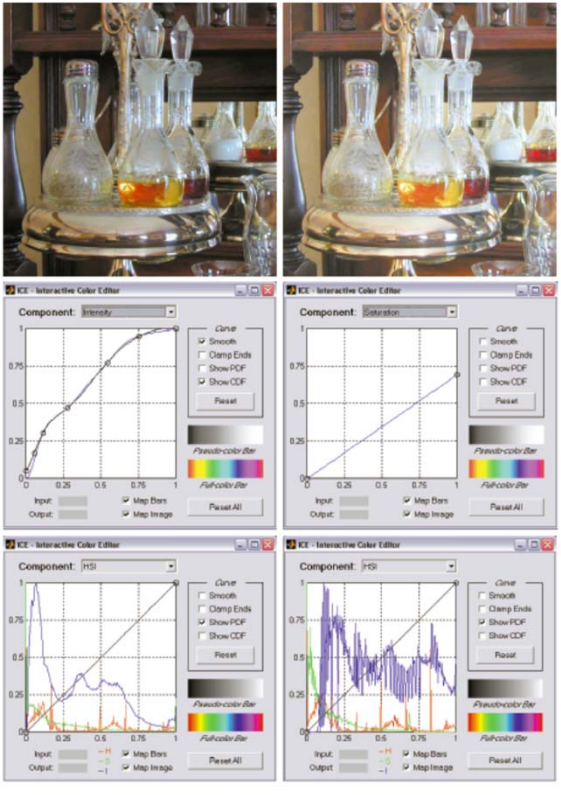
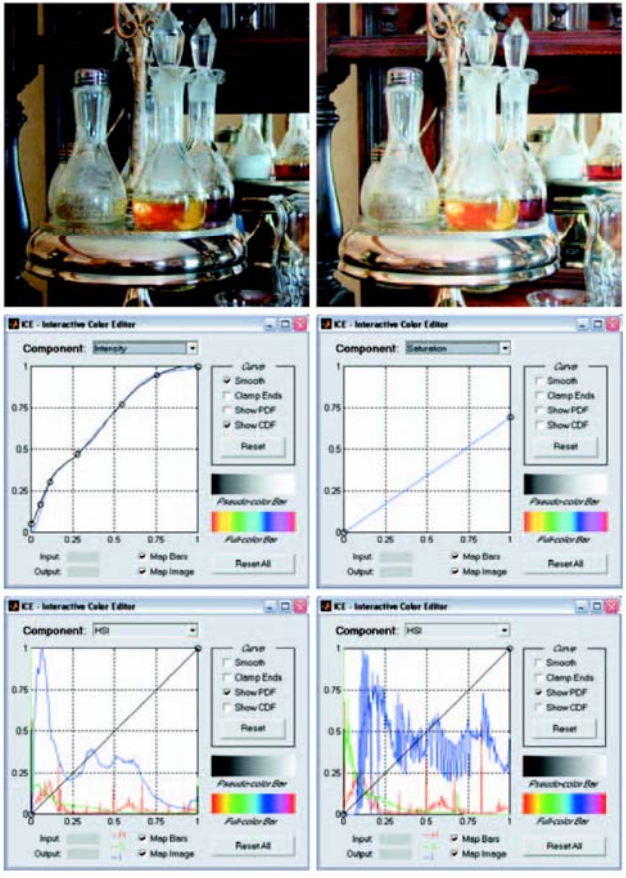


a b
c d
e f
FIGURE 6.21 Histogram equalization followed by saturation adjustment in the HSI color space: (a) input image; (b) mapped result; (c) intensity component mapping function and cumulative distribution function; (d) saturation component mapping function; (e) input image's component histograms;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

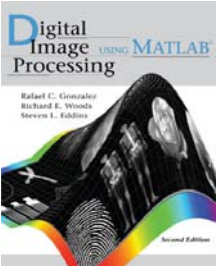
MATLAB

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);
```

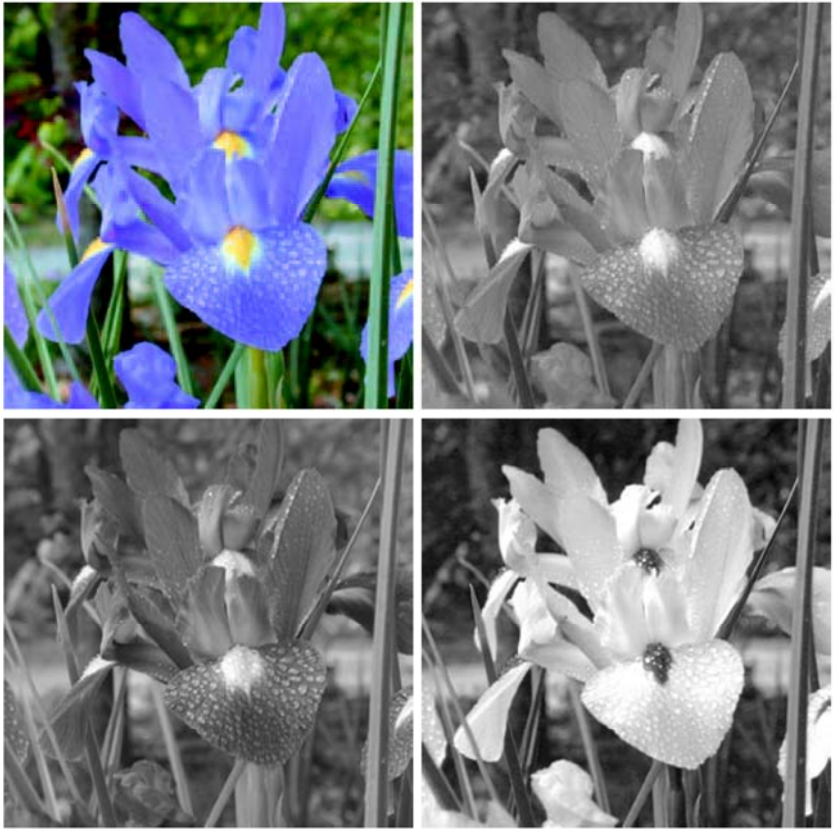


Chapter 7
Color Image Processing

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

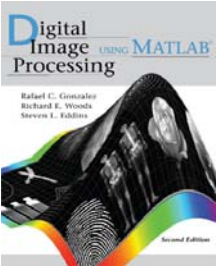
یک تصویر رنگی و مؤلفه‌های RGB آن



a b
c d

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

MATLAB



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Color Image Processing

a b c

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

فیلتر کردن تصویر رنگی در حوزه‌ی مکان

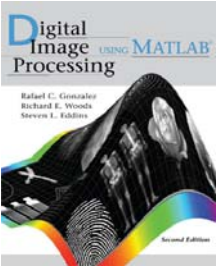
یک تصویر رنگی و مؤلفه‌های HSI آن

```
h = rgb2hsi(fc);
H = h(:,:,1);
S = h(:,:,2);
I = h(:,:,3);
```

a b c

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

MATLAB



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.

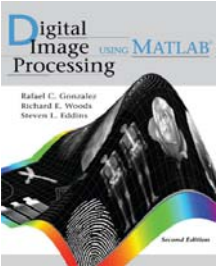
فیلتر کردن تصویر رنگی در حوزه‌ی مکان

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.

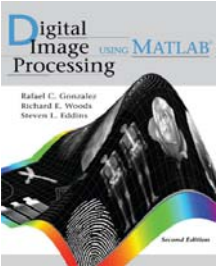
فیلتر کردن تصویر رنگی در حوزه‌ی مکان

تیزسازی تصویر رنگی با استفاده از لاپلاسین

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
z_4	z_5	z_6
z_7	z_8	z_9

−1	−2	−1
0	0	0
1	2	1

−1	0	1
−2	0	2
−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
z_4	z_5	z_6
z_7	z_8	z_9

−1	−2	−1
0	0	0
1	2	1

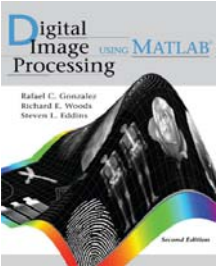
−1	0	1
−2	0	2
−1	0	1

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] = colorgrad(f,T)
```


MATLAB



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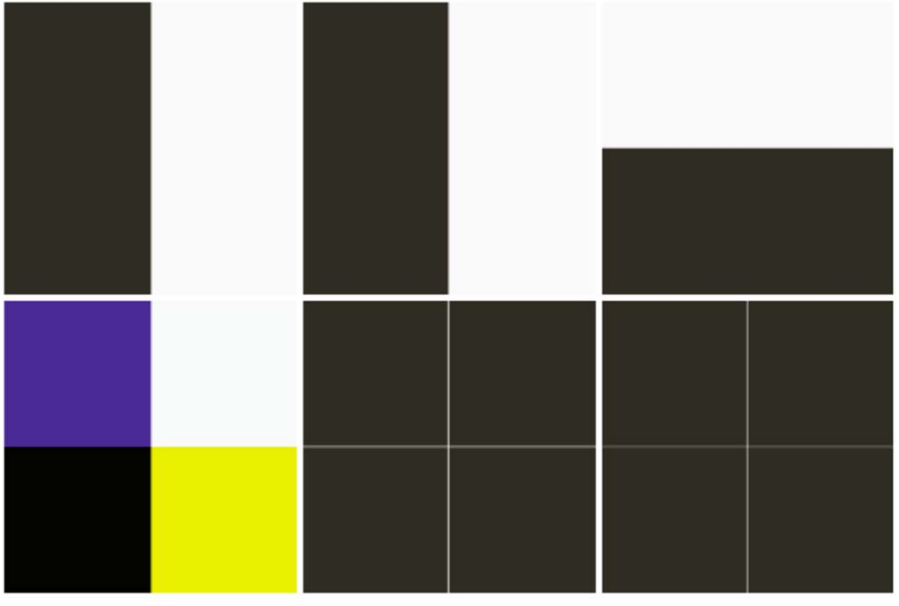
Color Image Processing



a b c
d e f

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] = colorgrad(f,T)
```

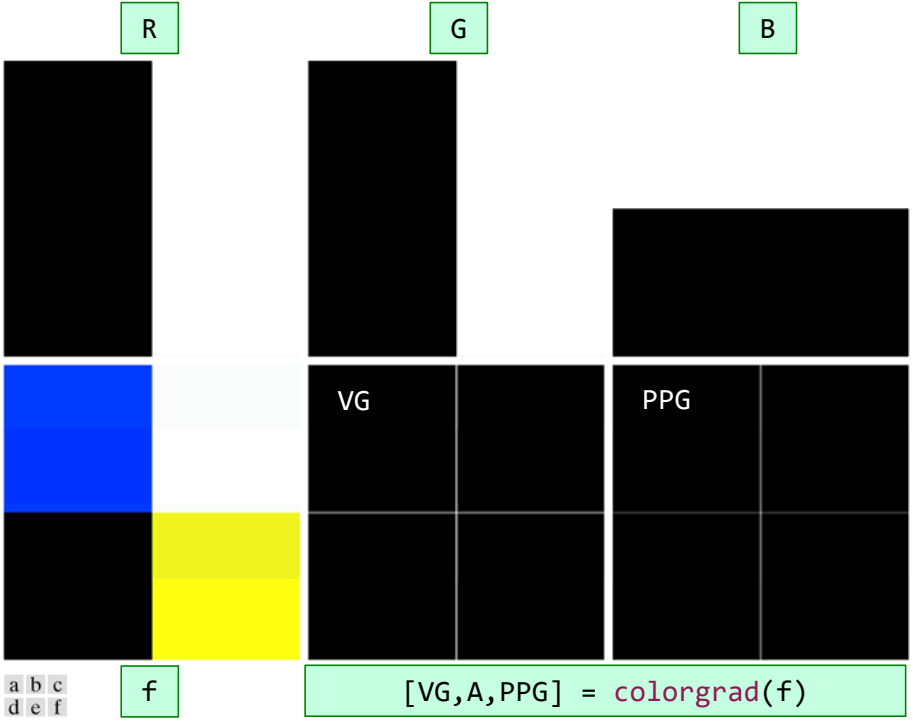
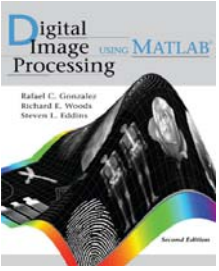


FIGURE (a) through (c) RGB component images (black is 0 and white is 255). (d) Corresponding color image. (e) Gradient computed directly in RGB vector space. (f) Composite gradient obtained by computing the 2-D gradient of each RGB component image separately and adding the results.



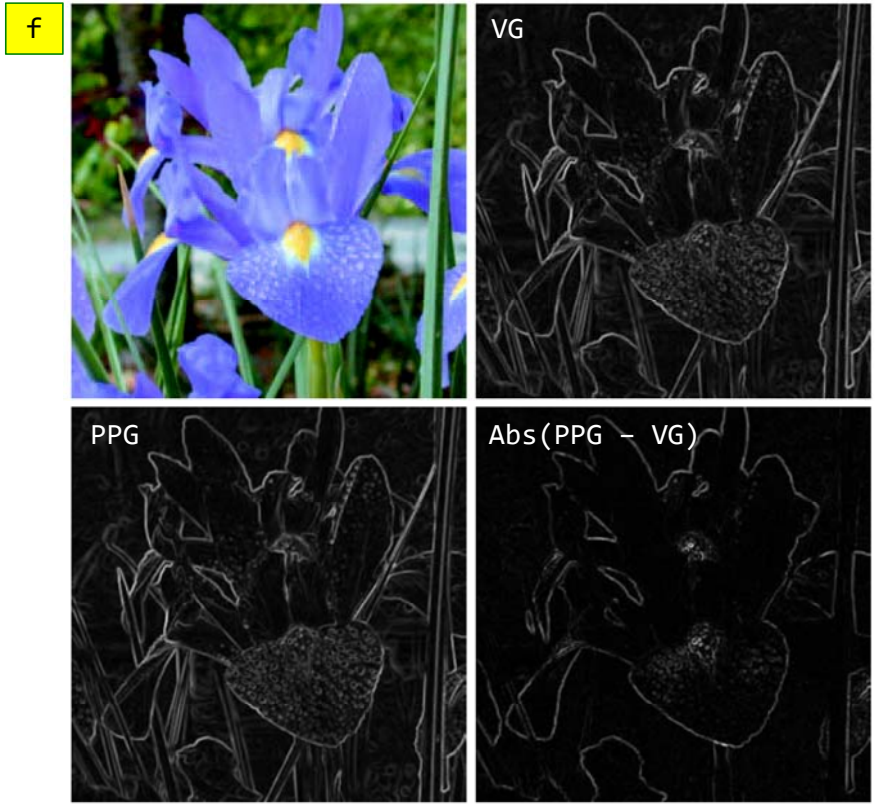
Chapter 7
Color Image Processing

a b
c d
FIGURE 6.28
(a) RGB image.
(b) Gradient computed in RGB vector space.
(c) Gradient computed as in Fig. 6.27(f).
(d) Absolute difference between (b) and (c), scaled to the range [0, 1].

عمل مستقیم در فضای برداری RGB

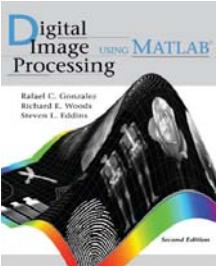
آشکارسازی لبه توسط گرادیان

```
[VG,A,PPG] = colorgrad(f,T)
```



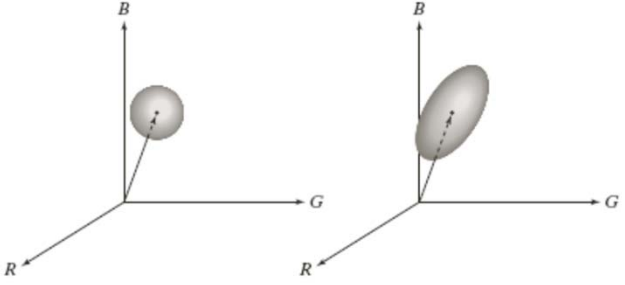
a b
c d

(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].



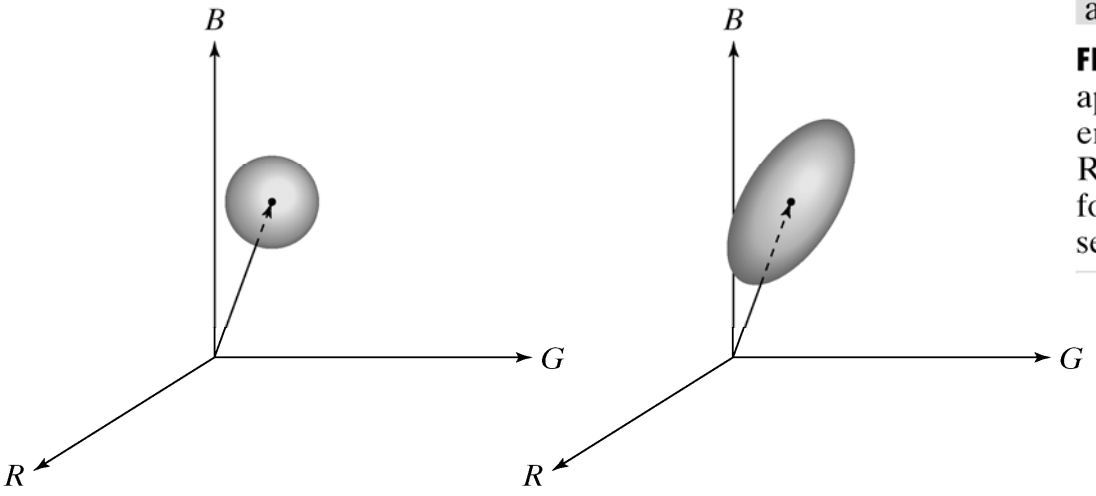
Chapter 7
Color Image Processing

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

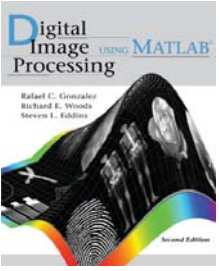


a b

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

```
S = colorseg(method,f,T,parameters)
```

```
'euclidean'
'mahalanobis'
```



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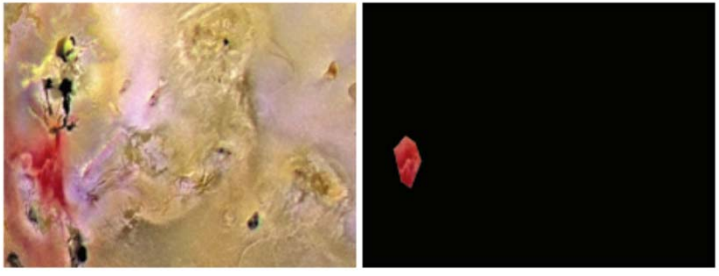
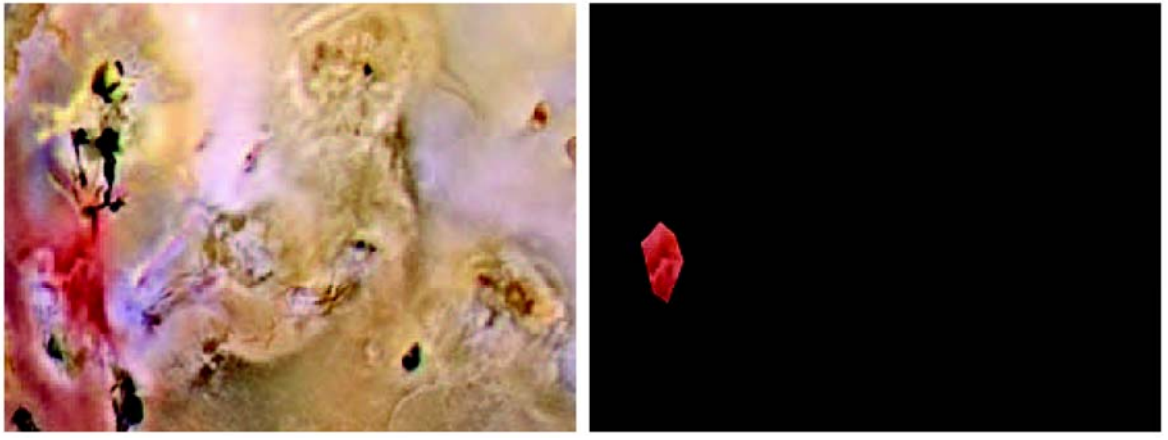


a b

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



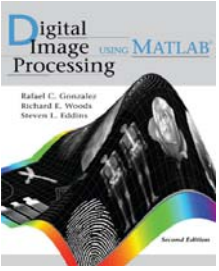
a b

(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
```


MATLAB



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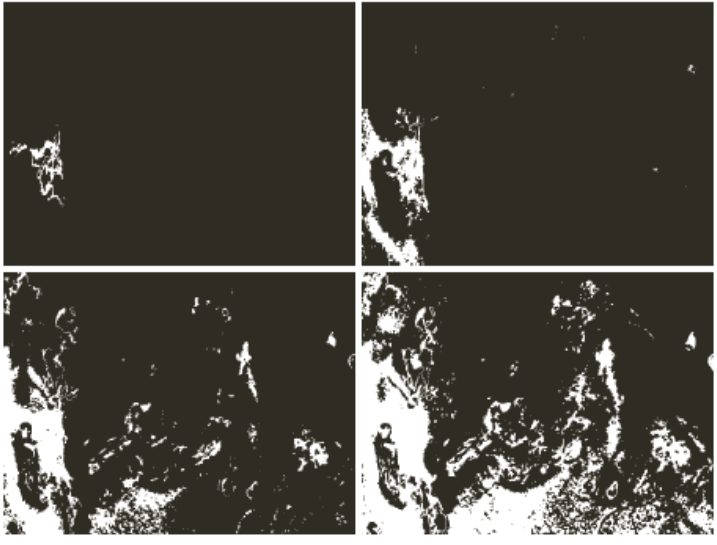
Color Image Processing



a b
c d

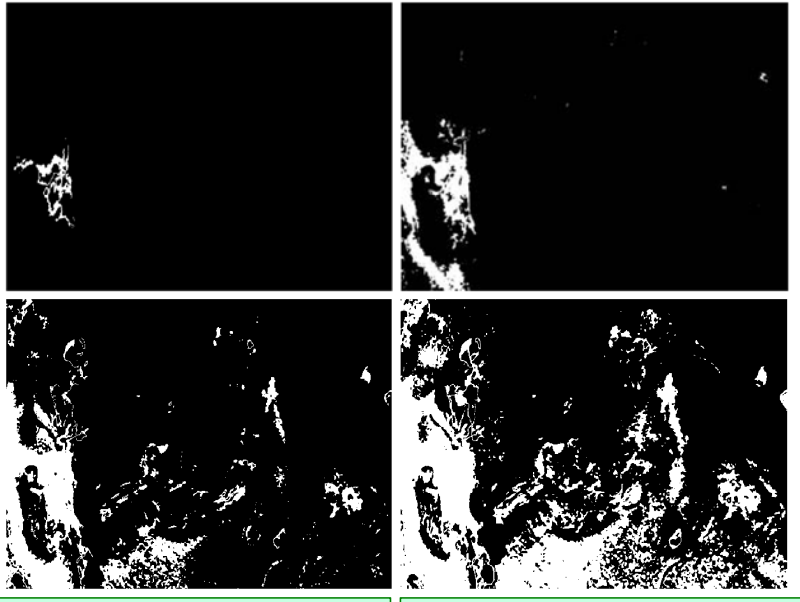
FIGURE 6.31 (a) through (d) Segmentation of Fig. 6.30(a) using option `'euclidean'` in function `colorseg` with $T = 25, 50, 75$, and 100, respectively.

عمل مستقیم در فضای برداری RGB

بخش‌بندی تصویر در فضای برداری RGB : مثال

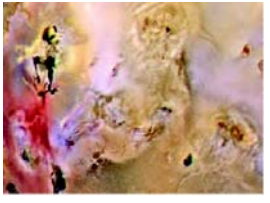
```
E25 = colorseg(method,f,25,'euclidean', m)
```

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



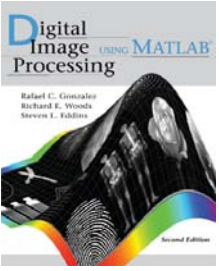
a b
c d

(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)
```



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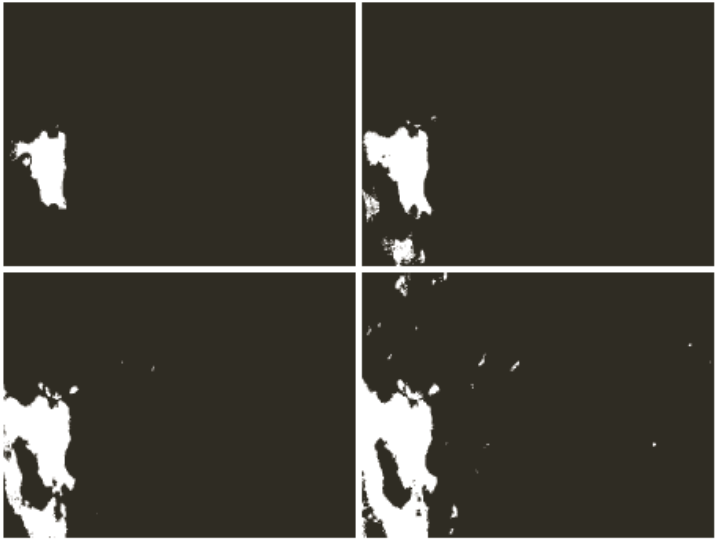


a b
c d

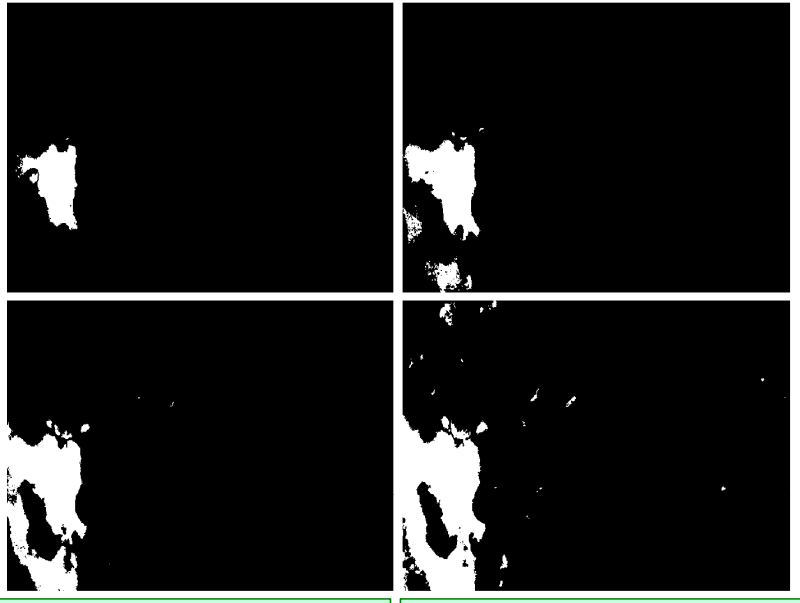
FIGURE 6.32
(a) through (d) Segmentation of Fig. 6.30(a) using option `'mahalanobis'` in function `colorseg` with $T = 25, 50, 75,$ and 100, respectively. Compare with Fig. 6.31.

عمل مستقیم در فضای برداری RGB

بخش‌بندی تصویر در فضای برداری RGB: مثال

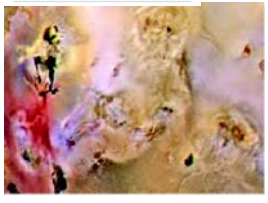
```
E25 = colorseg(method,f,25,'mahalanobis', m)
```

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



a b
c d

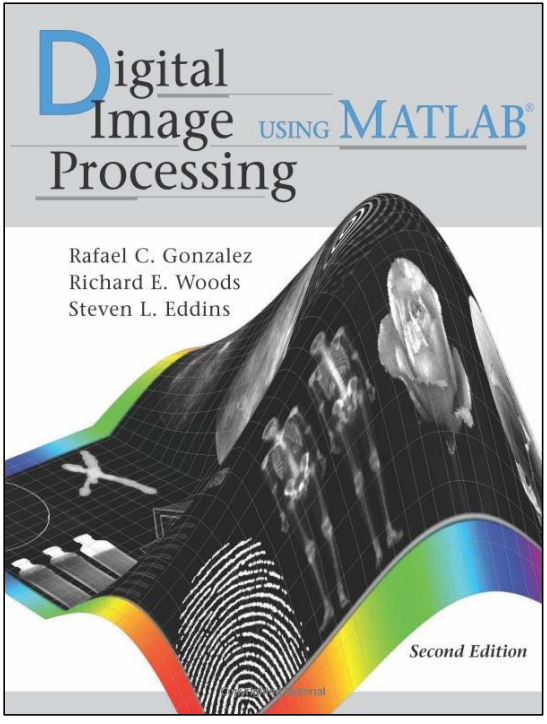
(a) through (d) Segmentation of Fig. 6.27(a) using option 'mahalanobis' in function colorseg with $T = 25, 50, 75,$ and 100, respectively. Compare with Fig. 6.28.



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

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

منبع اصلی



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