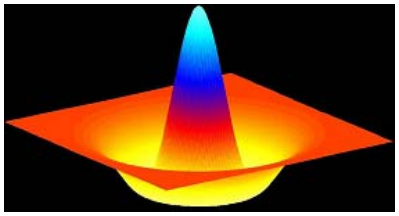


Procesamiento Digital de Imágenes

Procesamiento de Imágenes Color

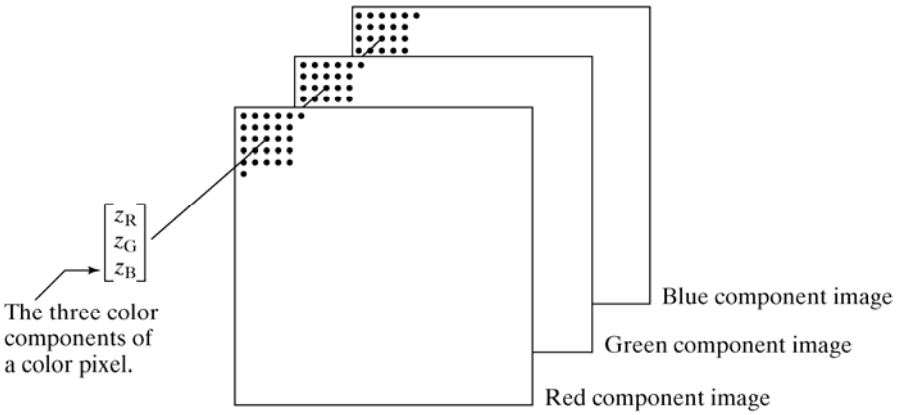
Representación Imágenes Color

Existen diversas maneras de representar las imágenes a color mediante los denominados ***Espacios de Colores***. Algunos de los más utilizados son:

- RGB
- CMYK
- HSV
- NTSC
- YCbCr

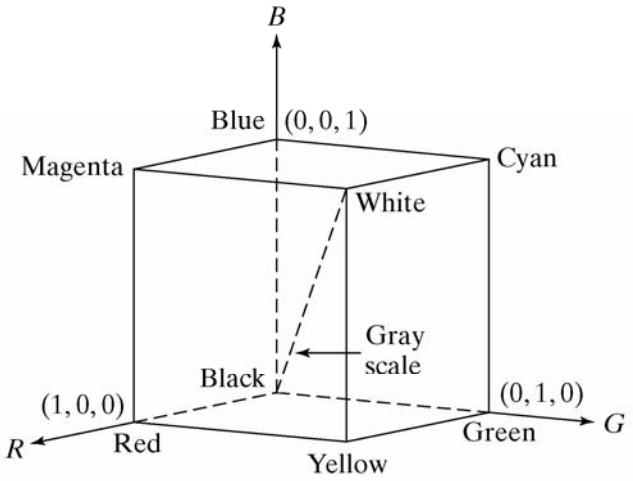
Representación RGB

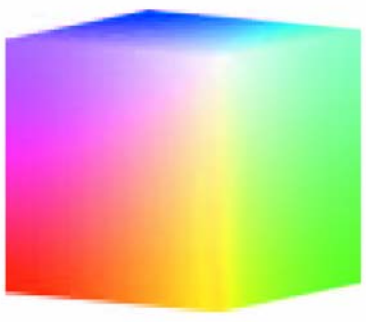
En el espacio RGB, el color de cada pixel viene representado por la combinación de 3 canales R (rojo), G (verde) y B (azul), respectivamente.



Representación RGB

El espacio RGB puede interpretarse como un cubo que contiene todos los posibles colores a representar

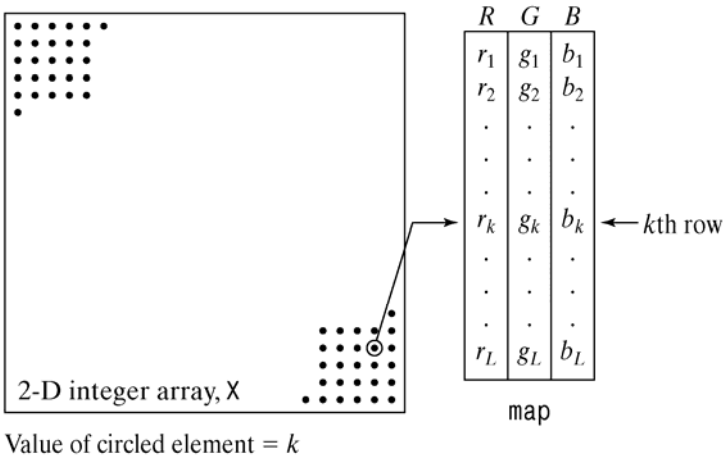




Matlab → `rgbcube`

Representación Indexada

En Matlab, las imágenes también pueden ser representadas de forma indexada mediante una matriz de índices y un mapa de colores



Matlab → `imshow(X, map)  colormap(map)`

Mapas de Color

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.

Manipulación imágenes RGB e Indexadas

Dithering: técnica usada en computación gráfica para crear la ilusión de profundidad de color en imágenes con una paleta de colores limitada.

Matlab → `X = dither(RGB, map)`

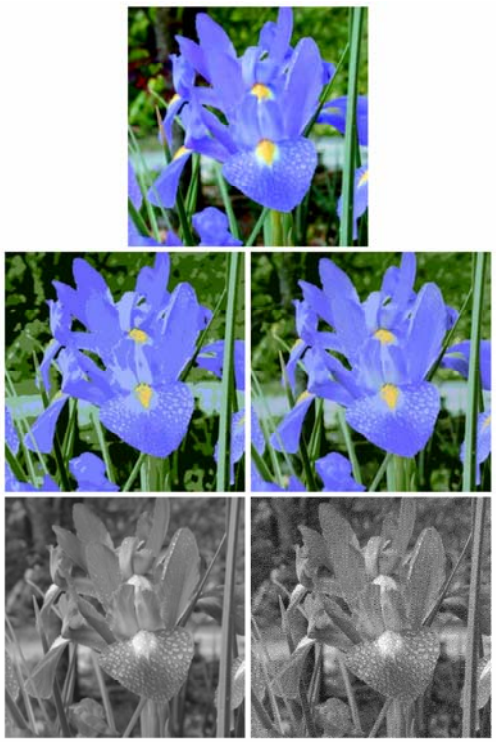
`BW = dither(gray_img)`

Manipulación imágenes RGB e Indexadas

Funciones de Matlab para conversión entre imágenes RGB e imágenes indexadas.

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.

Manipulación imágenes RGB e Indexadas



a
b c
d e

FIGURE 6.4
(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).

Representación CMY - CMYK

CMY está basada en la representación de pigmentos.

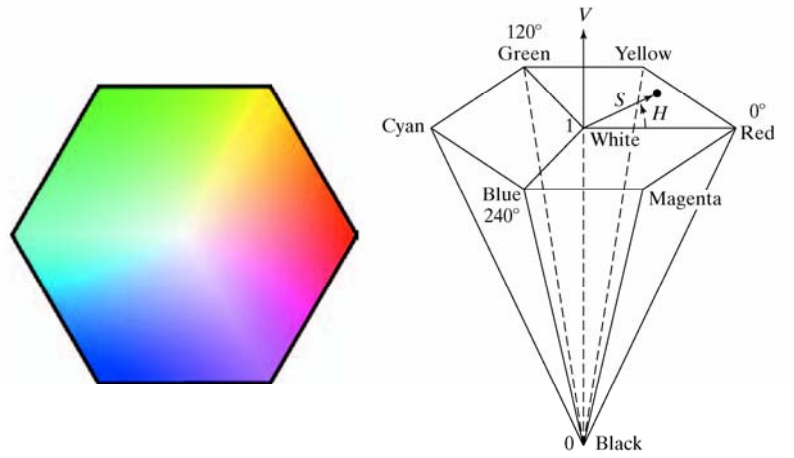
Cyan, Magenta y Amarillo, son los colores secundarios de la luz y, a su vez, los colores primarios en pigmentos.

$$\begin{bmatrix} C \\ M \\ Y \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} - \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

Matlab → `imcomplement`

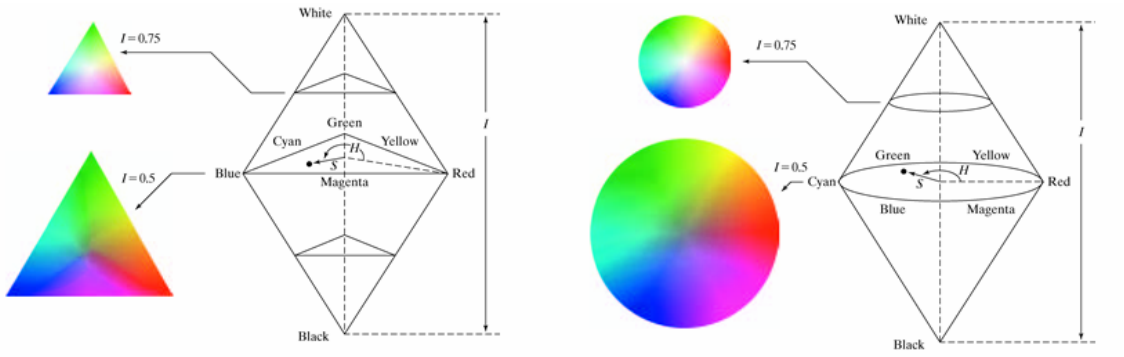
Representación HSV

El espacio HSV es una representación más cercana a la manera en que los humanos experimentan y describen la sensación de los colores



Matlab → `rgb2hsv, hsv2rgb`

Representación HSI

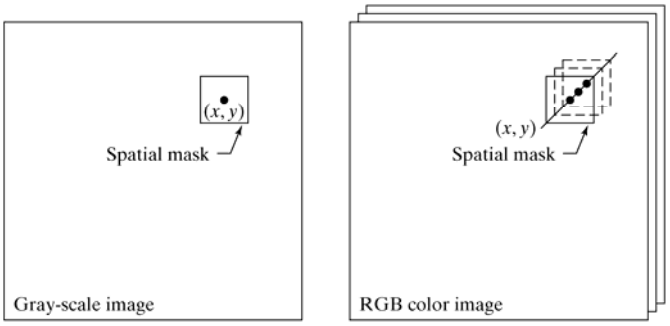


Matlab (Toolbox Libro) → `rgb2hsi, hsi2rgb`

Procesamiento Color

De manera general, el procesamiento de imágenes a color puede dividirse en tres casos principales:

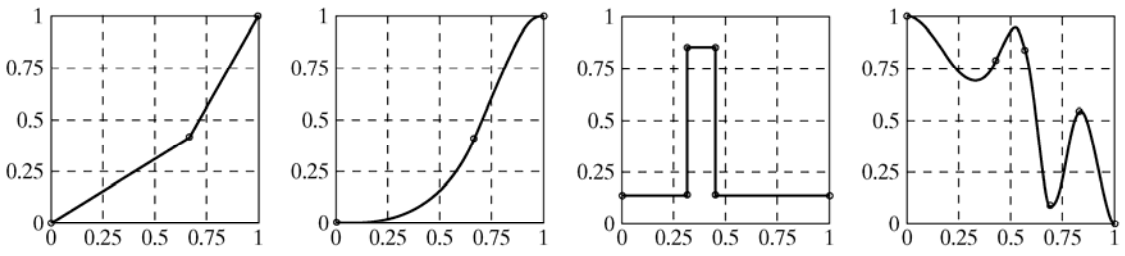
- **Transformación de color** (a nivel de pixels)
- **Procesamiento espacial** (por plano)
- **Procesamiento vectorial**



Transformación de color

Los colores (o intensidades) de una imagen se pueden modificar aplicando la siguiente transformación:

$$s_i = T_i(r_i)$$



a b c d

FIGURE 6.11 Specifying mapping functions using control points: (a) and (c) linear interpolation, and (b) and (d) cubic spline interpolation.

Transformación de color

Interfaz gráfica ICE (Interactive Color Editing) libro DIPUM

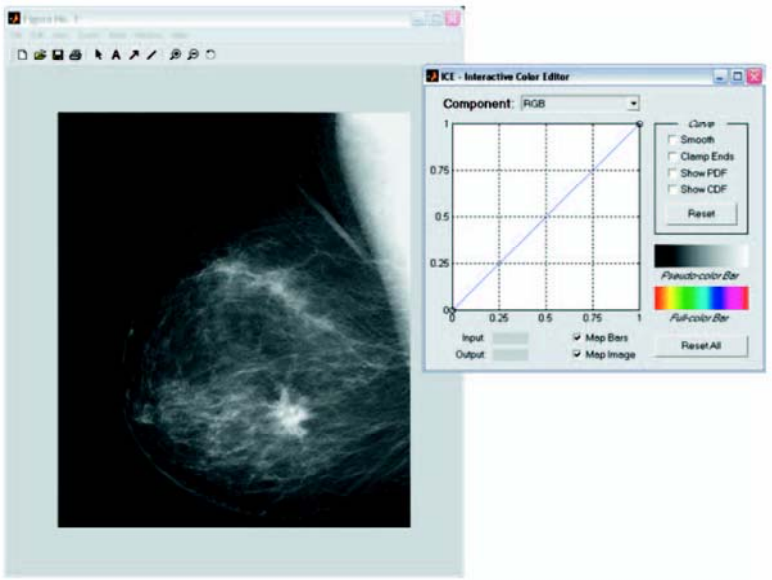


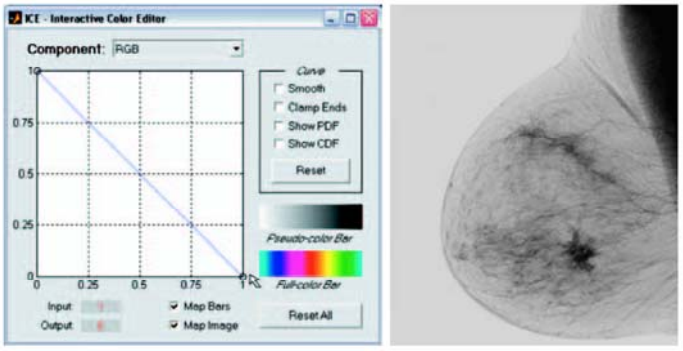
FIGURE 6.12 The typical opening windows of function `ice`. (Image courtesy of G. E. Medical Systems.)

Transformación de color

Interfaz gráfica ICE (Interactive Color Editing) libro DIPUM

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.

Transformación de color



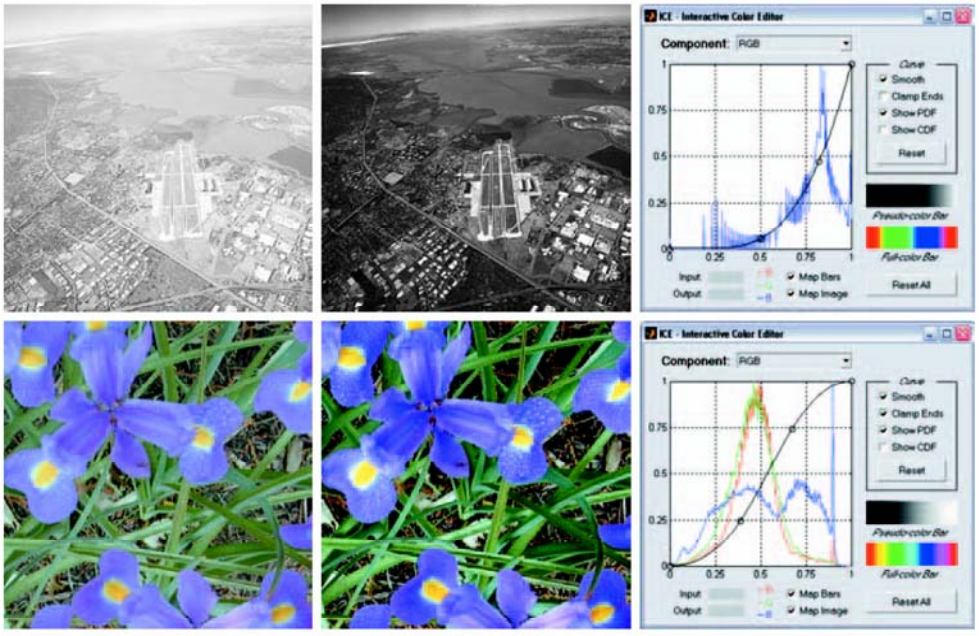
a b

FIGURE 6.13
(a) A negative mapping function, and (b) its effect on the monochrome image of Fig. 6.12.

a b

FIGURE 6.14
(a) A full color image, and (b) its negative (color complement).

Transformación de color



a b c
d e f

FIGURE 6.15 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.)

Filtrado Espacial

De la misma manera que para el caso de imágenes en niveles de grises, se puede aplicar el filtrado espacial para cada plano de una imagen color (RGB, HSV, etc.).

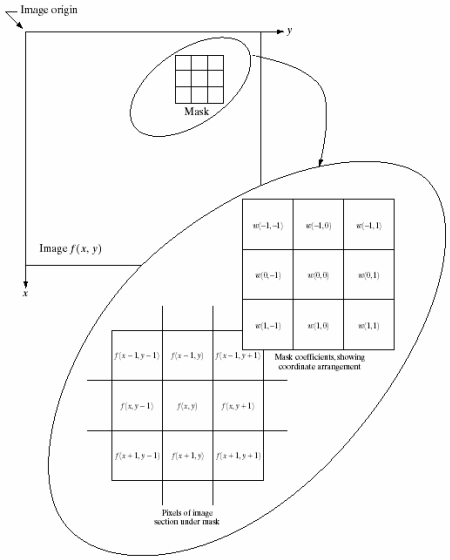


FIGURE 3.32 The mechanics of spatial filtering. The magnified drawing shows a 3×3 mask and the image section directly under it; the image section is shown displaced out from under the mask for ease of readability.

Filtrado Espacial

Filtro Pasabajos: El proceso de filtrado espacial se plantea de la misma manera, solo que en vez de utilizar valores de pixels, ahora tenemos vectores de valores de pixels.

$$\bar{\boldsymbol{c}}(\mathrm{x},\mathrm{y}) = \frac{1}{K}\sum_{(s,t)\in S_{xy}} \boldsymbol{c}(\boldsymbol{s},\boldsymbol{t})$$

$$\bar{\boldsymbol{c}}(\mathrm{x},\mathrm{y}) = \begin{bmatrix} \frac{1}{K}\sum_{(s,t)\in S_{xy}} R(s,t) \\ \frac{1}{K}\sum_{(s,t)\in S_{xy}} G(s,t) \\ \frac{1}{K}\sum_{(s,t)\in S_{xy}} B(s,t) \end{bmatrix}$$

Filtrado Espacial

```
>> fR = f(:,:,1);
>> fG = f(:,:,2);
>> fB = f(:,:,3);
>> w = ones(3)/9;
>> fR_pb = imfilter(fR,w);
>> fG_pb = imfilter(fG,w);
>> fB_pb = imfilter(fB,w);
>> f_pb = cat(3, fR_pb, fG_pb, fB_pb);
>> figure; imshow(f_pb);
```


Filtrado Espacial

a b
c d

FIGURE 6.19
(a) RGB image; (b) through (d) are the red, green and blue component images, respectively.

Filtrado Espacial

a b c

FIGURE 6.20 From left to right: hue, saturation, and intensity components of Fig. 6.19(a).

Filtrado Espacial

a b c

FIGURE 6.21 (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.

Filtrado Espacial

Filtro Laplaciano: Para enfatizar los bordes de una imagen a color, se puede utilizar, al igual que para imágenes en niveles de grises, un filtro Laplaciano.

$$\nabla^2[\boldsymbol{c}(x,y)] = \begin{bmatrix} \nabla^2 R(x,y) \\ \nabla^2 G(x,y) \\ \nabla^2 B(x,y) \end{bmatrix}$$

```
>> w = ones(3);  w(2,2) = -8;
>> f_en = imsubtract(f_pb, imfilter(f_pb,w));
>> figure; imshow(f_en);
```


Filtrado Espacial

a b

FIGURE 6.22 (a) Blurred image. (b) Image enhanced using the Laplacian, followed by contrast enhancement using function `ice`.