Digital Image Processing:

Frequency Domain

Lowpass Filtering:

$$G(u, v) = H(u, v)F(u, v)$$

$$H(u, v) = \begin{cases} 1 & \text{if } D(u, v) \le D_0 \\ 0 & \text{if } D(u, v) > D_0 \end{cases}$$

$$D(u, v) = (u^2 + v^2)^{1/2}.$$

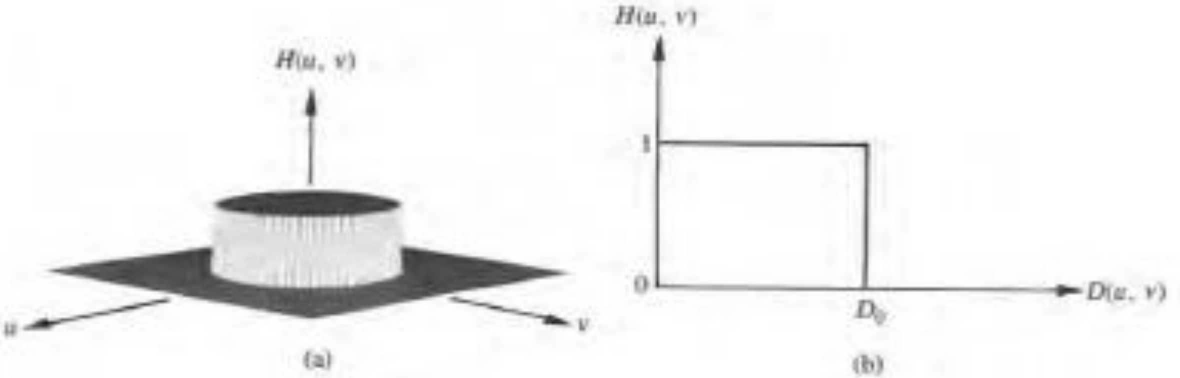
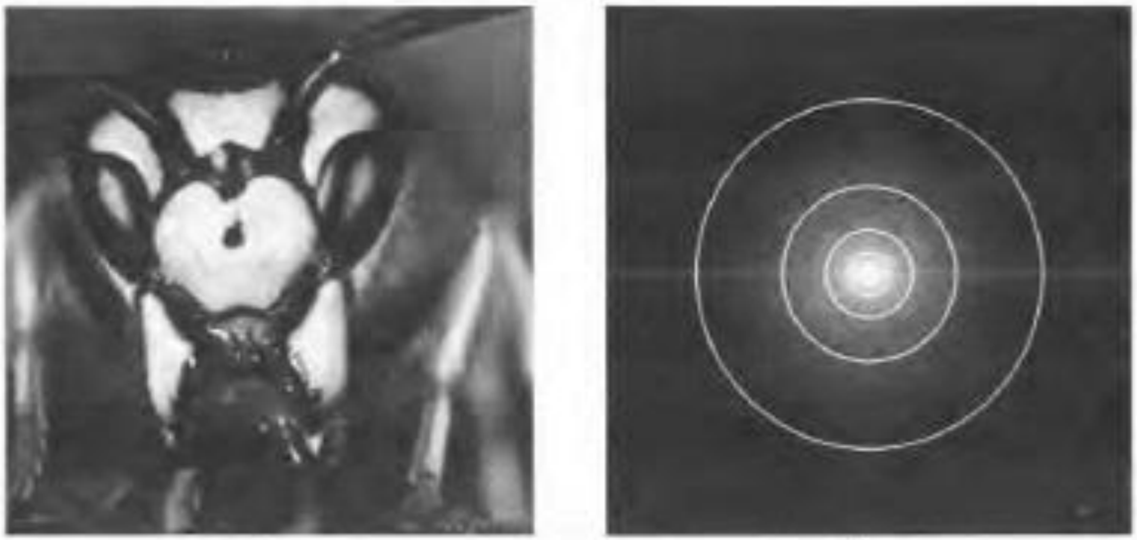


Figure 4.30 *(a) Perspective plot of an ideal lowpass filter transfer function; (b) filter cross section.*

Frequency Domain



(a) (b)

Figure 4.31 *(a) 512 × 512 image and (b) its Fourier spectrum. The superimposed circles, which have radii equal to 8, 18, 43, 78, and 152, enclose 90, 93, 95, 99, and 99.5 percent of the image power, respectively.*

Lowpass filtering

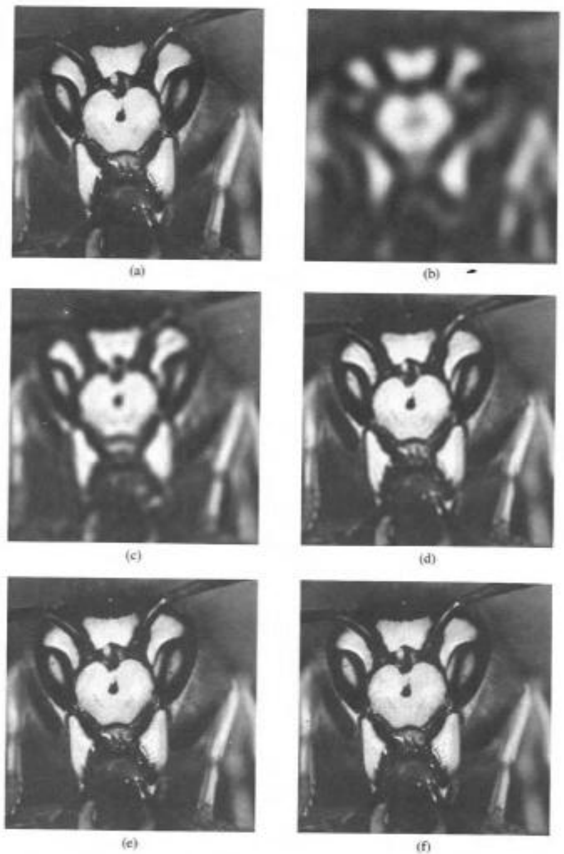


Figure 4.32 (a) Original image; (b)–(f) results of ideal lowpass filtering with the cutoff frequency set at the radii shown in Fig. 4.31(b).

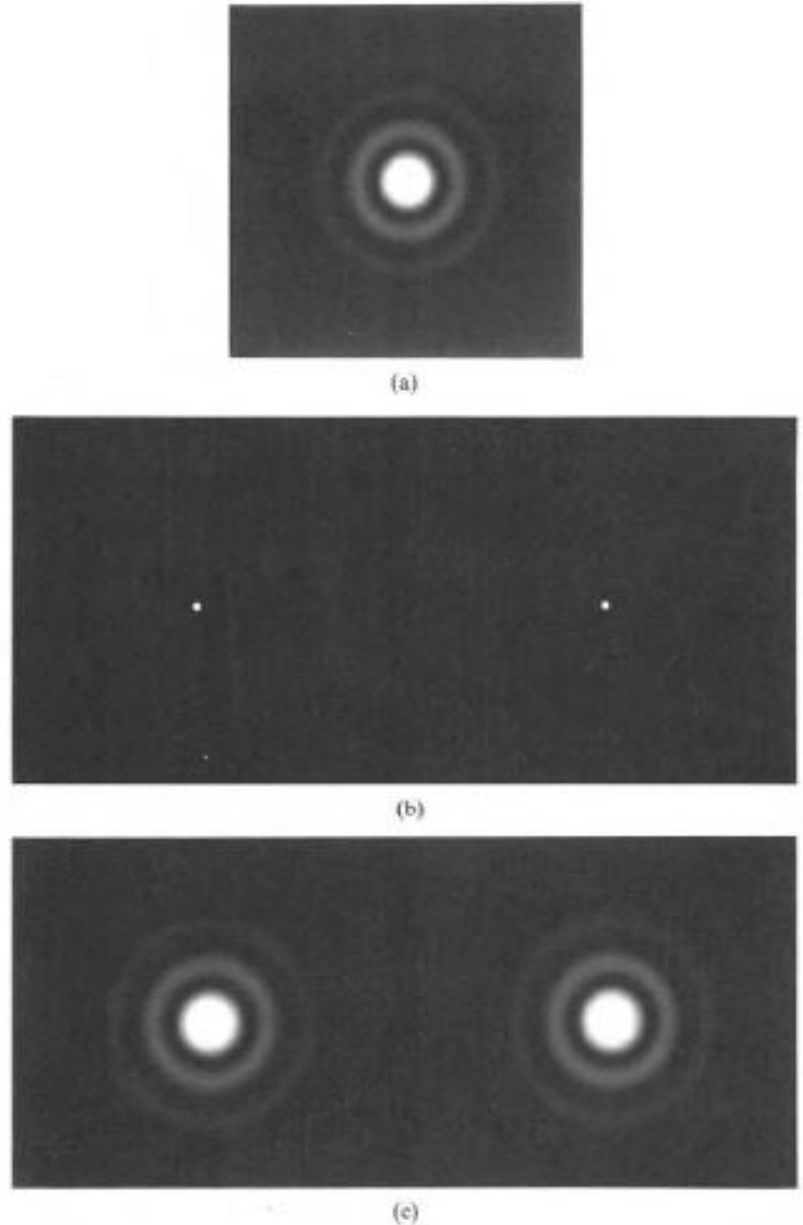


Figure 4.33 Illustration of the blurring process in the spatial domain: (a) blurring function $h(x, y)$ for an ideal lowpass filter; (b) a simple image composed of two bright dots; (c) convolution of $h(x, y)$ and $f(x, y)$.

Lowpass Filtering

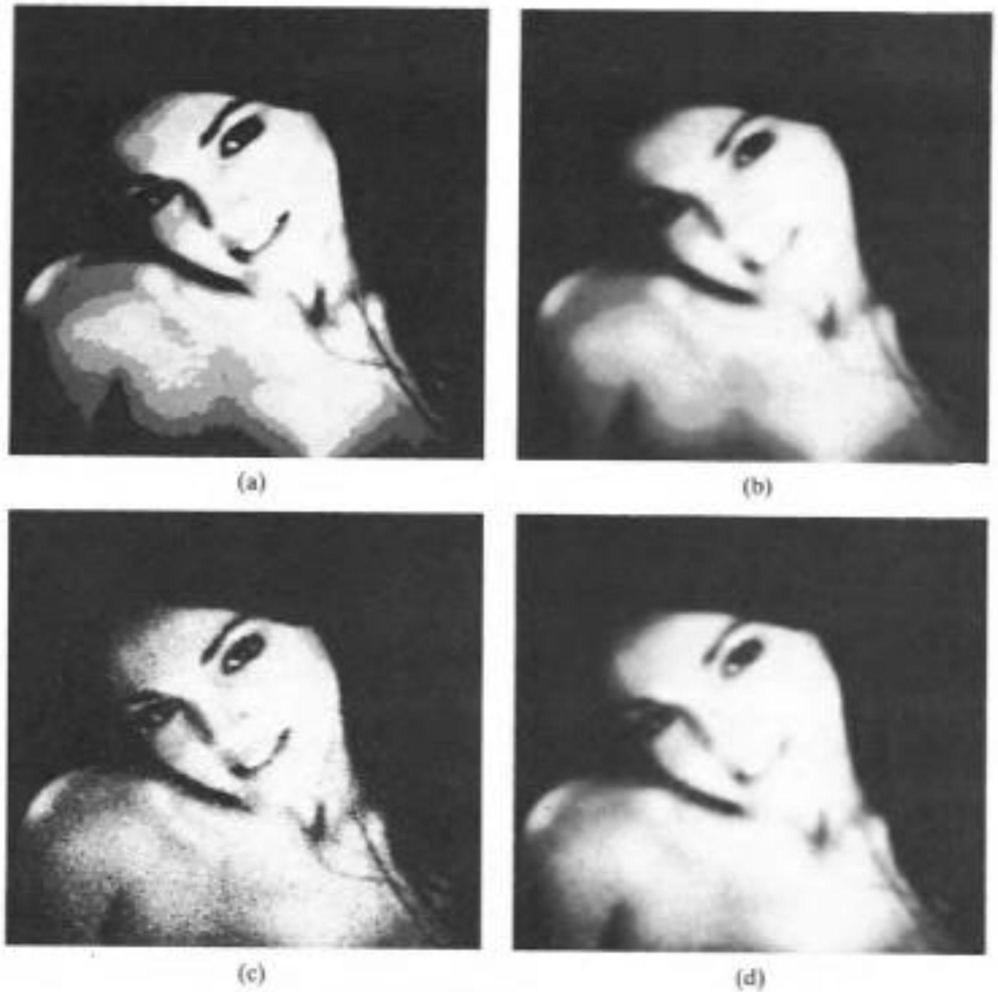


Figure 4.36 Two examples of image smoothing by lowpass filtering (see text).

Highpass filtering

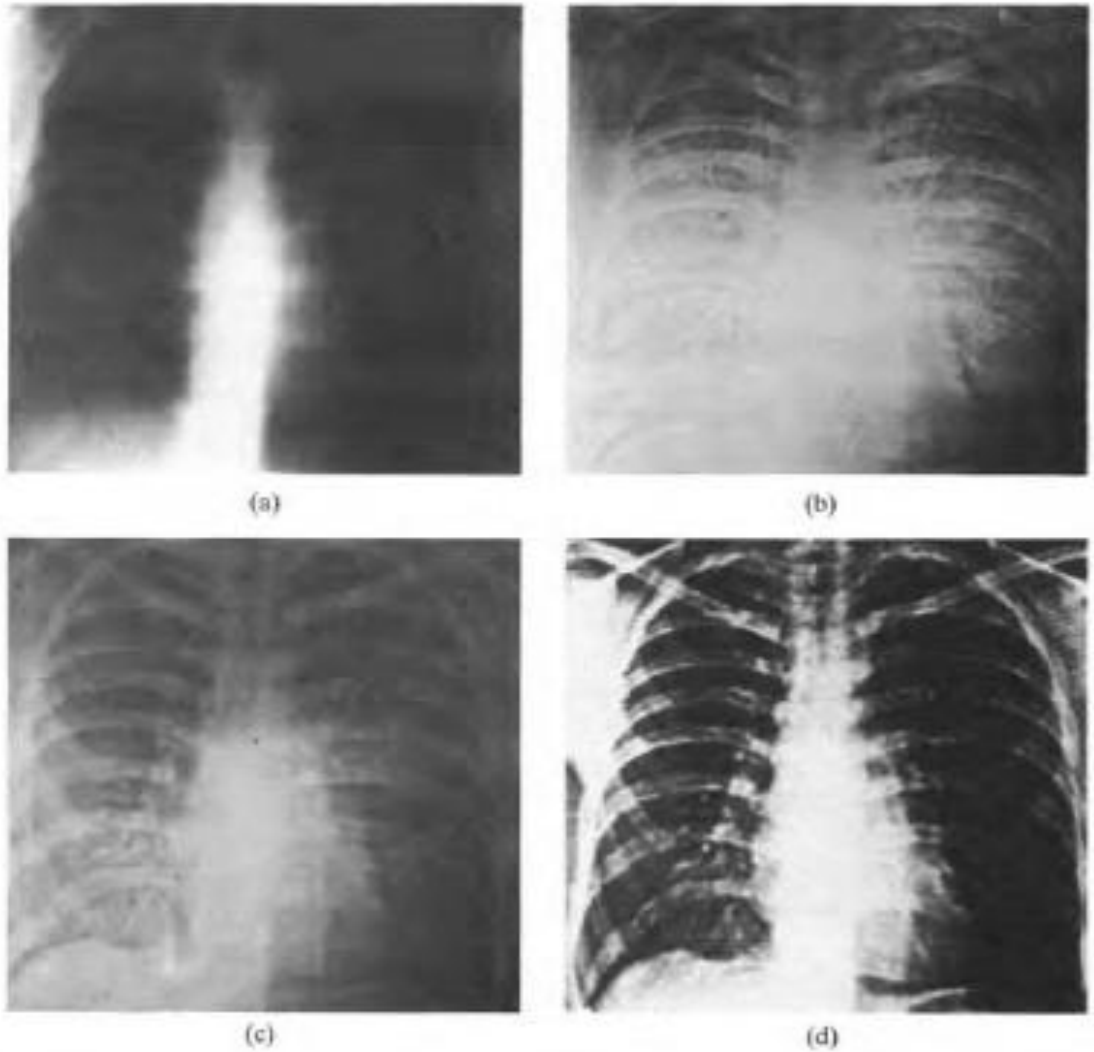


Figure 4.39 *Example of highpass filtering: (a) original image; (b) image processed with a highpass Butterworth filter; (c) result of high-frequency emphasis; (d) high-frequency emphasis and histogram equalization. (From Hall et al. [1971].)*

Homomorphic Filtering

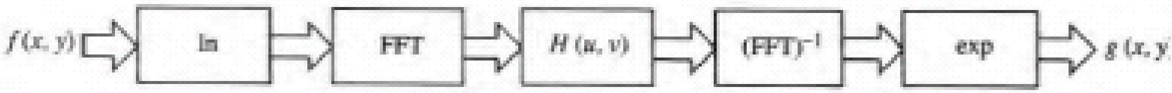


Figure 4.40 *Homomorphic filtering approach for image enhancement.*

$$f(x, y) = i(x, y)r(x, y)$$

(a) (b)

Figure 4.42 *(a) Original image; (b) image processed by homomorphic filtering to achieve simultaneous dynamic range compression and contrast enhancement. (From Stockham [1972].)*

Color Processing

The RGB color Model:

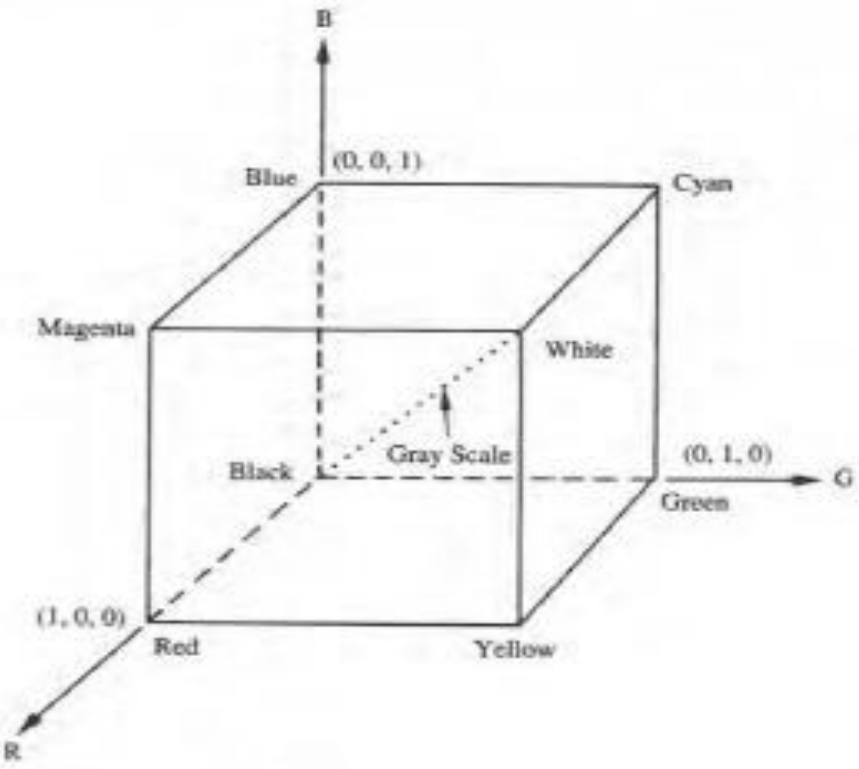


Figure 4.44 *RGB color cube. Points along the main diagonal have gray values, from black at the origin to white at point (1, 1, 1).*

Color Processing

The CMY color Model

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

The YIQ color model

$$\begin{bmatrix} Y \\ I \\ Q \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ 0.596 & -0.275 & -0.321 \\ 0.212 & -0.523 & 0.311 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

Color Processing

Conversion from RGB to HIS model

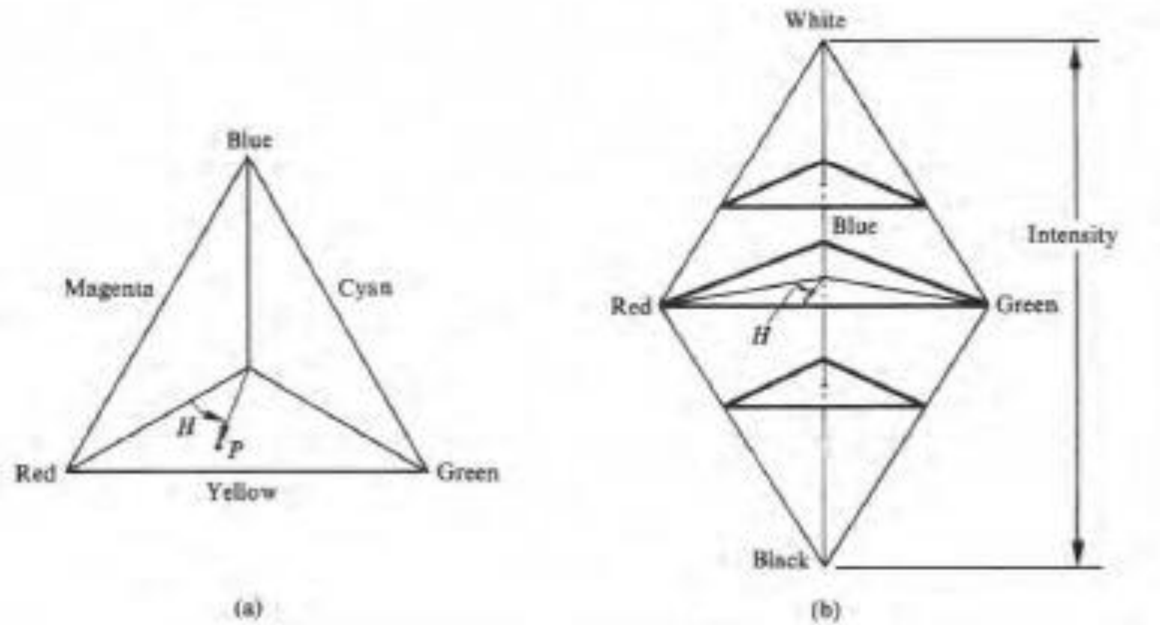


Figure 4.45 (a) HSI color triangle; (b) HSI color solid.

Color Processing

Intensity slicing

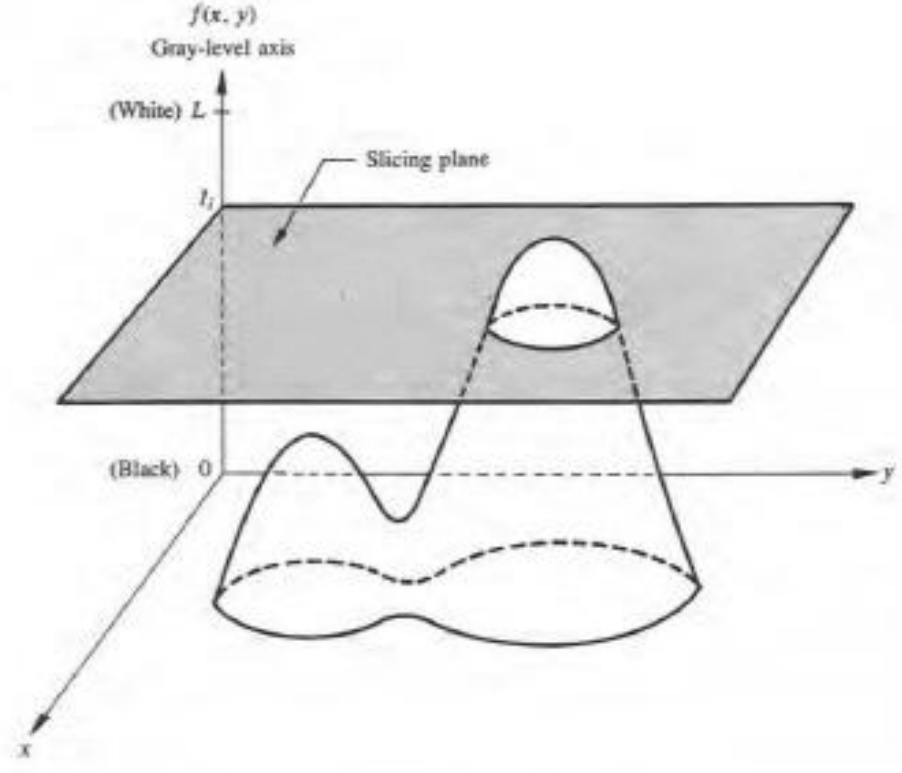


Figure 4.48 Geometric interpretation of the intensity-slicing technique.

Color Processing

Gray level color transformation

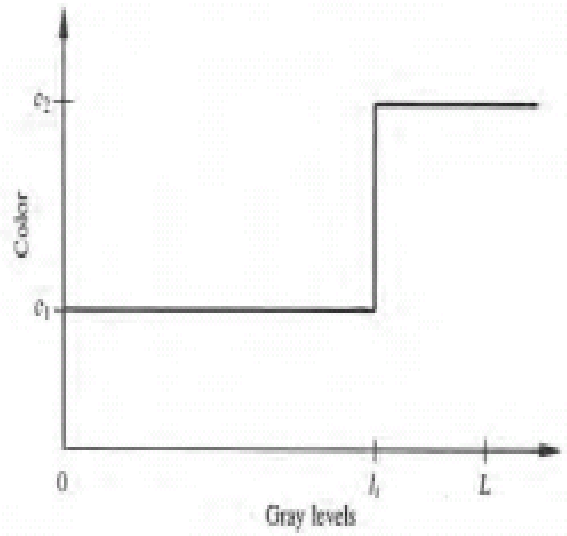


Figure 4.49 An alternative representation of the intensity-slicing method.

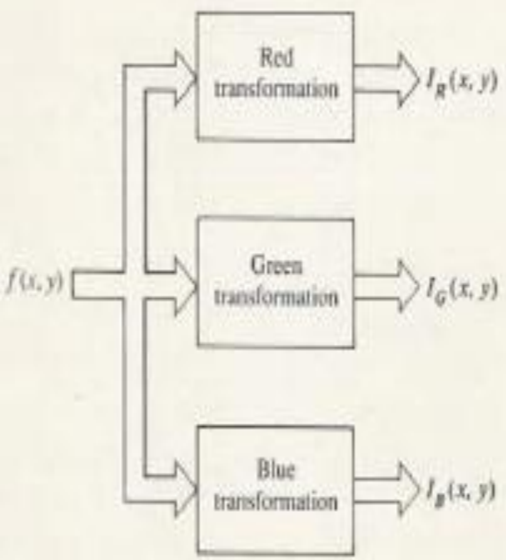


Figure 4.50 Functional block diagram for pseudo-color image processing. I_R, I_G, and I_B are fed into the red, green, and blue inputs, respectively, of an RGB color monitor.

Color Processing

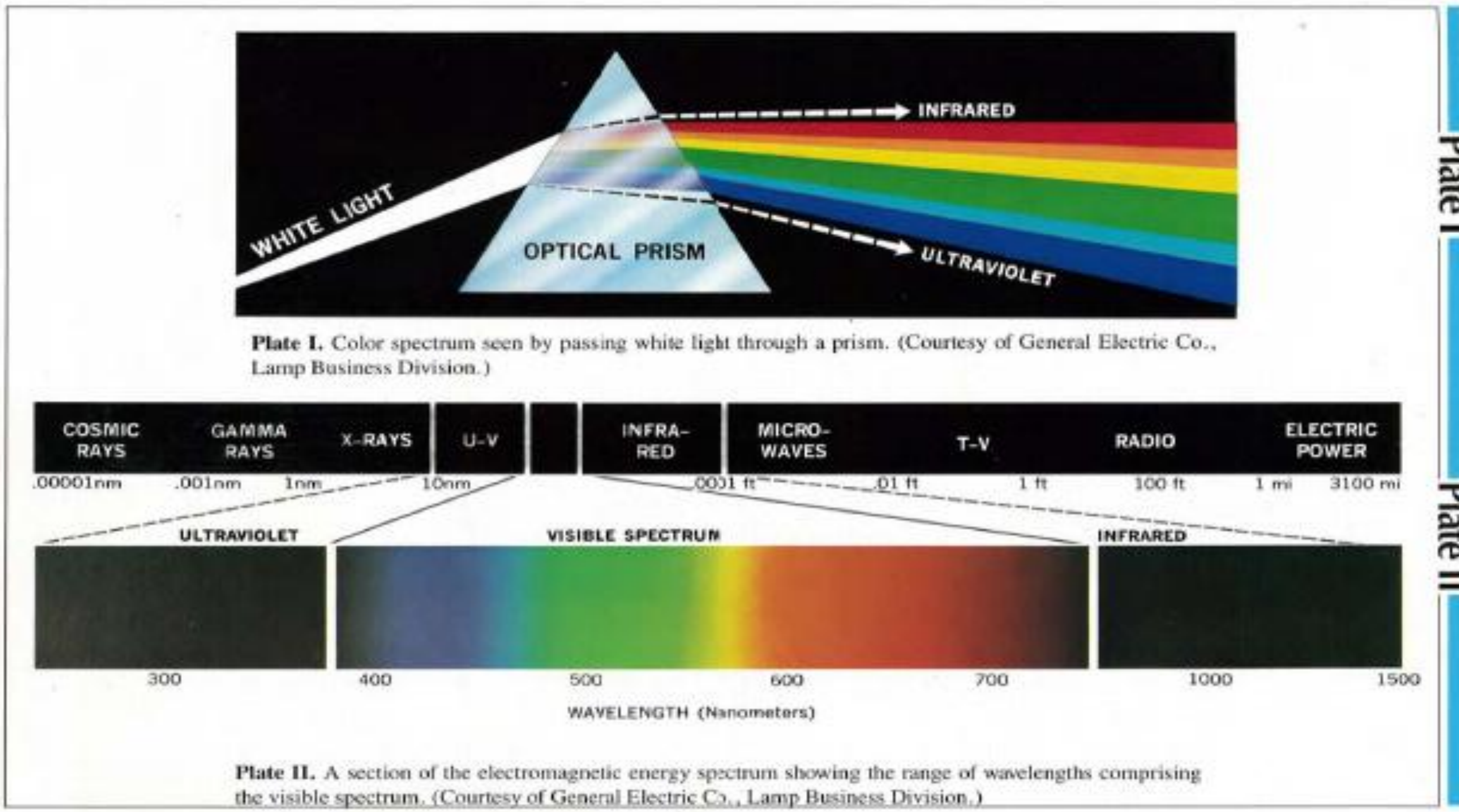
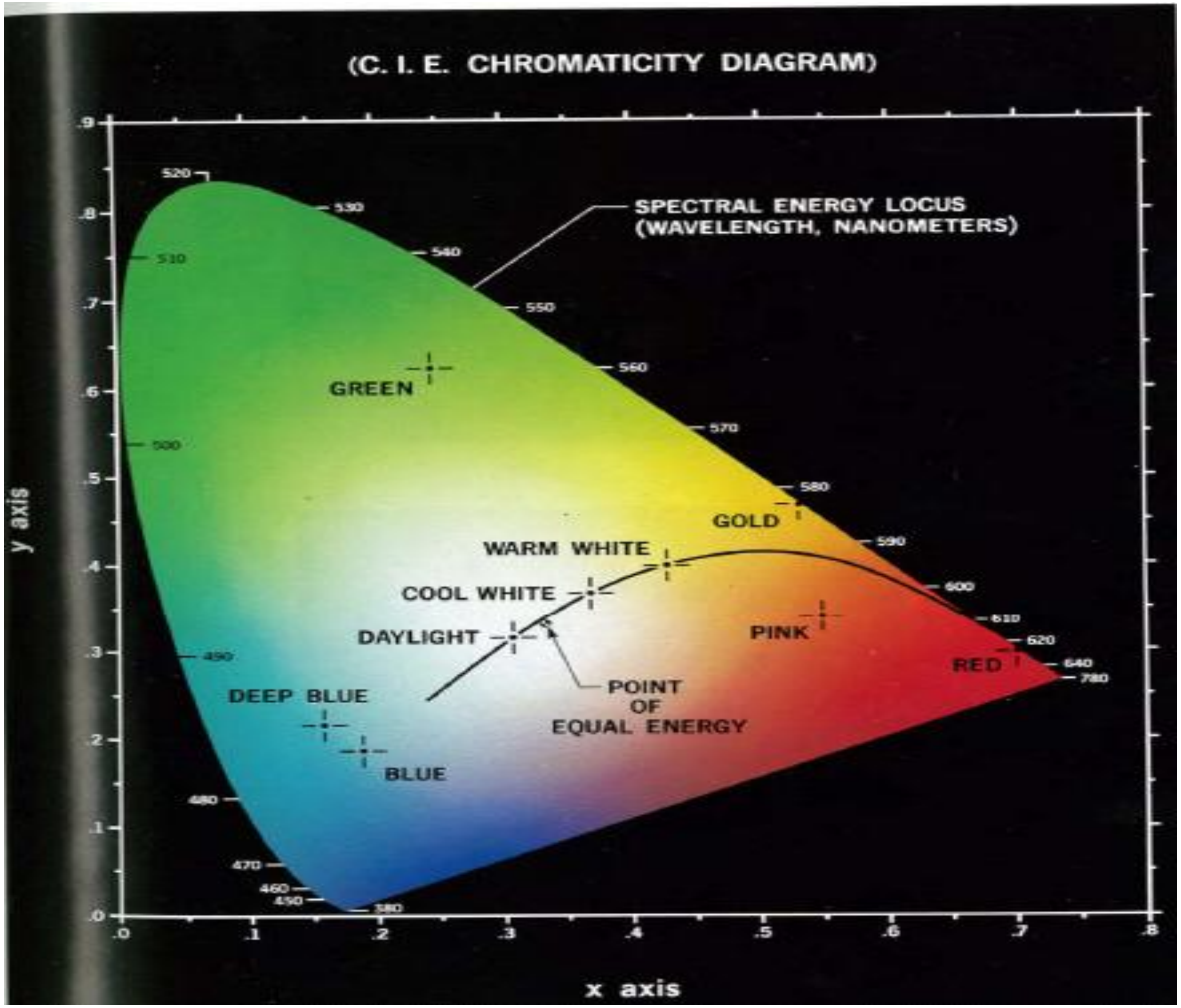


Plate I. Color spectrum seen by passing white light through a prism. (Courtesy of General Electric Co., Lamp Business Division.)

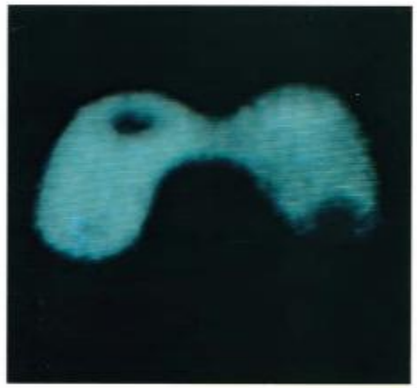
Plate II. A section of the electromagnetic energy spectrum showing the range of wavelengths comprising the visible spectrum. (Courtesy of General Electric Co., Lamp Business Division.)

Color Processing



Color Processing

Plate V

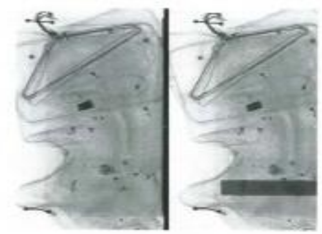


(a)

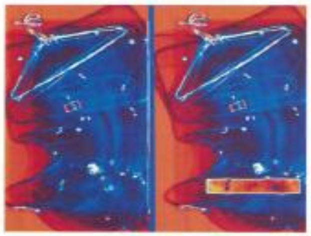
(b)

Plate V. (a) Monochrome image of the Picker Thyroid Phantom. (b) Result of density slicing into eight color regions. (Courtesy of Dr. J.L. Blankenship, Instrumentation and Controls Division, Oak Ridge National Laboratory.)

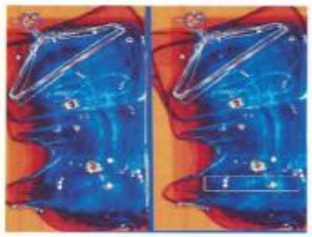
Plate VI



(a)



(b)



(c)

Plate VI. Pseudo-color enhancement by using the gray-level to color transformations in Fig. 4.38. Original image courtesy of Dr. Mike Hurwitz, Research and Development Center, Westinghouse Electric Corporation.

Color Processing

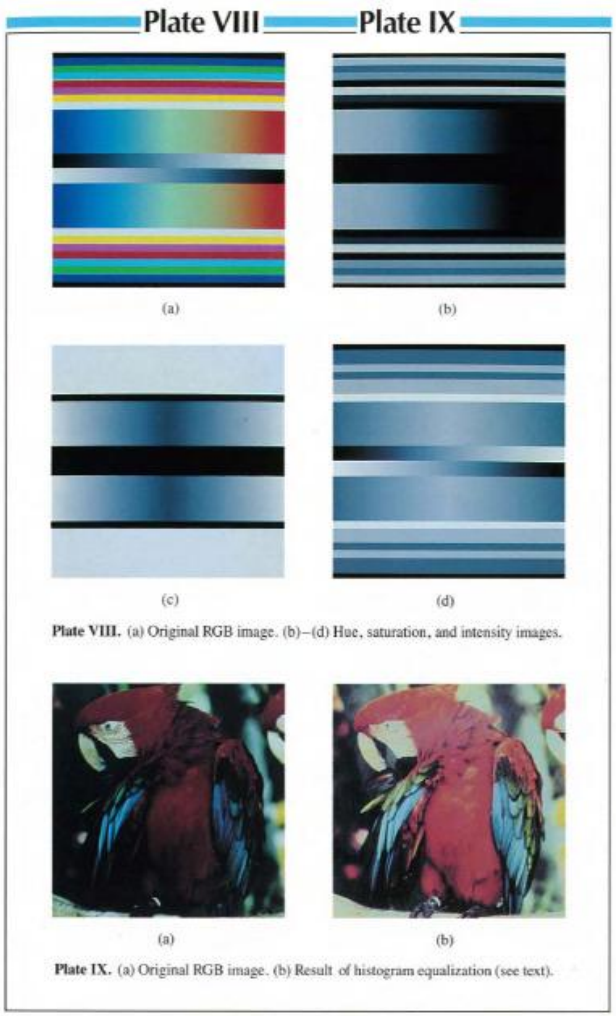


Plate VIII Plate IX

(a) (b)

(c) (d)

Plate VIII. (a) Original RGB image. (b)–(d) Hue, saturation, and intensity images.

(a) (b)

Plate IX. (a) Original RGB image. (b) Result of histogram equalization (see text).

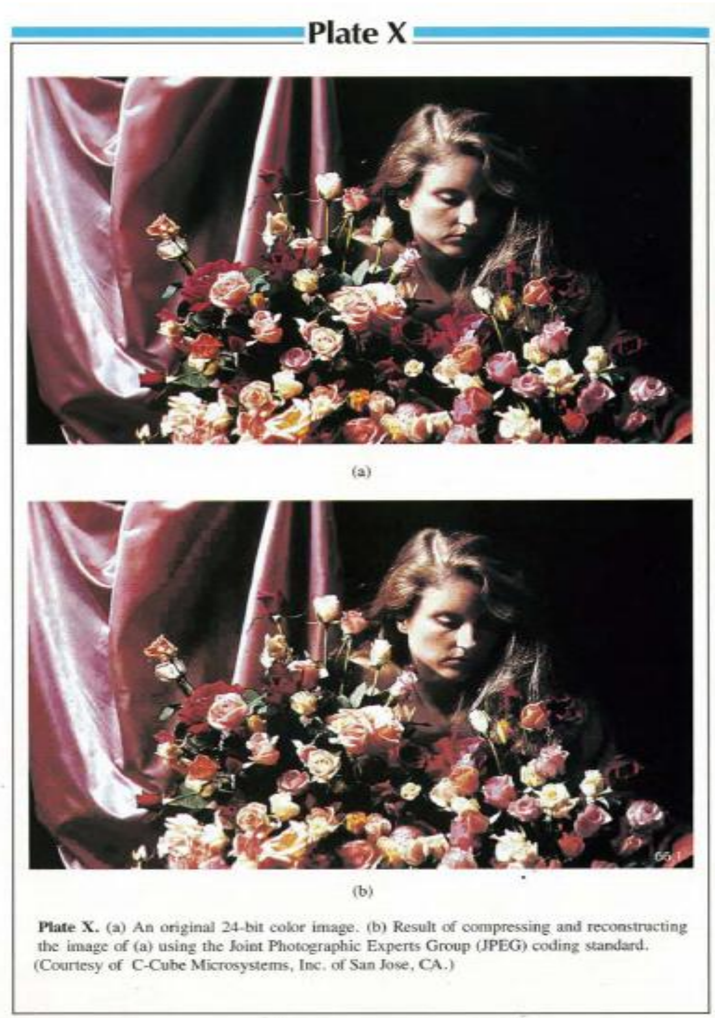


Plate X

(a)

(b)

Plate X. (a) An original 24-bit color image. (b) Result of compressing and reconstructing the image of (a) using the Joint Photographic Experts Group (JPEG) coding standard. (Courtesy of C-Cube Microsystems, Inc. of San Jose, CA.)

Color Processing

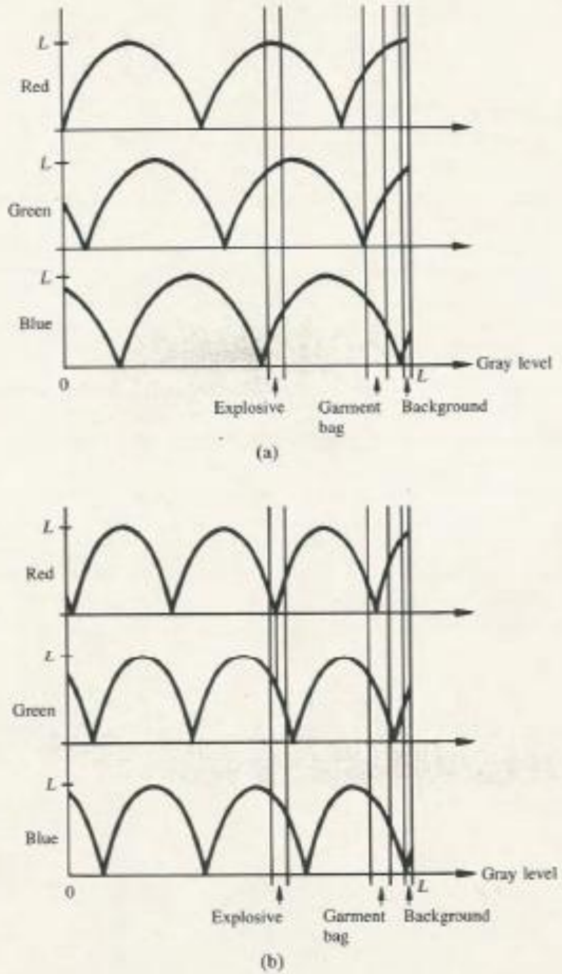


Figure 4.51 Transformation functions used to obtain the images in Plate VI.