Mathematics & Computer Science

(Image Processing, Computer Vision, Intelligent System)

Digital Image Processing Fundamental

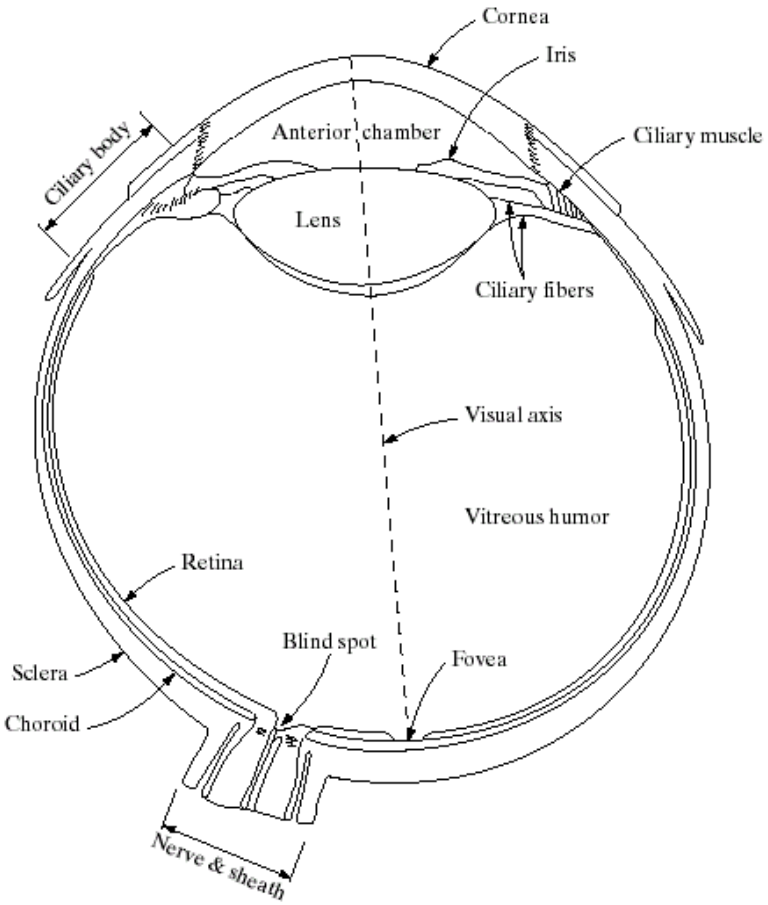

FIGURE 2.1 Simplified diagram of a cross section of the human eye.

Structure of Human Eye

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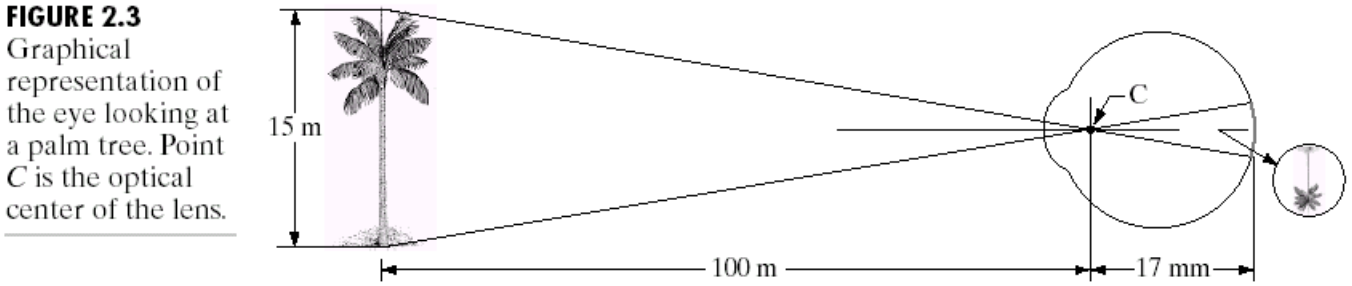

FIGURE 2.3
Graphical representation of the eye looking at a palm tree. Point *C* is the optical center of the lens.

Image Formation in Human Eye

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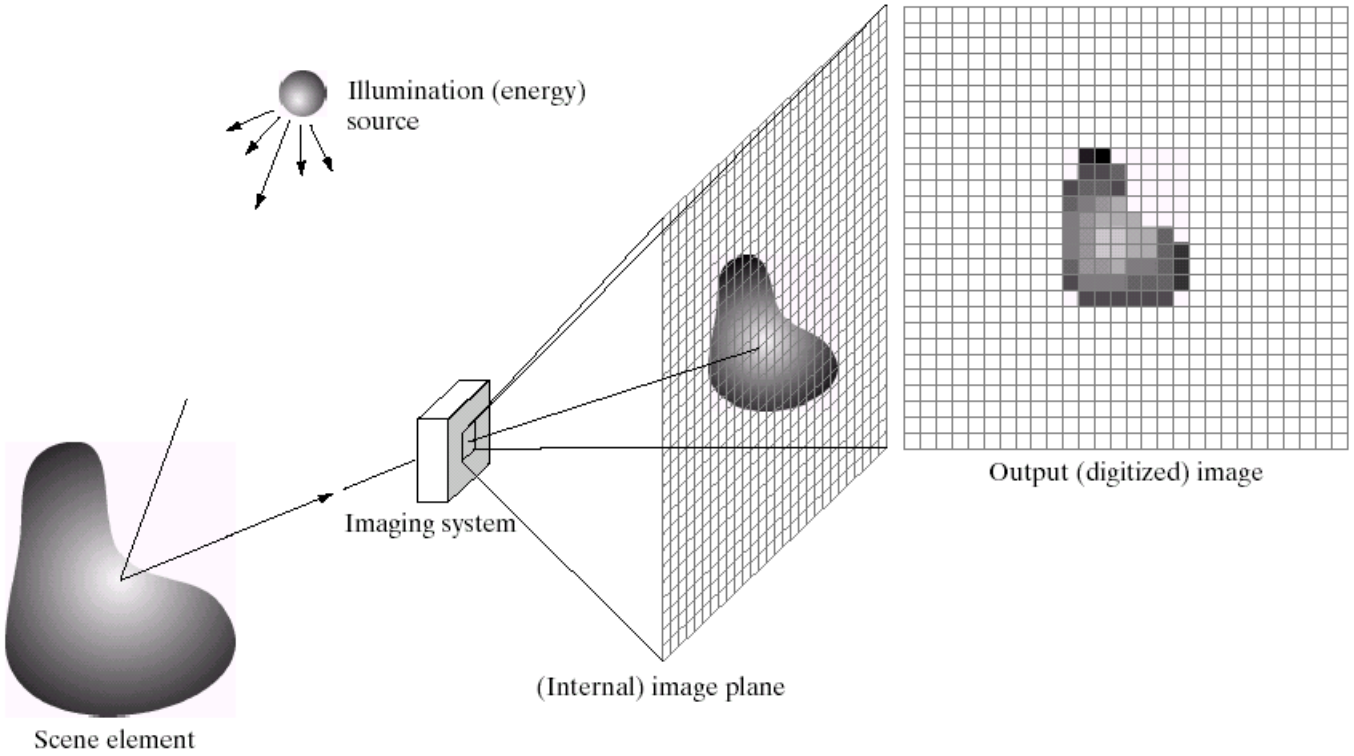

a
b c d e

FIGURE 2.15 An example of the digital image acquisition process. (a) Energy ("illumination") source. (b) An element of a scene. (c) Imaging system. (d) Projection of the scene onto the image plane. (e) Digitized image.

Digital Image Formation

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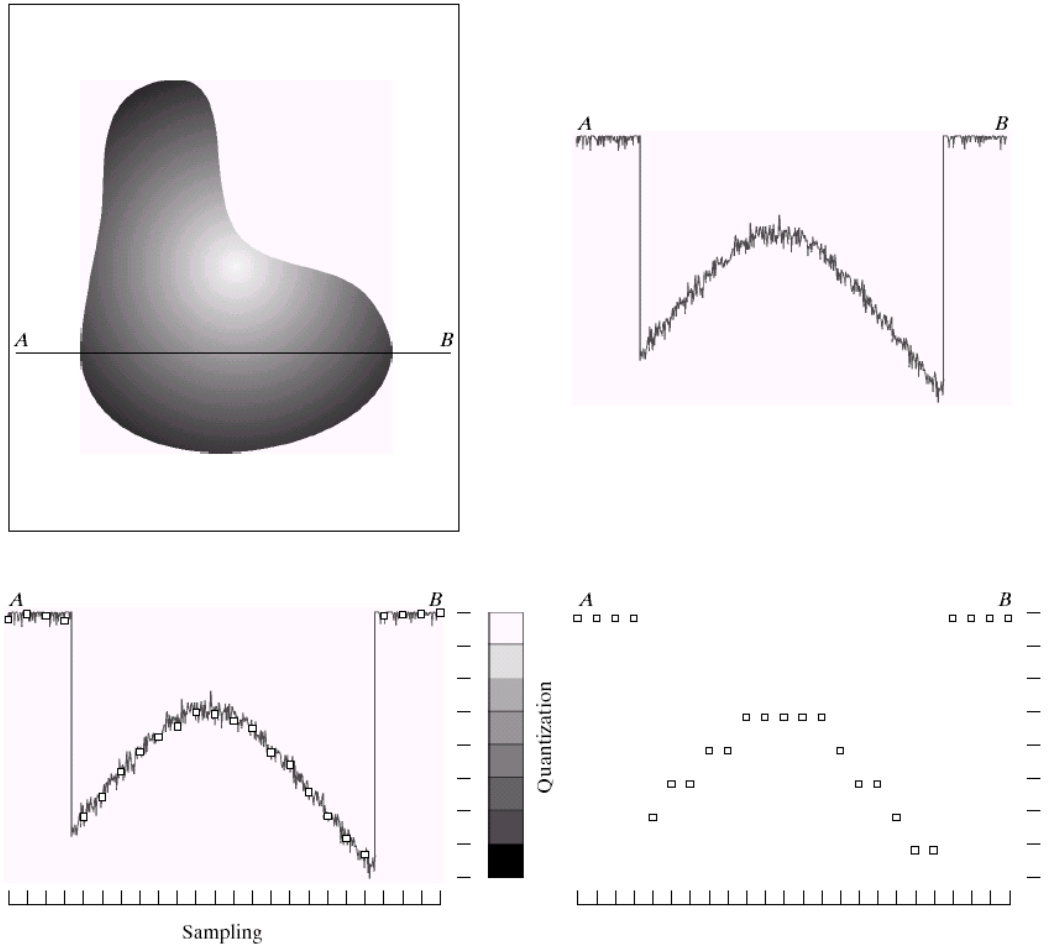
Image Sampling & Quantization



a b
c d

FIGURE 2.16 Generating a digital image. (a) Continuous image. (b) A scan line from *A* to *B* in the continuous image, used to illustrate the concepts of sampling and quantization. (c) Sampling and quantization. (d) Digital scan line.

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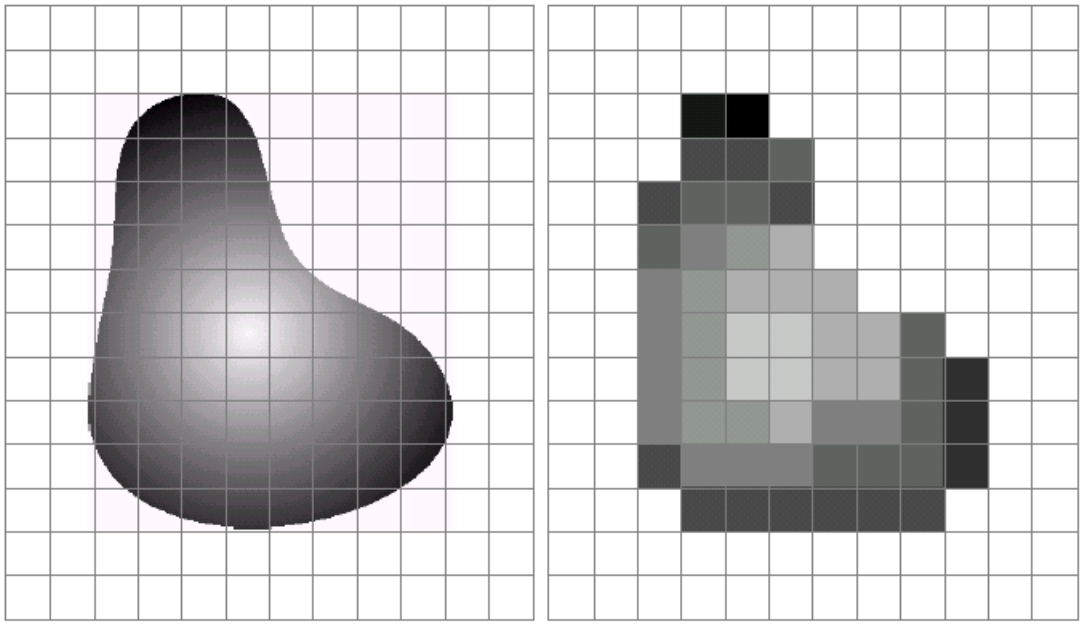

a b

FIGURE 2.17 (a) Continuos image projected onto a sensor array. (b) Result of image sampling and quantization.

Digital Image

Digital Image Processing Fundamental

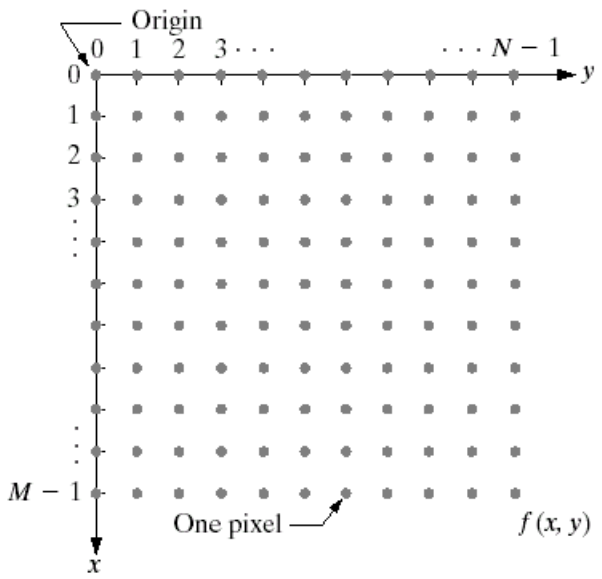

FIGURE 2.18 Coordinate convention used in this book to represent digital images.

Digital Image Representation

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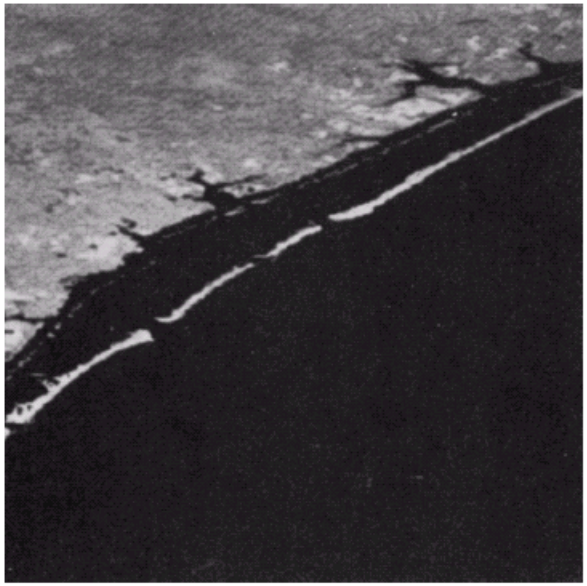
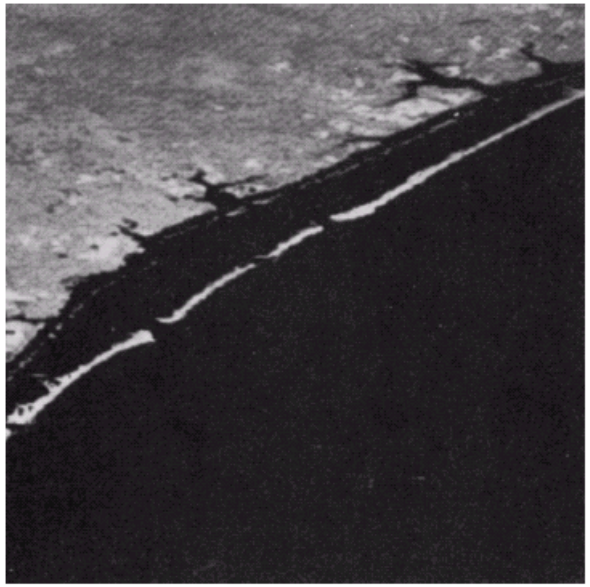


Image

Digital Image Processing Fundamental



Image

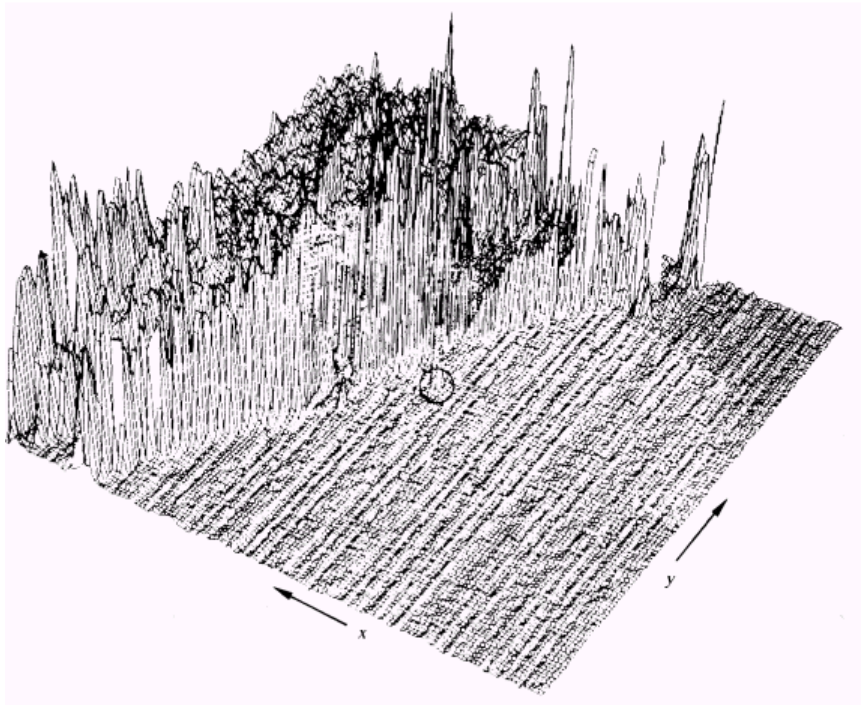
130	128	100	128	140	128	132	128
192	140	120	142	132	146	192	142
120	128	95	128	112	128	95	128
192	64	192	64	0	0	0	0
120	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Matrix

Digital Image Processing Fundamental

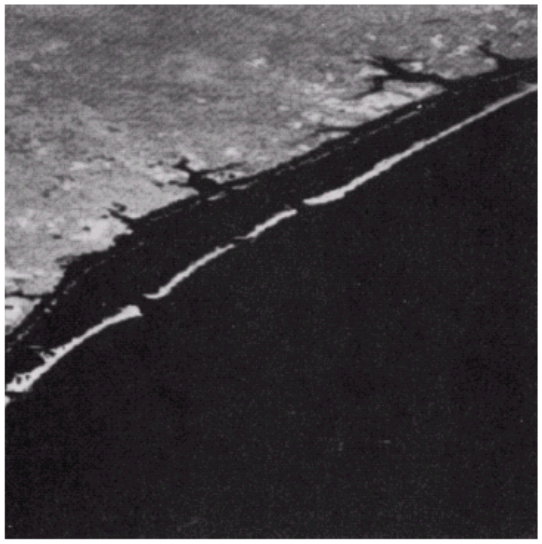
130	128	100	128	140	128	132	128
192	140	120	142	132	146	192	142
120	128	95	128	112	128	95	128
192	64	192	64	0	0	0	0
120	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Matrix



$f(x, y)$

Digital Image Processing Fundamental



130	128	100	128	140	128	132	128
192	140	120	142	132	146	192	142
120	128	95	128	112	128	95	128
192	64	192	64	0	0	0	0
120	0	0	0	0	0	0	0
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0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

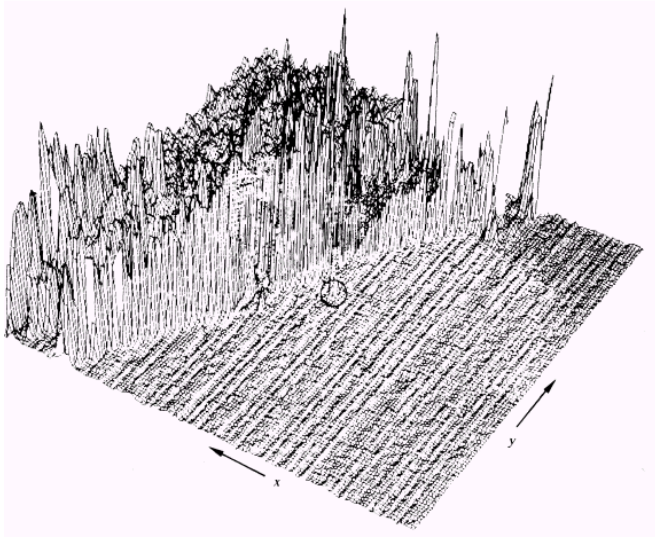


Image Matrix $f(x, y)$

Digital Image Processing Fundamental

Digital Image

Digital Image Processing Fundamental

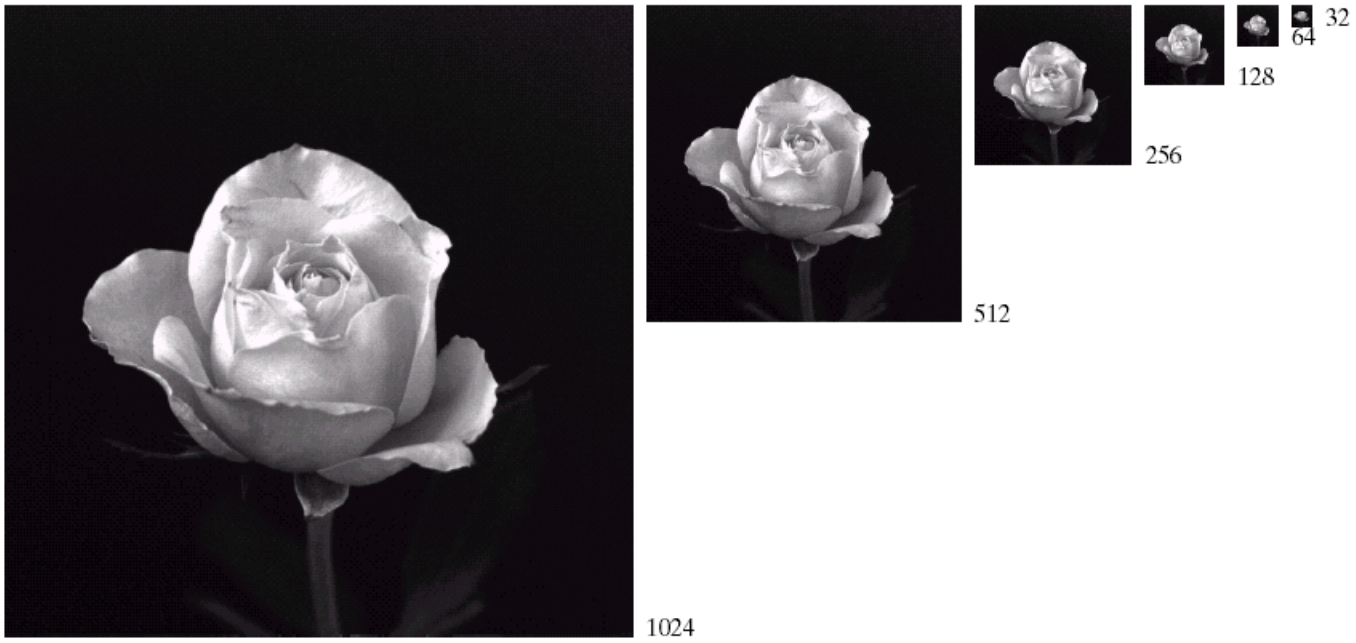


FIGURE 2.19 A 1024 × 1024, 8-bit image subsampled down to size 32 × 32 pixels. The number of allowable gray levels was kept at 256.

Digital Image Resizing (Shrinking)

Digital Image Processing Fundamental

How can we reduce size (shrink) of a digital image?

Digital Image Processing Fundamental

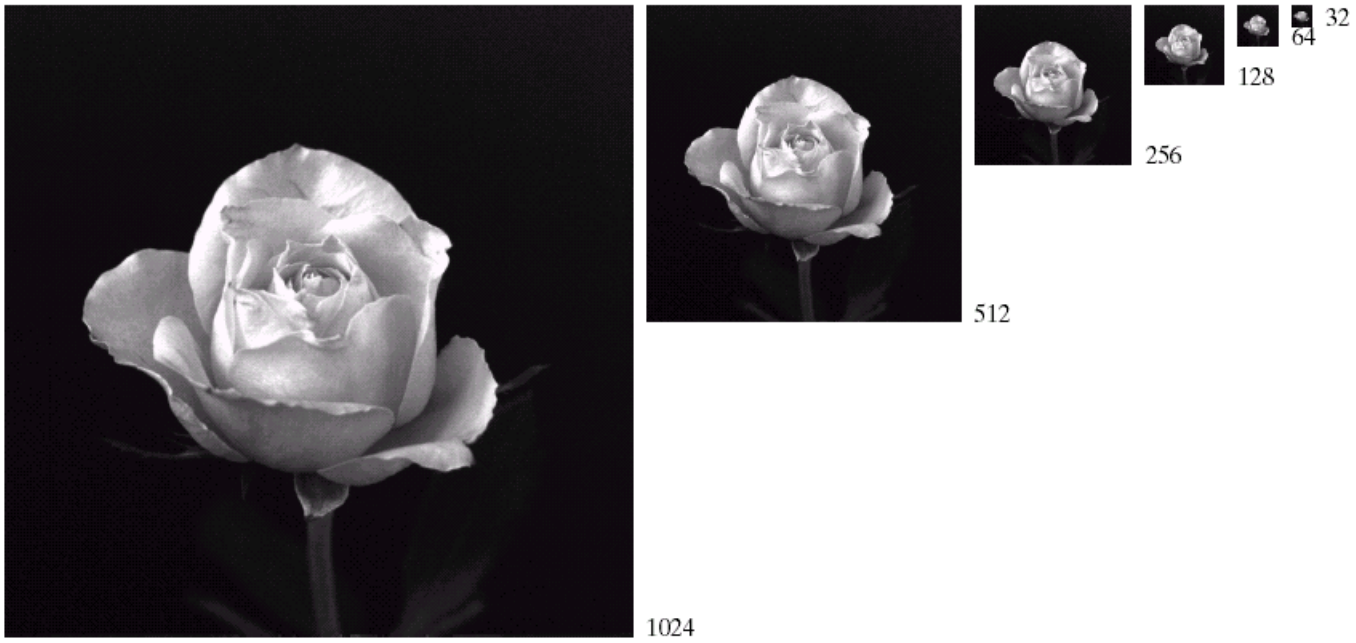
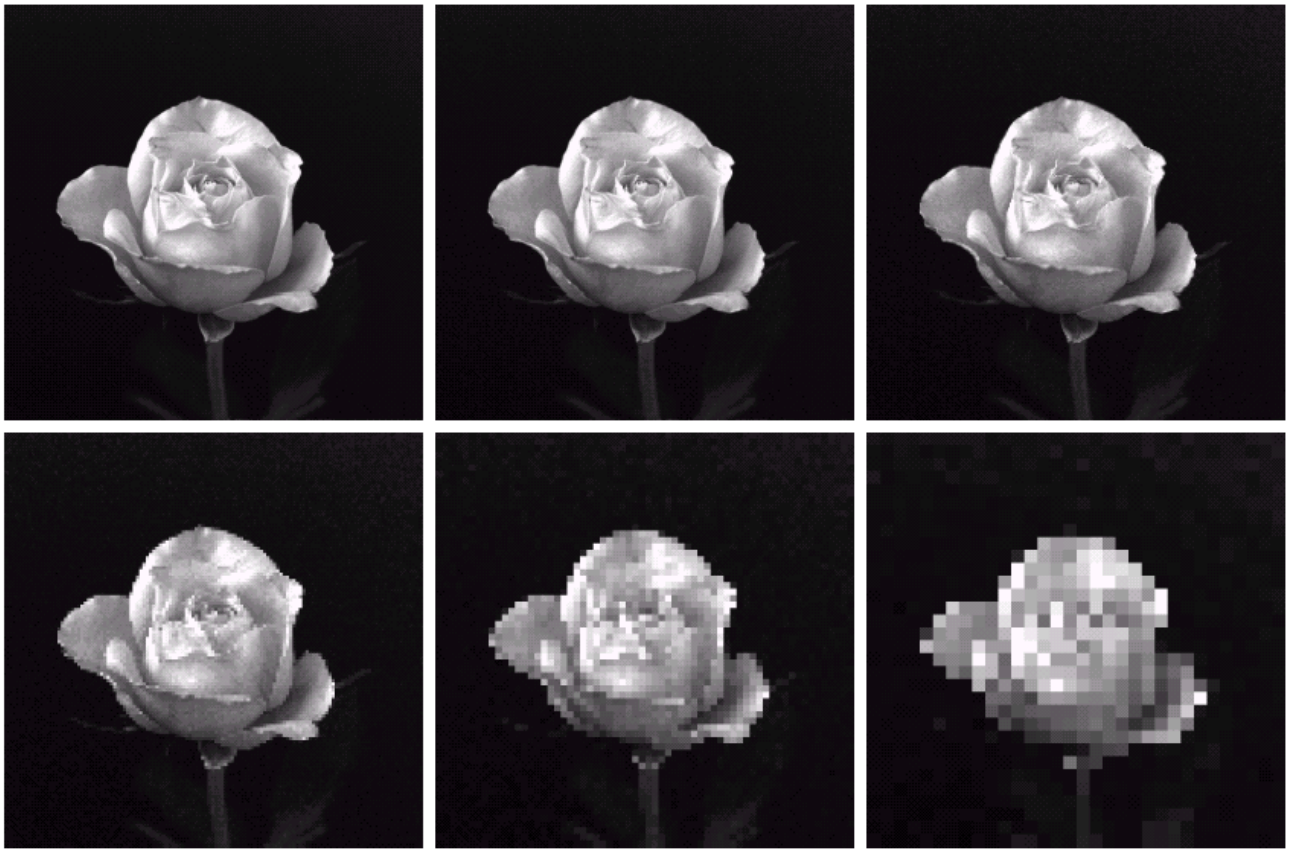


FIGURE 2.19 A 1024 × 1024, 8-bit image subsampled down to size 32 × 32 pixels. The number of allowable gray levels was kept at 256.

How can we enlarge a digital image?

Digital Image Processing Fundamental



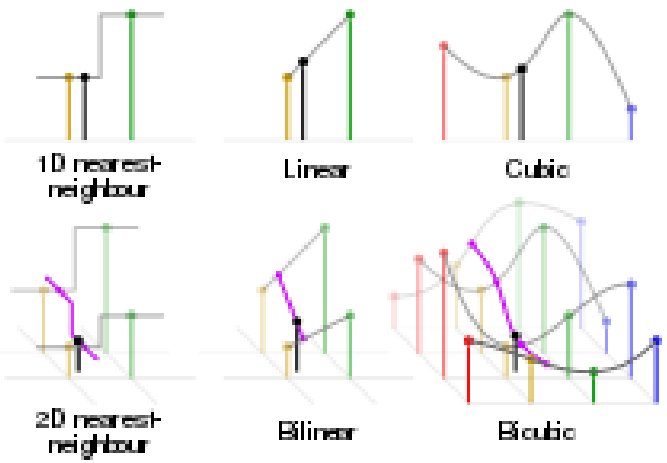
a b c
d e f

FIGURE 2.20 (a) 1024 × 1024, 8-bit image. (b) 512 × 512 image resampled into 1024 × 1024 pixels by row and column duplication. (c) through (f) 256 × 256, 128 × 128, 64 × 64, and 32 × 32 images resampled into 1024 × 1024 pixels.

Digital Image Resizing (zooming)

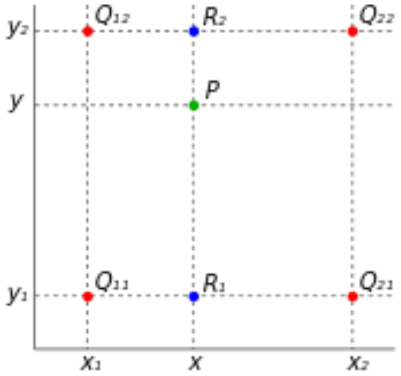
Digital Image Processing Fundamental

Digital Image Resizing Functions



Digital Image Processing Fundamental

Digital Image Resizing (zooming) by Bilinear Interpolation



The four red dots show the data points and the green dot is the point at which we want to interpolate.

$$f(x,y) \approx a_0 + a_1x + a_2y + a_3xy$$

$$\begin{bmatrix} 1 & x_1 & y_1 & x_1y_1 \\ 1 & x_1 & y_2 & x_1y_2 \\ 1 & x_2 & y_1 & x_2y_1 \\ 1 & x_2 & y_2 & x_2y_2 \end{bmatrix} \begin{bmatrix} a_0 \\ a_1 \\ a_2 \\ a_3 \end{bmatrix} = \begin{bmatrix} f(Q_{11}) \\ f(Q_{12}) \\ f(Q_{21}) \\ f(Q_{22}) \end{bmatrix}$$

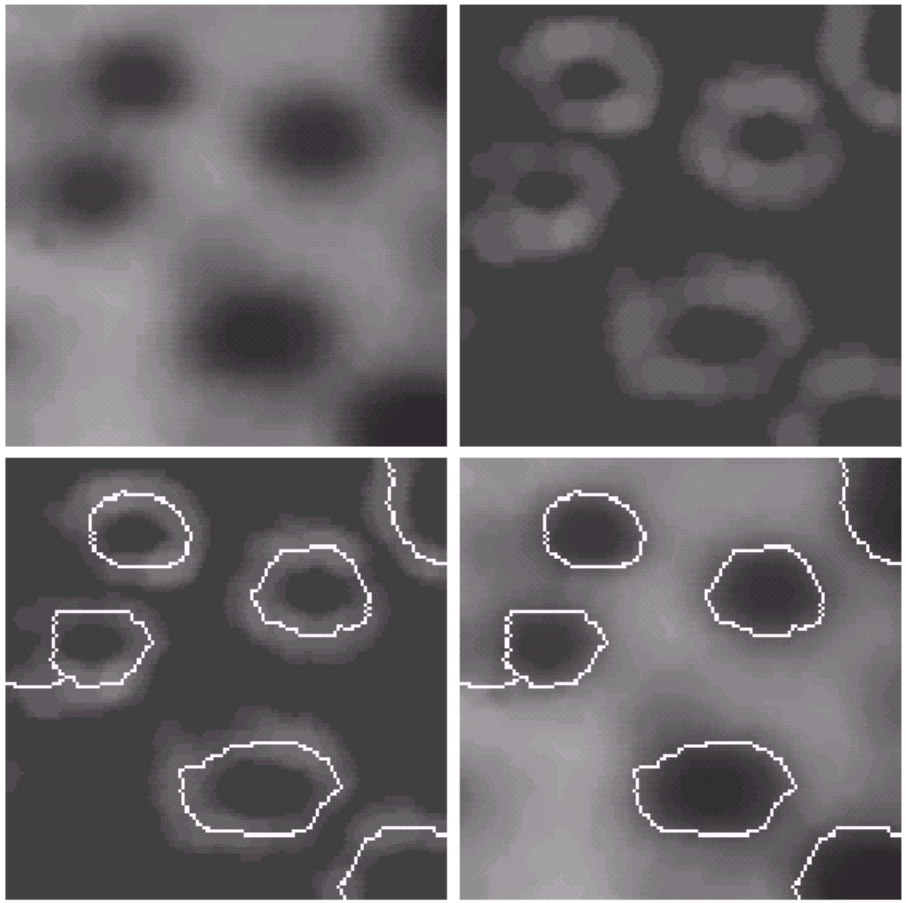
Digital Image Processing Fundamental

Object Recognition

Digital Image Processing Fundamental

a b
c d

FIGURE 10.46
(a) Image of blobs. (b) Image gradient.
(c) Watershed lines.
(d) Watershed lines superimposed on original image.
(Courtesy of Dr. S. Beucher, CMM/Ecole des Mines de Paris.)



Detect Boundary
& Compute Area

Digital Image Processing Fundamental

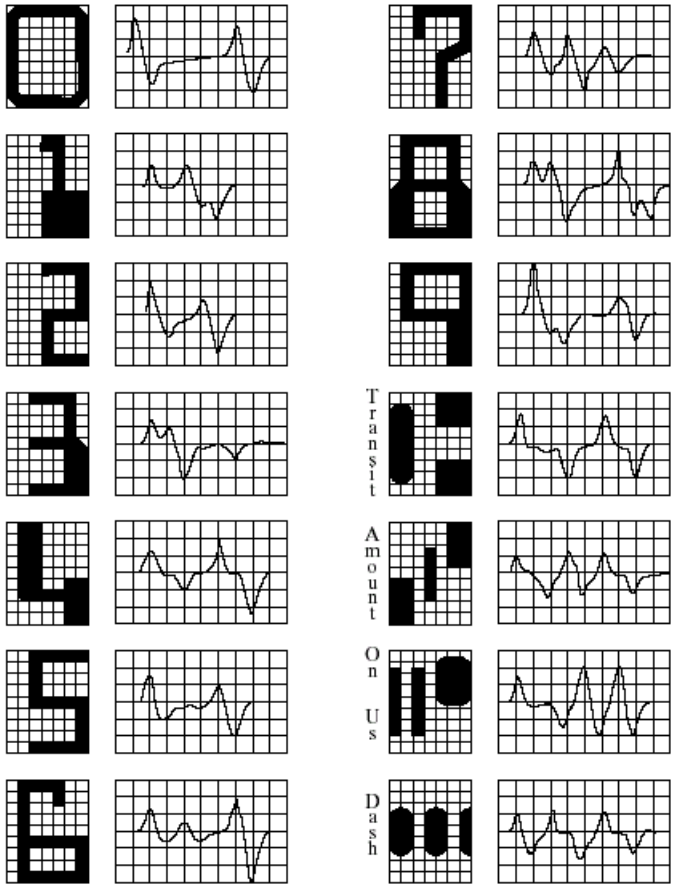


FIGURE 12.7 American Bankers Association E-13B font character set and corresponding waveforms.

Digit Recognition