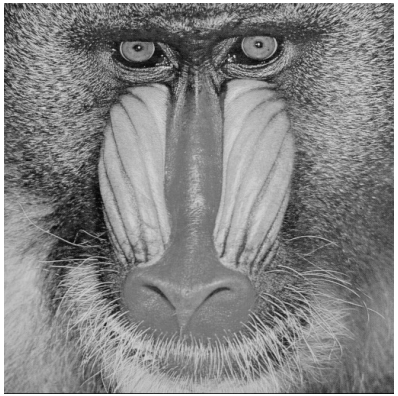
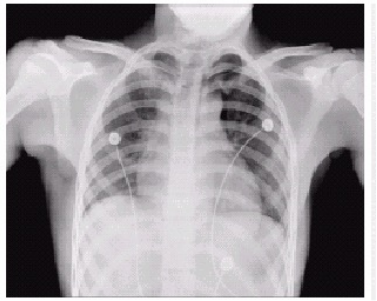
Digital Image Processing

Digital Image Processing

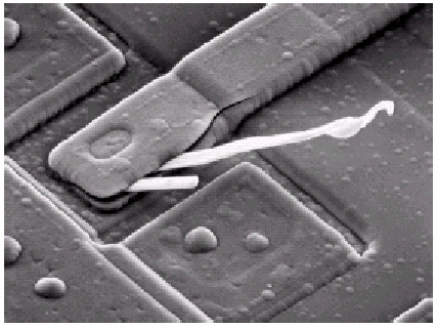


Acquisition: Photography

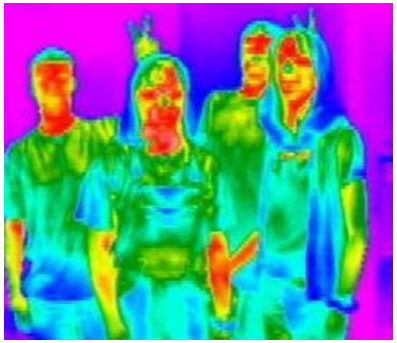
Digital Image Processing



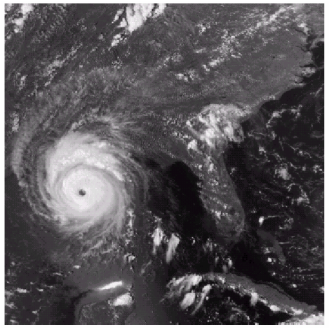
X-ray/CT/MRI



Electron Microscope



Thermal Imaging

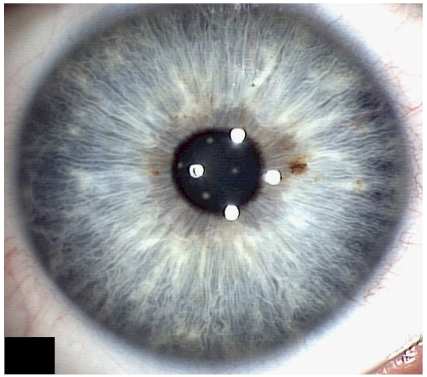


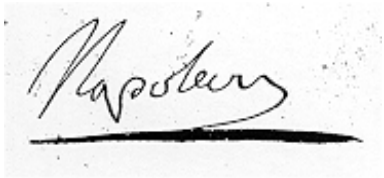
Remote Sensing

Other Acquisition Modalities

Digital Image Processing

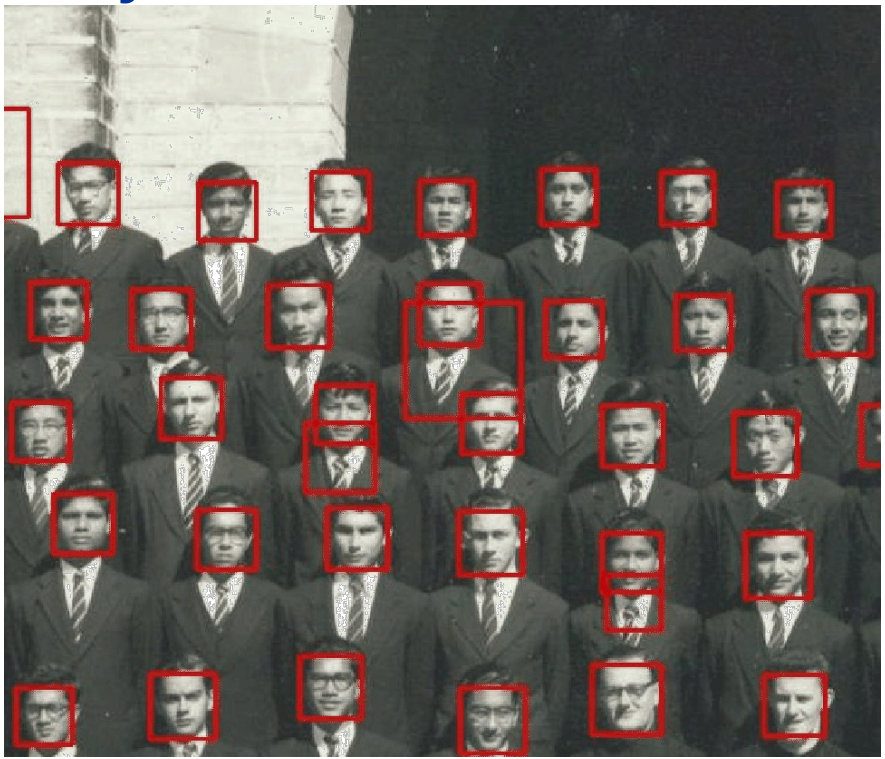
Some Applications: Biometric and Recognition





Digital Image Processing: Applications

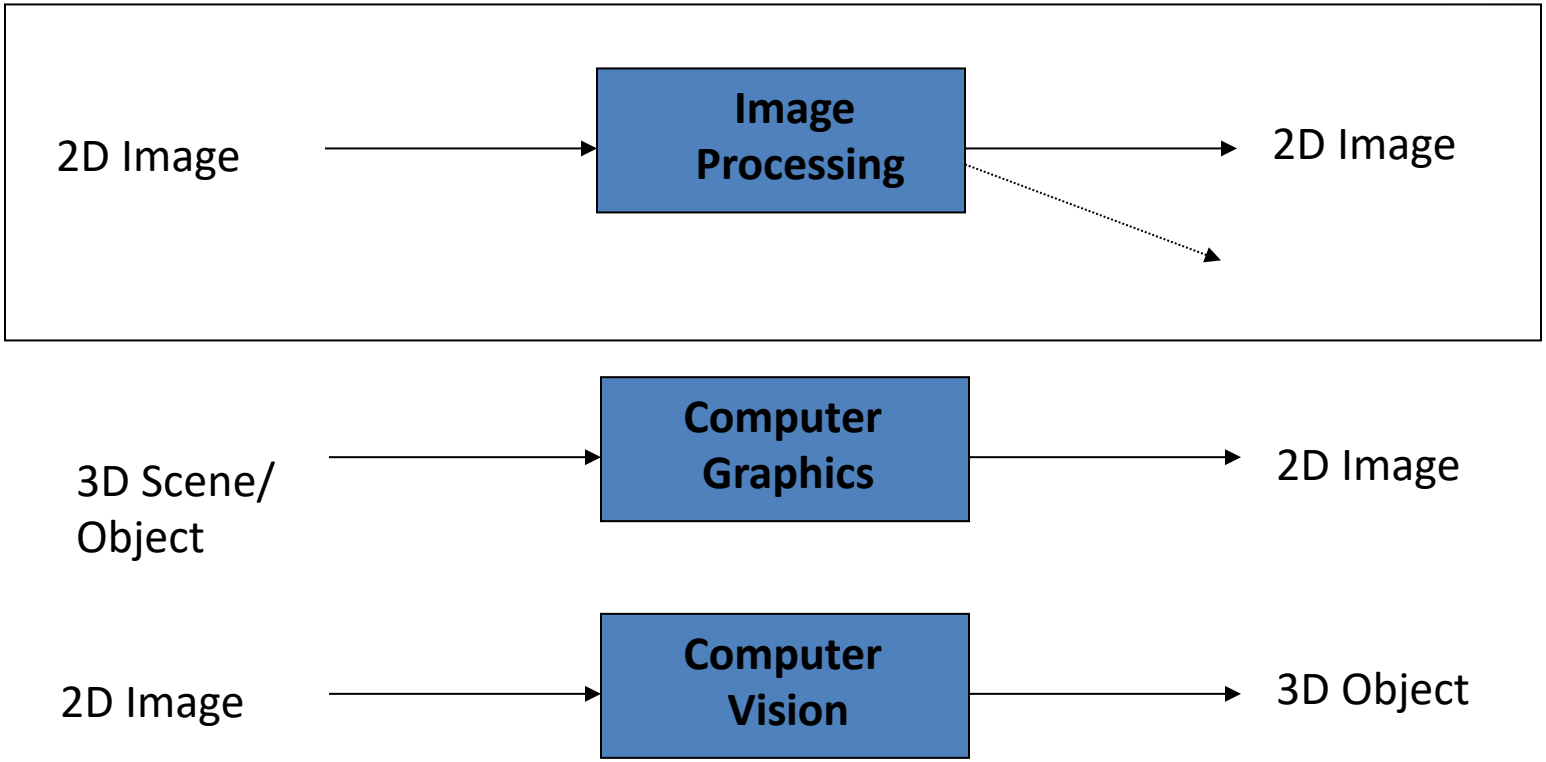
Object Detection



Digital Image Processing: Applications

Computational Photography

Digital Image Processing

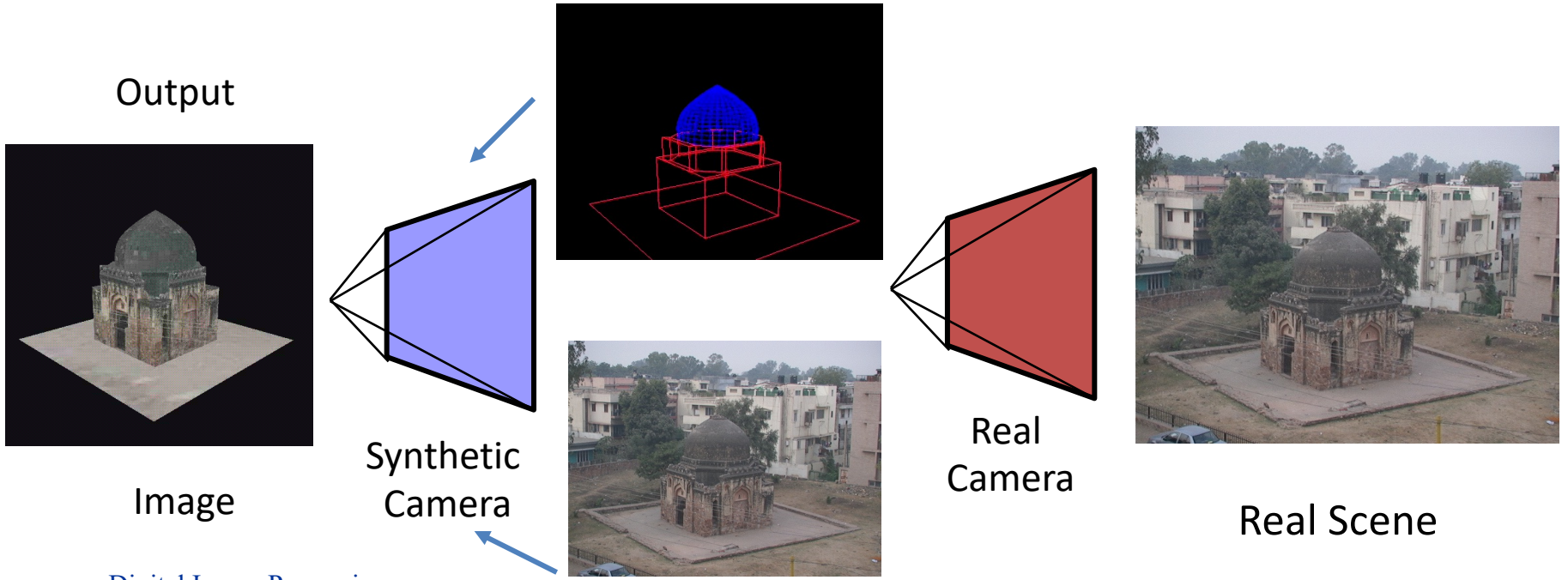


Digital Image Processing

Computer Graphics

Digital Image Processing

Computer Vision



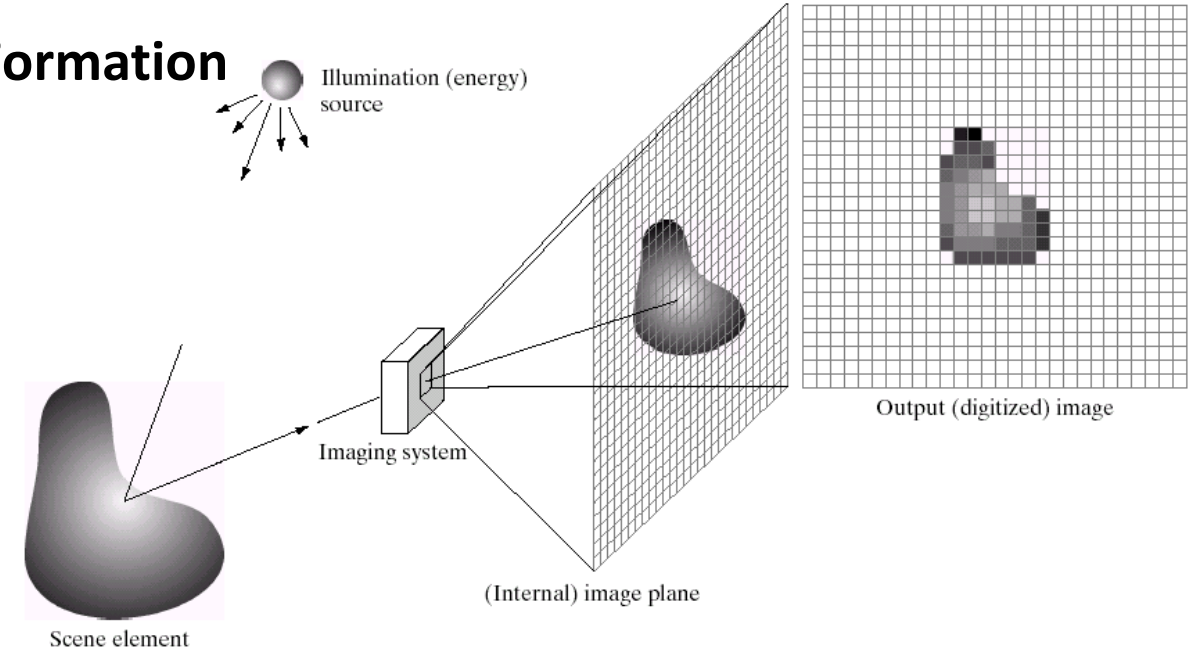
Digital Image Processing

Course Contents (Tentative)

Fundamentals
Image Enhancement
Image Segmentation
Image Restoration
Image Transforms
Image Compression (+Video)
Image Analysis:
    Representation/Description
    Recognition/Identification

Fundamentals

Image Formation

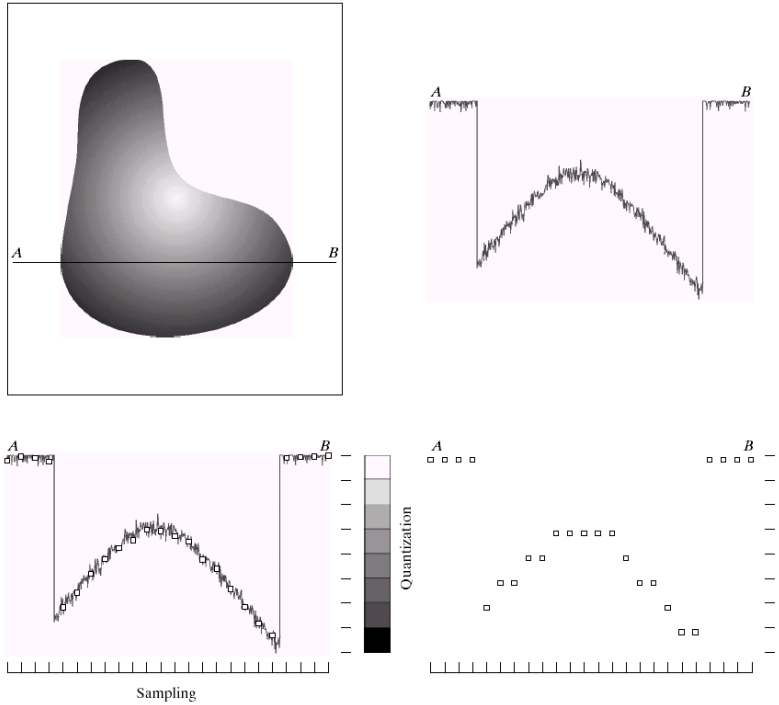


a b c d e

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.

Fundamentals

Sampling and Quantization

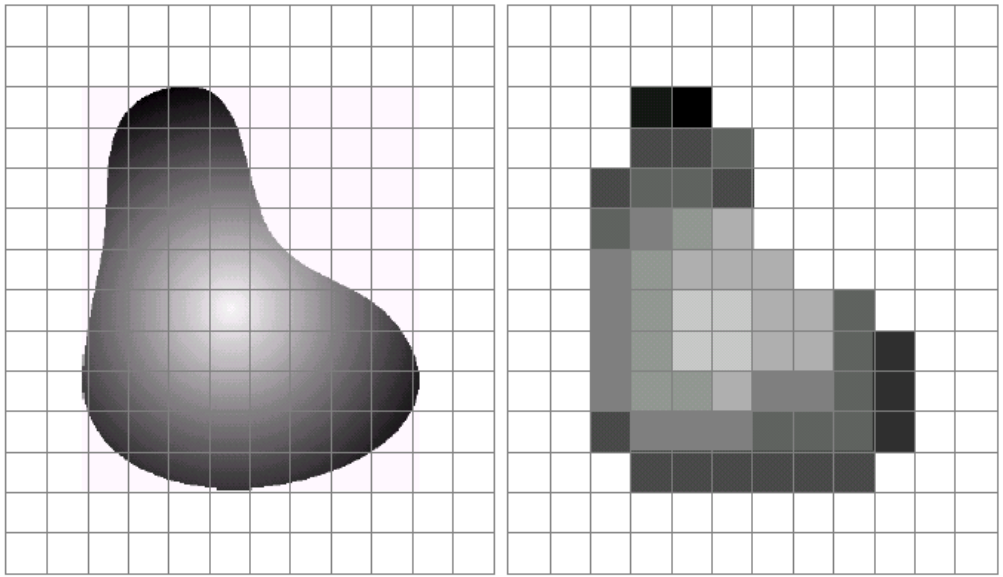


a b
c d

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.

Fundamentals

Sampling and Quantization



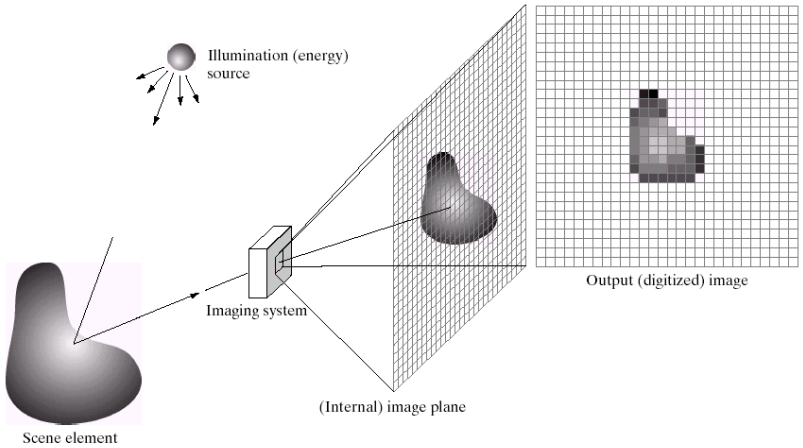
a b

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

Fundamentals

- An image is a spatial representation of an object, a 2D or 3D scene.
- Abstractly, an image is a continuous function defining a rectangular region of a plane

– intensity image - proportional to radiant energy received by a sensor/dete



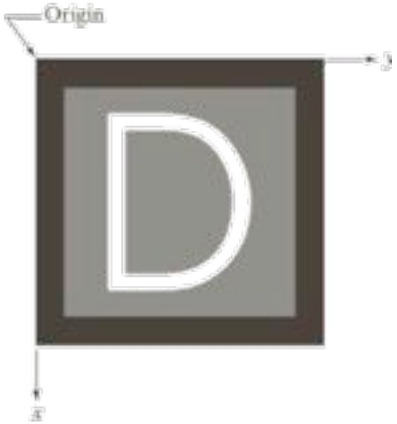
a b c d e

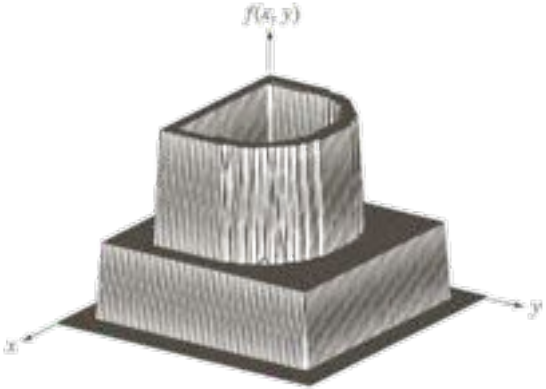
FIGURE 2.15 An example of the digital image acquisition process. (a) Energy ("illumination") source. (b) An element of a scene. (c) Imaging system. (d) Projection of the scene onto the image plane. (e) Digitized image.

Fundamentals

- An image can be thought of as a function with resulting values of the light intensity at each point over a planar region.

2D function f(x,y)





Fundamentals

Image Representation

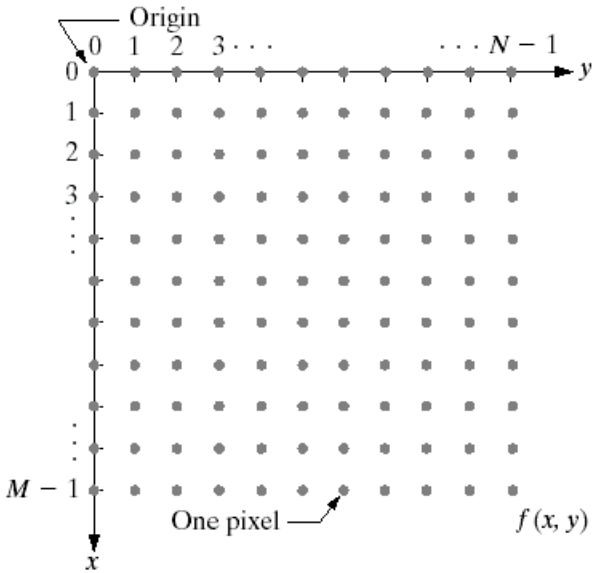


FIGURE 2.18 Coordinate convention used in this book to represent digital images.

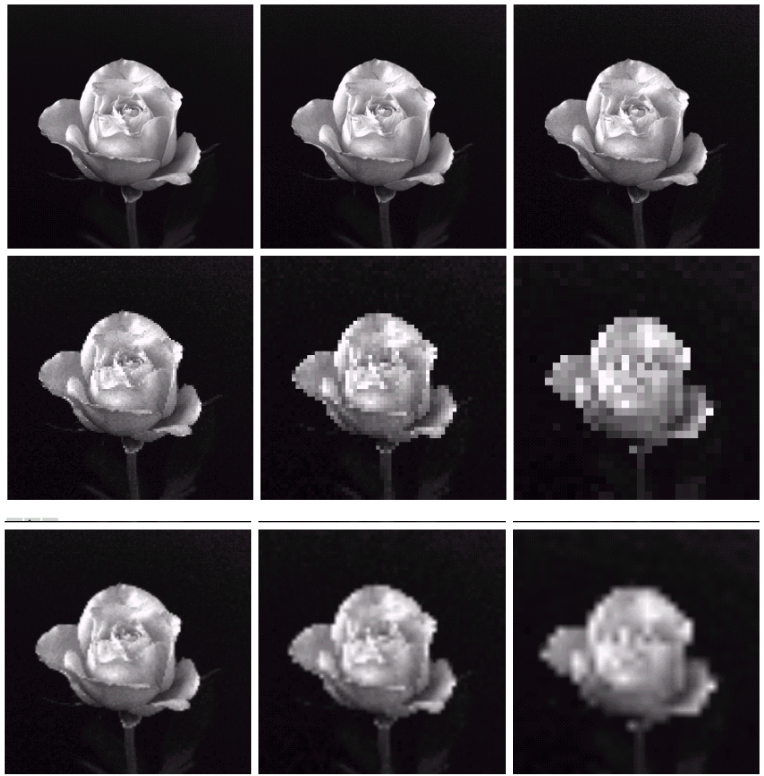
Fundamentals

Image Resolution (Spatial)

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.

Fundamentals

Image Resolution (Spatial)



Fundamentals

Image Resolution (Spatial)

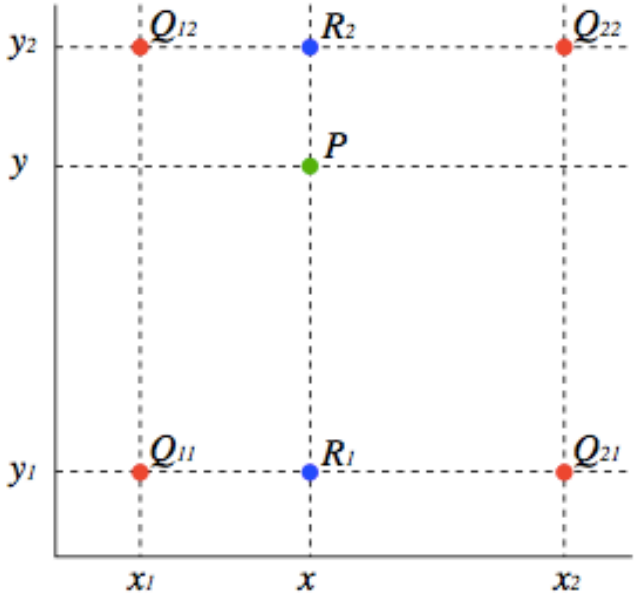
Bilinear Interpolation

$$f(x, y_1) \approx \frac{x_2 - x}{x_2 - x_1} f(Q_{11}) + \frac{x - x_1}{x_2 - x_1} f(Q_{21}),$$

$$f(x, y_2) \approx \frac{x_2 - x}{x_2 - x_1} f(Q_{12}) + \frac{x - x_1}{x_2 - x_1} f(Q_{22}).$$

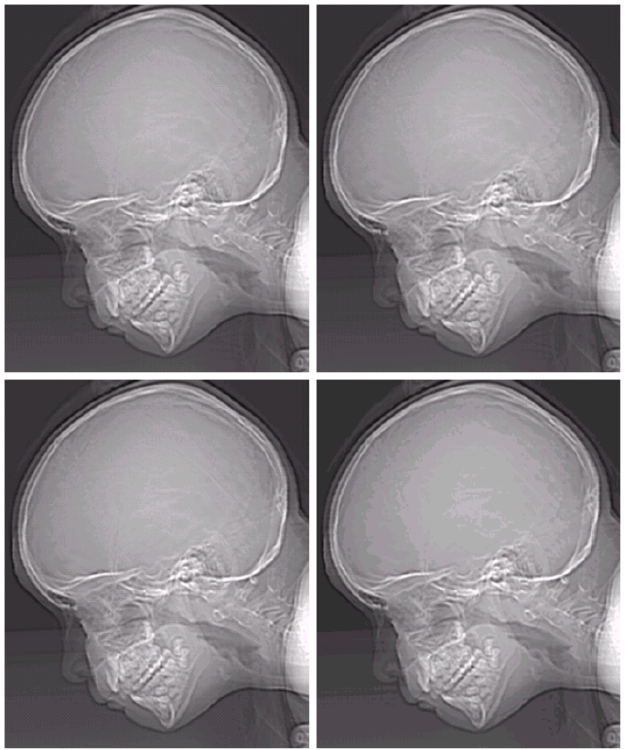
$$f(x, y) \approx \frac{y_2 - y}{y_2 - y_1} f(x, y_1) + \frac{y - y_1}{y_2 - y_1} f(x, y_2)$$

$$= \frac{1}{(x_2 - x_1)(y_2 - y_1)} \begin{bmatrix} x_2 - x & x - x_1 \end{bmatrix} \begin{bmatrix} f(Q_{11}) & f(Q_{12}) \\ f(Q_{21}) & f(Q_{22}) \end{bmatrix} \begin{bmatrix} y_2 - y \\ y - y_1 \end{bmatrix}.$$



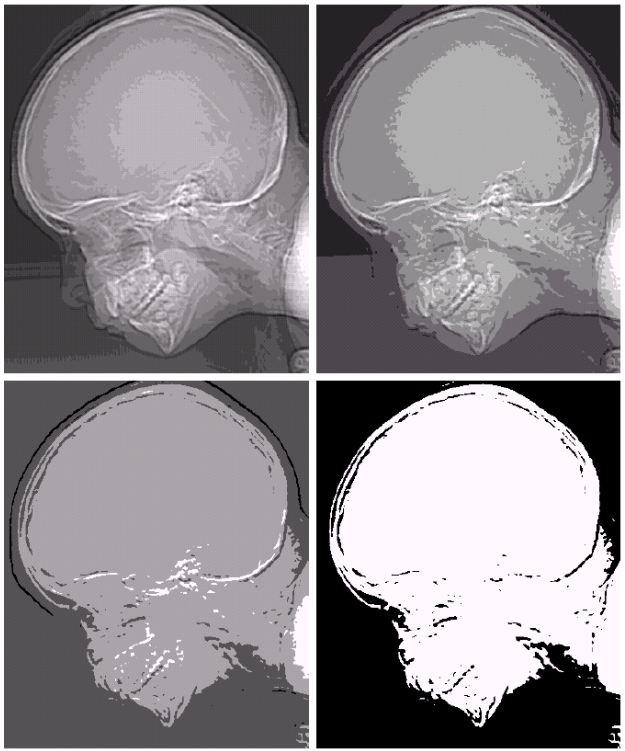
Fundamentals

Image Resolution (Intensity Levels)



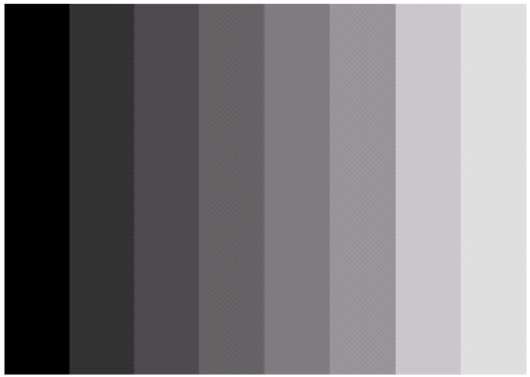
a b
c d

FIGURE 2.21
(a) 452 × 374, 256-level image. (b)–(d) Image displayed in 128, 64, and 32 gray levels, while keeping the spatial resolution constant.

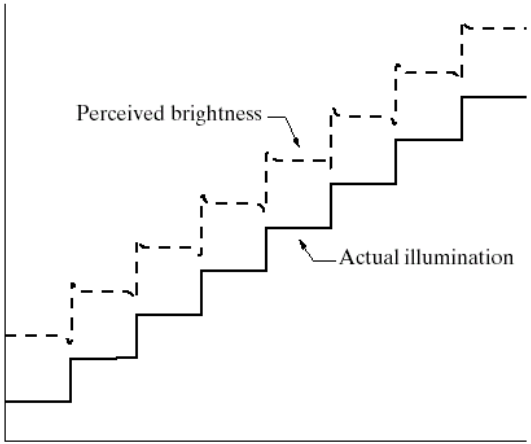


Fundamentals

Intensity/ Luminance and Brightness



Mach Band Effect



Simultaneous Contrast

Fundamentals

Other Operations

Neighborhood

N_4, N_D, N_8

Adjacency/Connectivity

4-connected

8-connected

Distance

Euclidian

D_4

D_8