

# DIGITAL IMAGE PROCESSING

# **Image Processing:**

**Processing of images to:**

- Improve Quality**
- Recognize objects in an image**
- Count number of objects in an image**

## **Applications of Image Processing:**

- 1. Image Enhancement: Improving the contrast of images. Contrast may be low due to poor lighting as in wildlife photography.**
- 2. Removal of Motion blur / noise**
- 3. Image Classification / Object recognition**
- 4. Image Compression**





## Blurring due to uniform motion

12-5996 New York, NY, Statue of Liberty with Stinson  
Aerials Only Gallery 508-295-5551(C) (E)

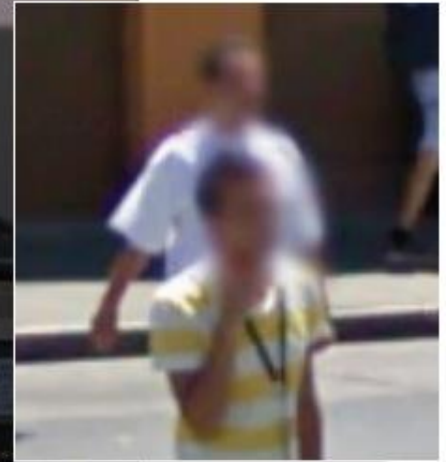
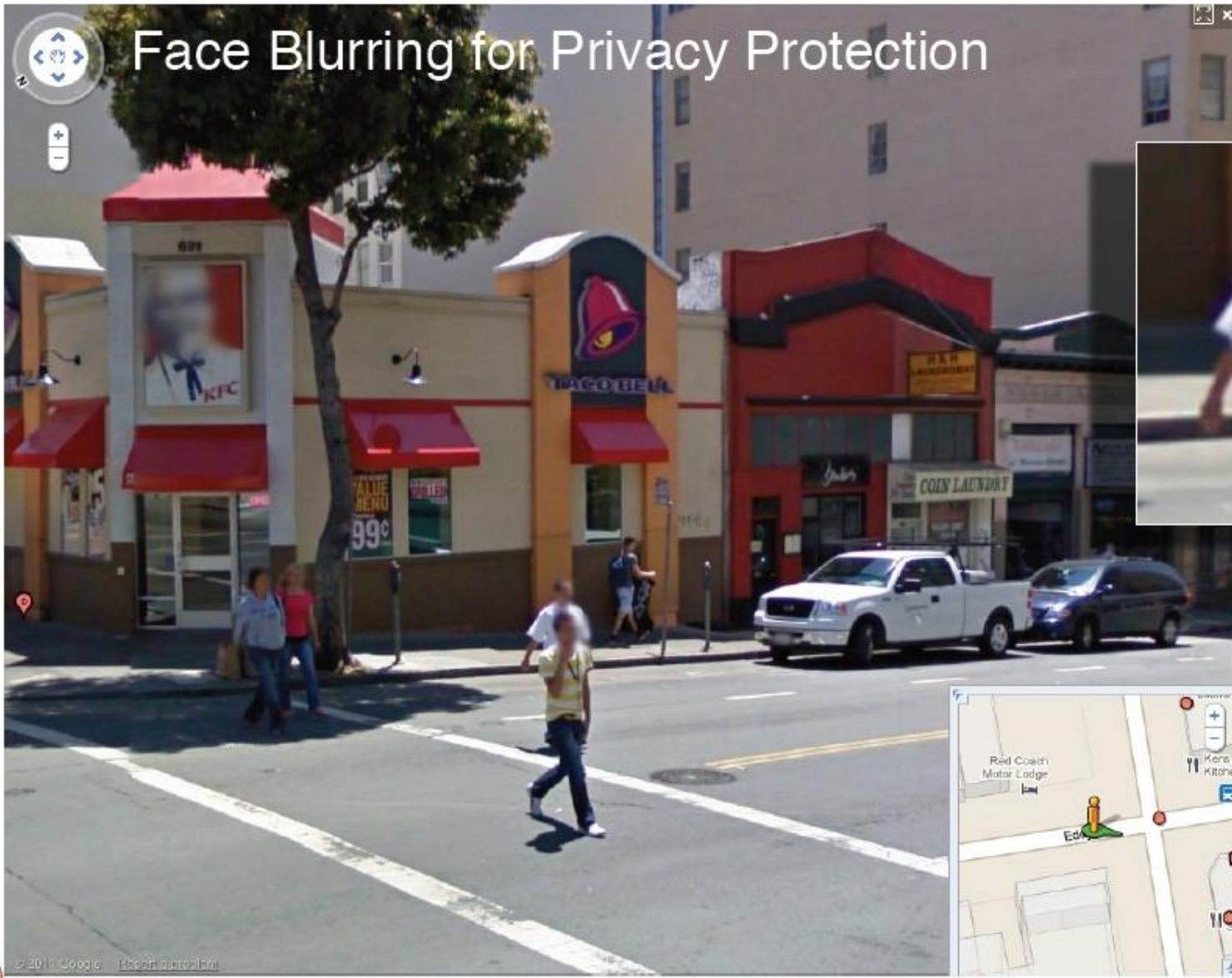








# Face Blurring for Privacy Protection

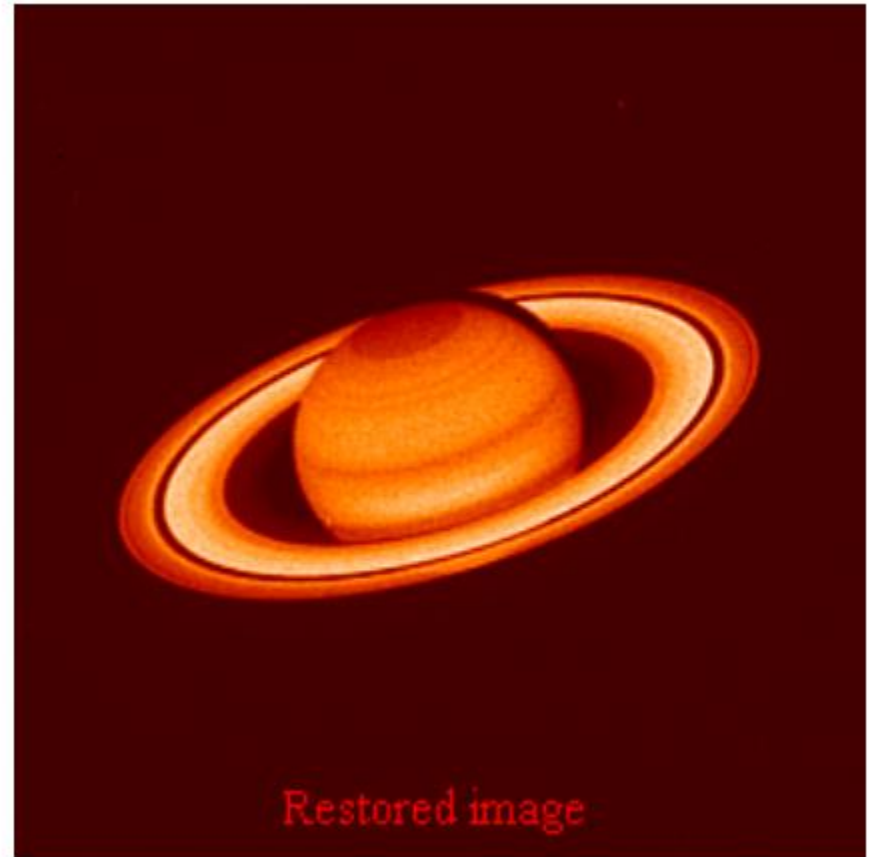


# **Some fields which use Image Processing:**

- 1. Medical Imaging**
- 2. Remote Sensing.**
- 3. All areas of Science and Engineering.**
- 4. Movies (Special Effects)**

# Restoration of image from Hubble Space Telescope!

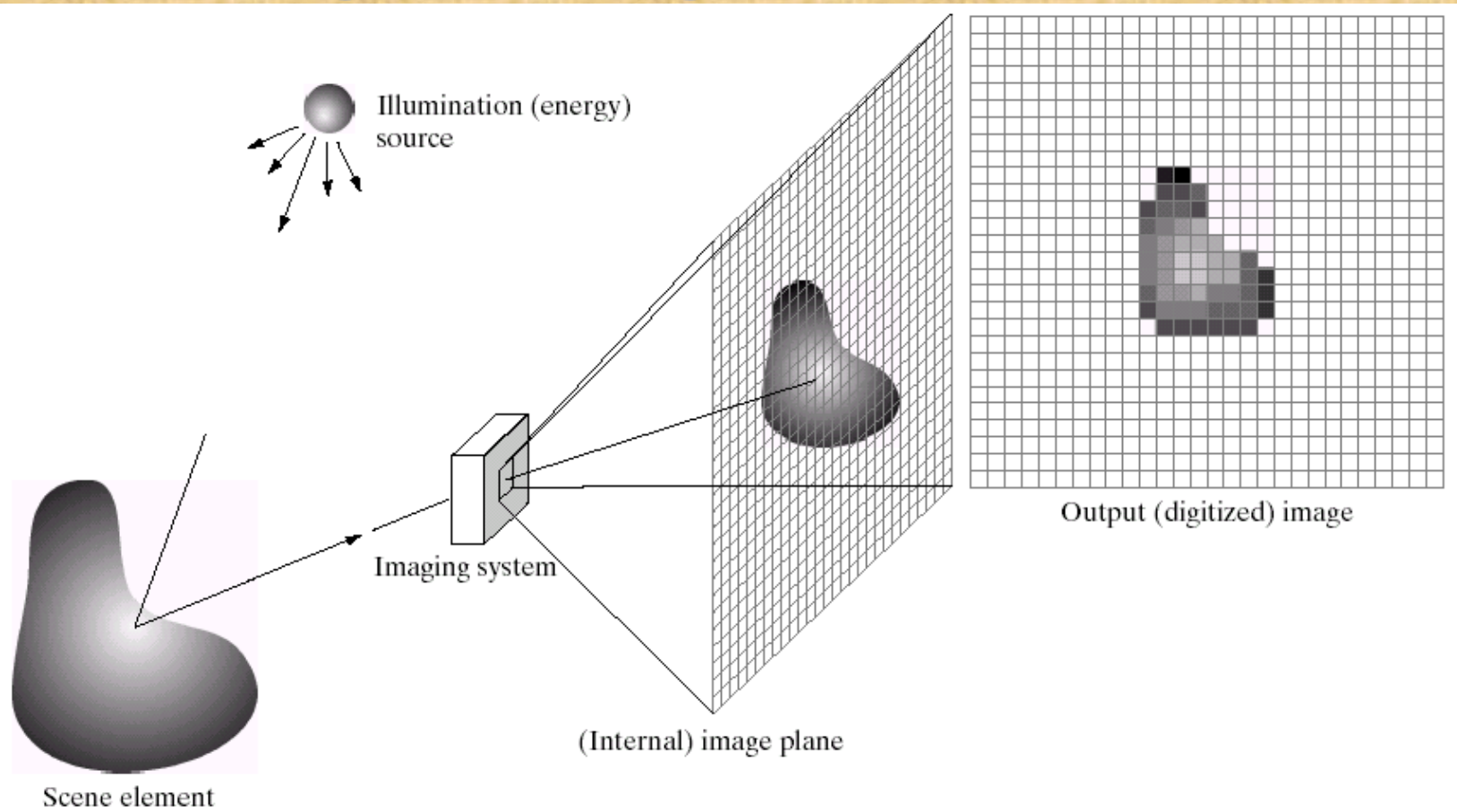
Source: IVPL Northwestern University, Chicago



# Morphing: Linear combination of two images



# Digital Image ACQUISITION

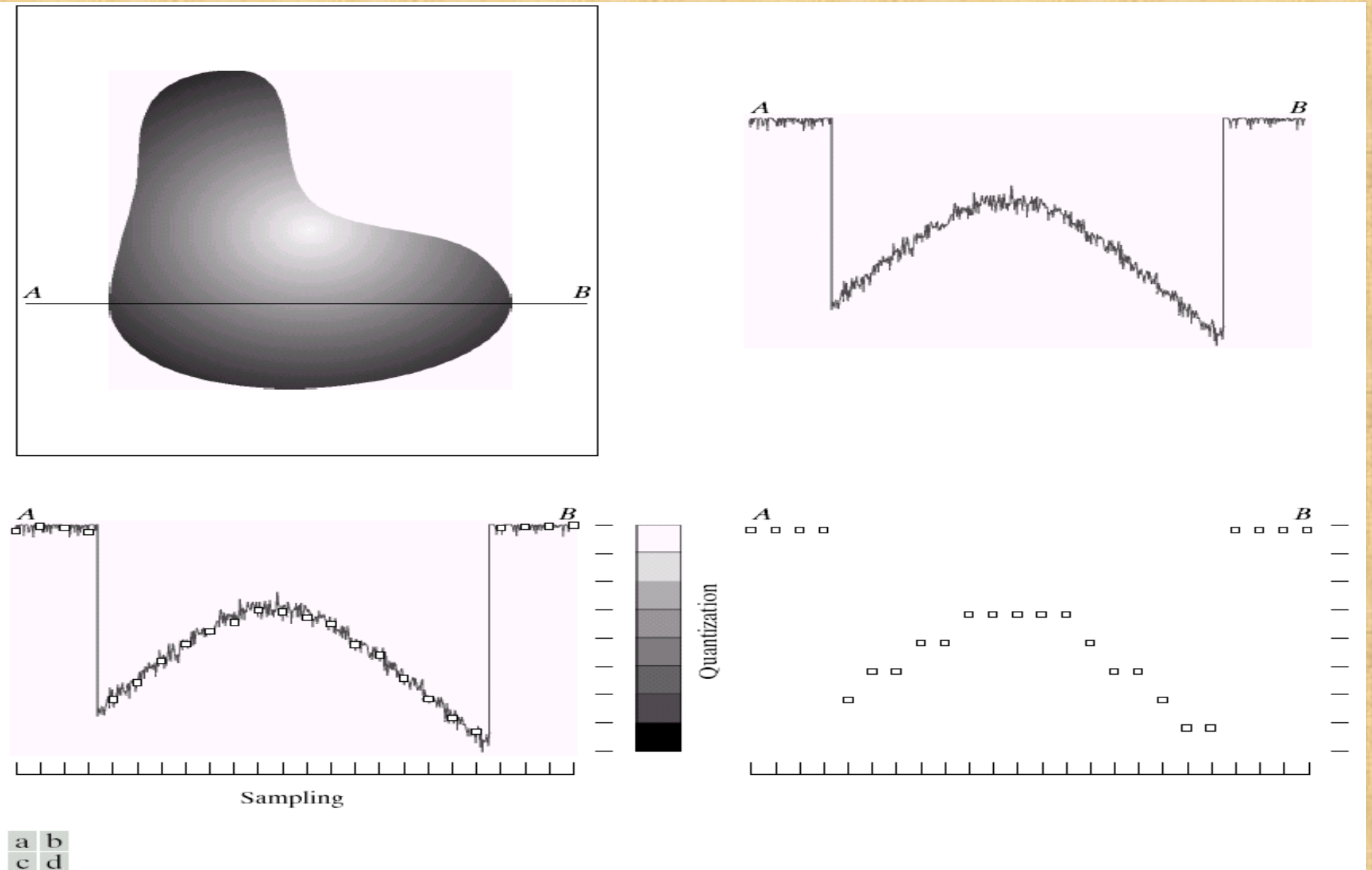


a b c d e

**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.

Slide courtesy of : Prof. Gonzalez & Prof. Woods

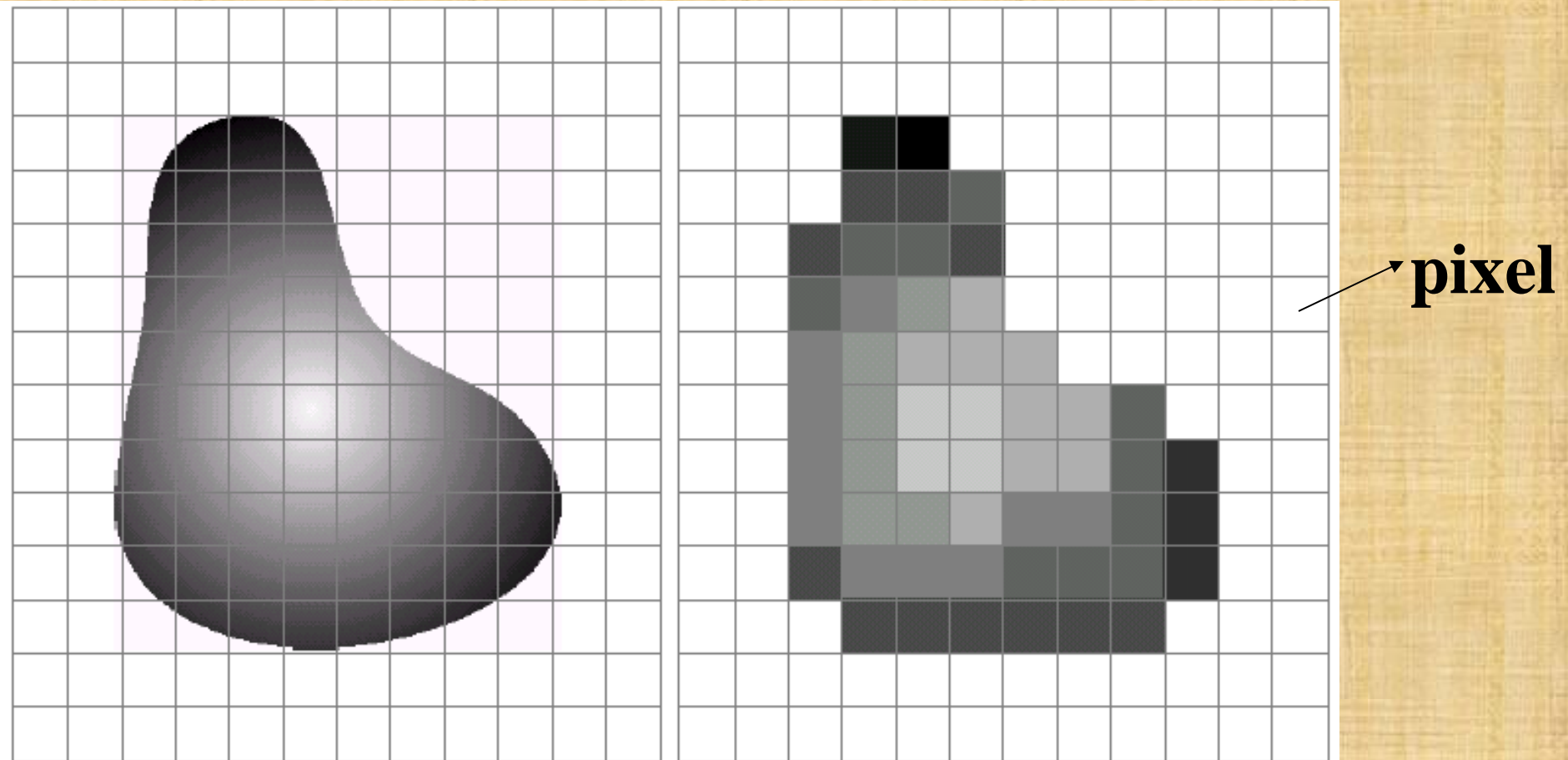
# SAMPLING AND QUANTISATION



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.

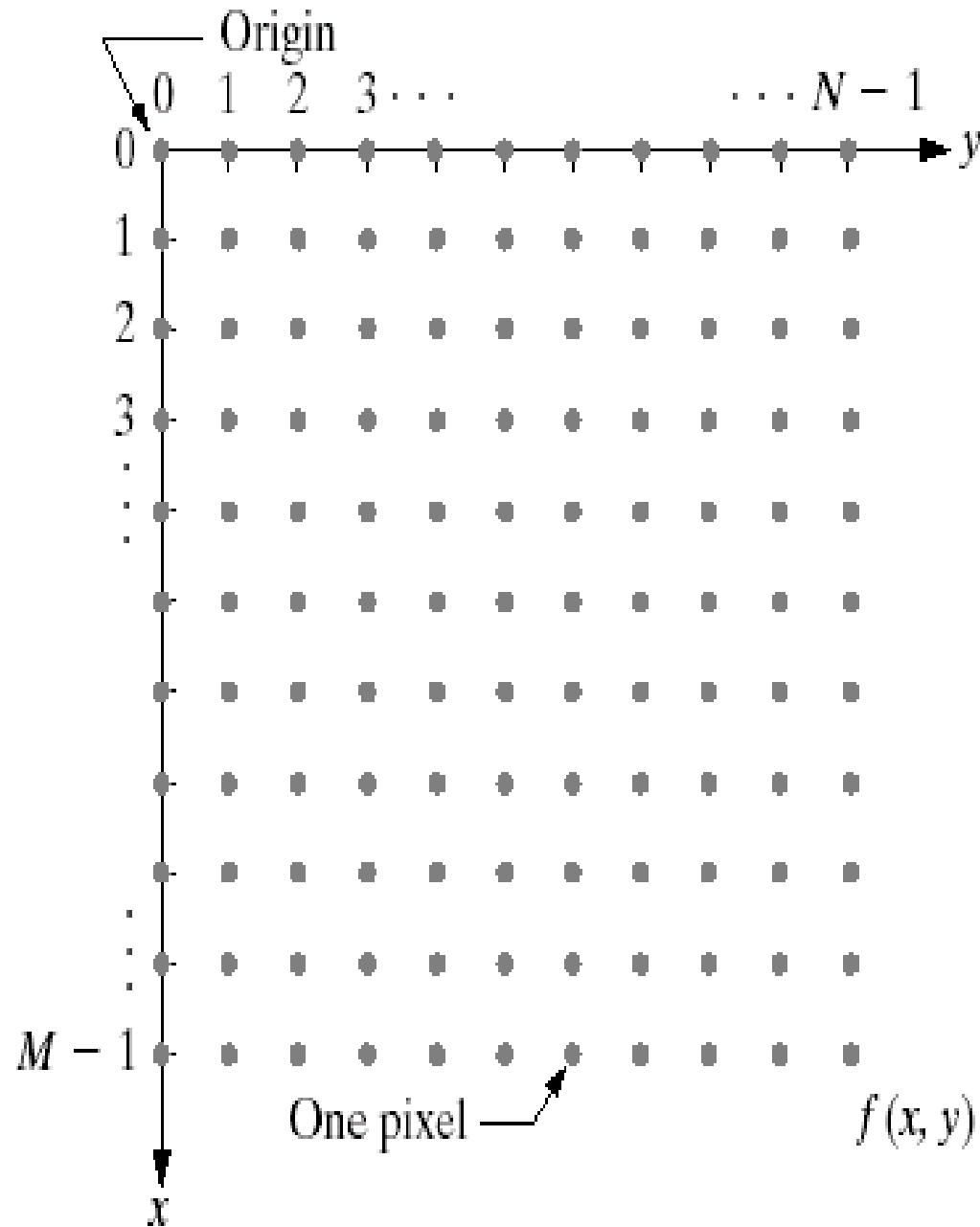
# SAMPLING AND QUANTISATION



a b

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

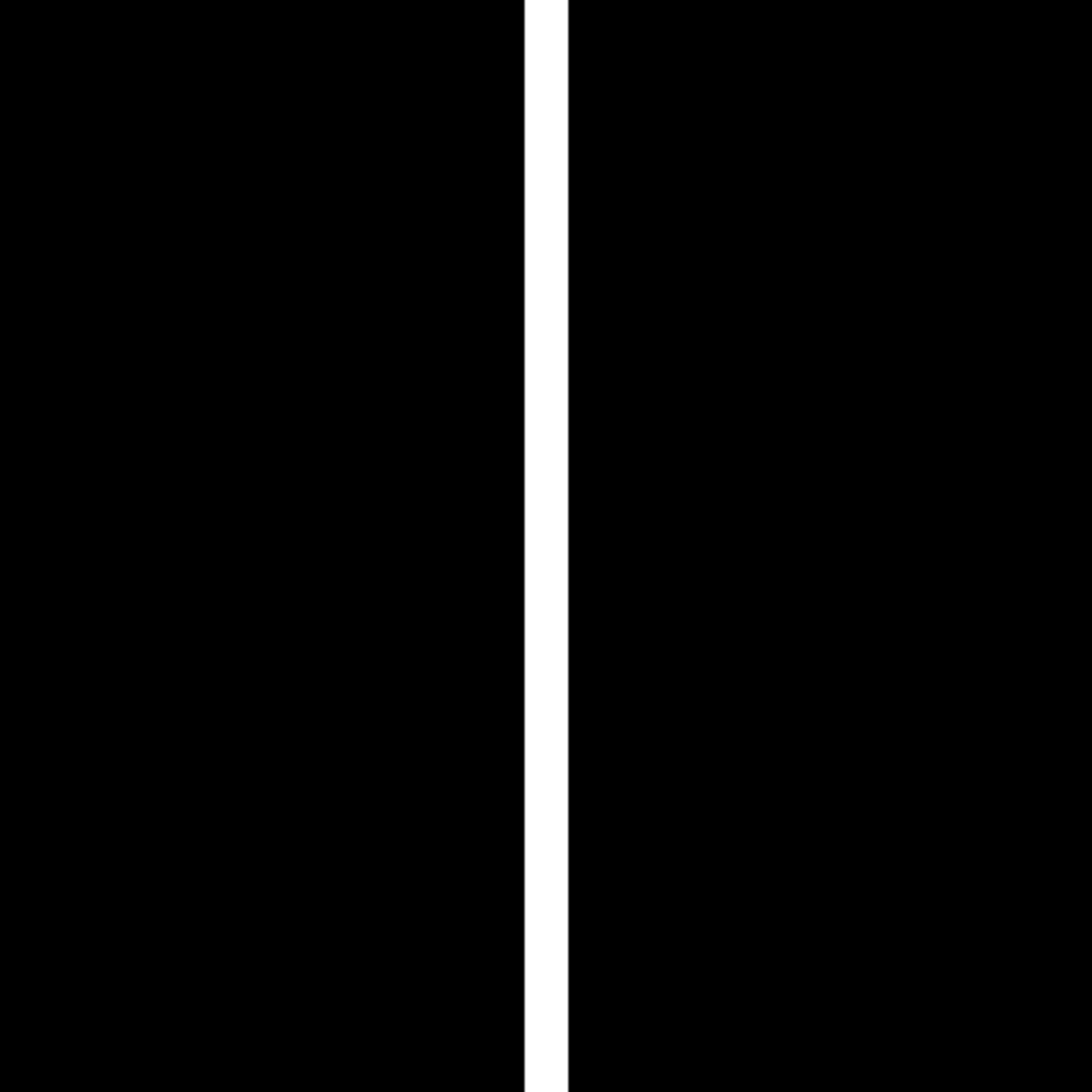
# Digital Image : CONVENTION



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

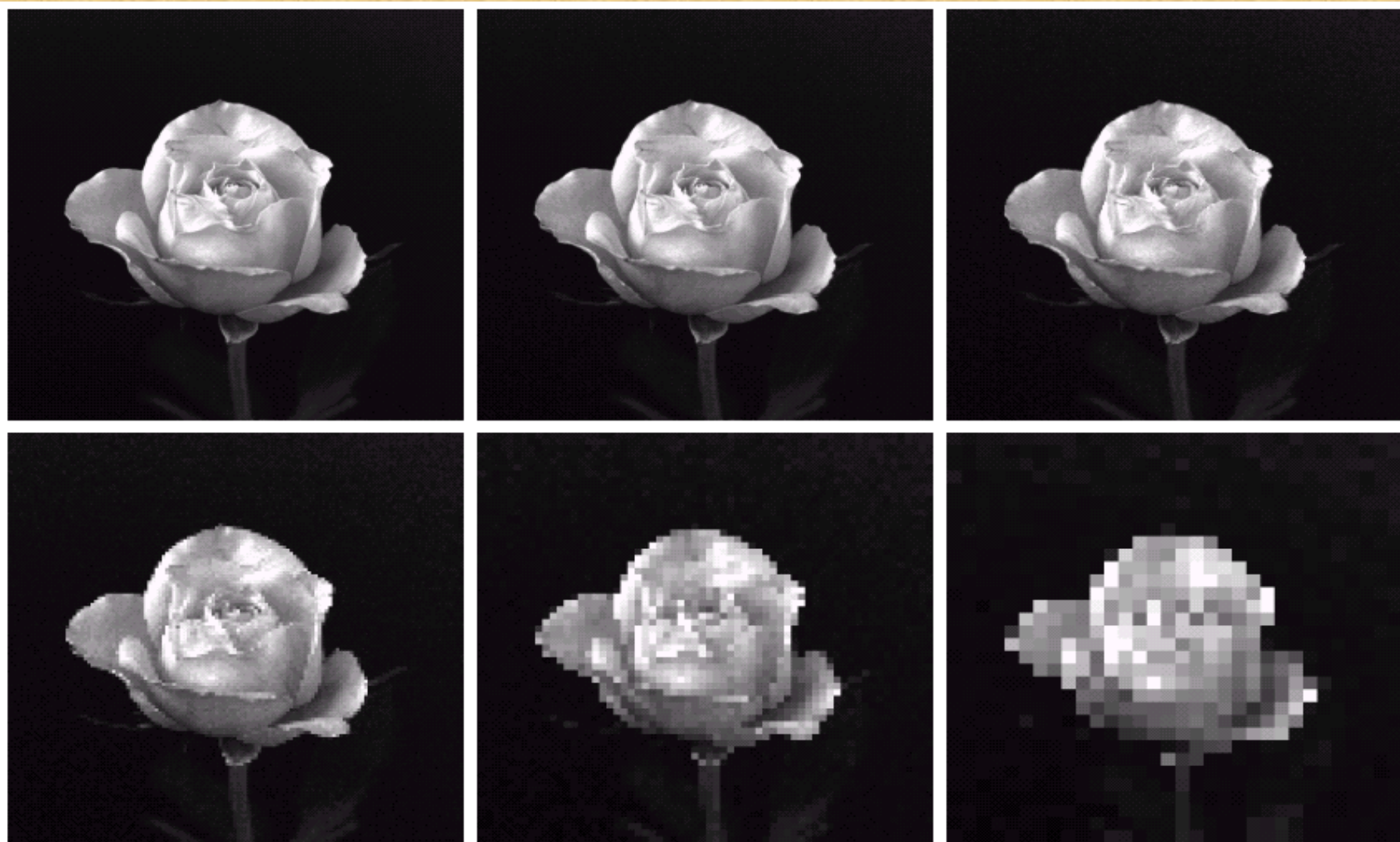
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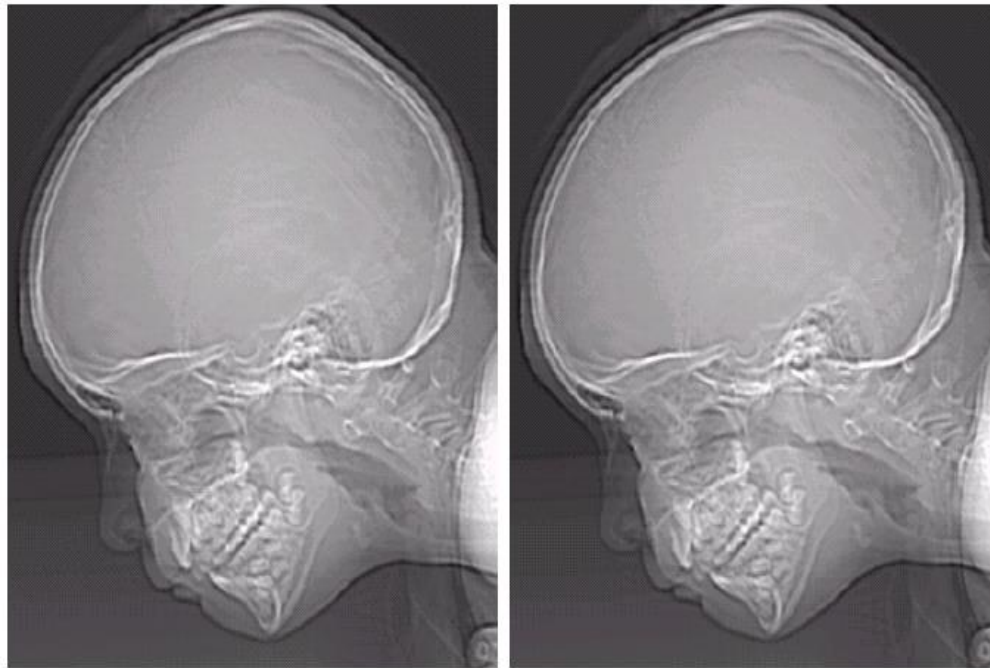
# EFFECT OF SAMPLING



a	b	c
d	e	f

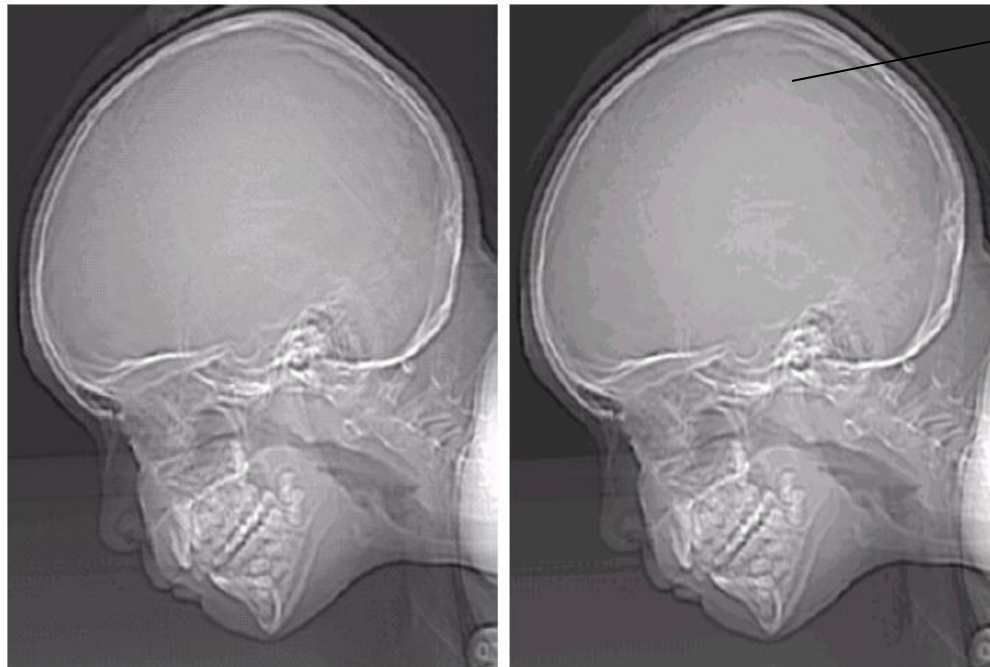
**FIGURE 2.20** (a)  $1024 \times 1024$ , 8-bit image. (b)  $512 \times 512$  image resampled into  $1024 \times 1024$  pixels by row and column duplication. (c) through (f)  $256 \times 256$ ,  $128 \times 128$ ,  $64 \times 64$ , and  $32 \times 32$  images resampled into  $1024 \times 1024$  pixels.

# EFFECT OF QUANTISATION



a	b
c	d

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



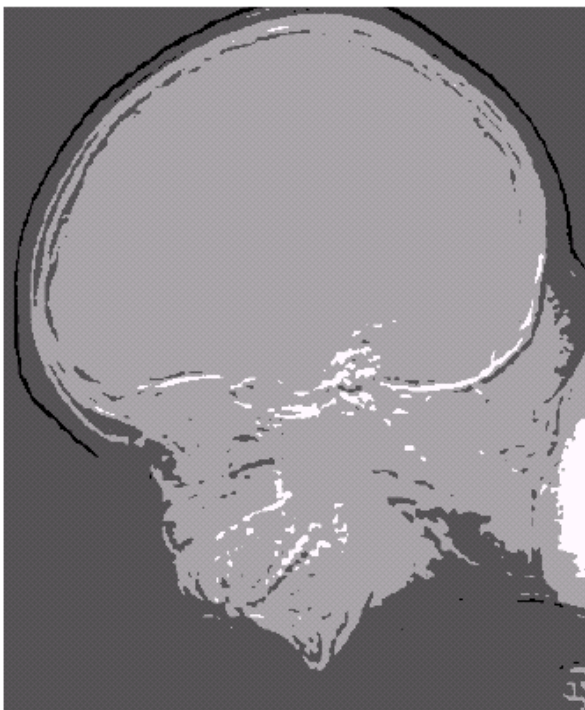
**False  
contouring**

e f  
g h

**FIGURE 2.21**

*(Continued)*

(e)–(h) Image displayed in 16, 8, 4, and 2 gray levels. (Original courtesy of Dr. David R. Pickens, Department of Radiology & Radiological Sciences, Vanderbilt University Medical Center.)



**STORAGE SPACE FOR IMAGE:**

**IMAGE OF SIZE  $M \times N$  with  $2^K$  GRAY  
LEVELS:**

$$M \times N \times K$$

## **References:**

**<http://sites.google.com/site/pkthiruvikraman>**

**“Digital Image Processing” by Gonzalez & Woods**

**Website of Textbook:**

**<http://www.imageprocessingplace.com/>**

**For: solutions to some of the book problems and other material.**

**Useful site on Image Processing and related areas:**

**<http://homepages.inf.ed.ac.uk/rbf/CVonline/books.htm>**