الوسائط المتعددة و برمجتها

السنة الثالثة

قسم تقنيات الحاسوب

المحاضرة الثانية

إعداد

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Chapter 2

Digital Image Fundamentals

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Representing Digital Images

The result of sampling and quantization is a matrix of real numbers.
Suppose that a continuous f(x,y) is approximated by equally spaced samples arranged in the form of an (MXN) array as shown :

$$f(x,y) \cong \begin{vmatrix} f(0,0) & f(0,1) & \cdots\cdots & f(0,N-1) \\ f(1,0) & f(1,1) & \cdots\cdots & f(1,N-1) \\ . & . & \cdots\cdots & \\ . & . & \cdots\cdots & \\ . & . & \cdots\cdots & \\ . & . & \cdots\cdots & \\ f(M-1,0) & f(M-1,1) & \cdots\cdots & f(M-1,N-1) \end{vmatrix}$$

Representing Digital Images

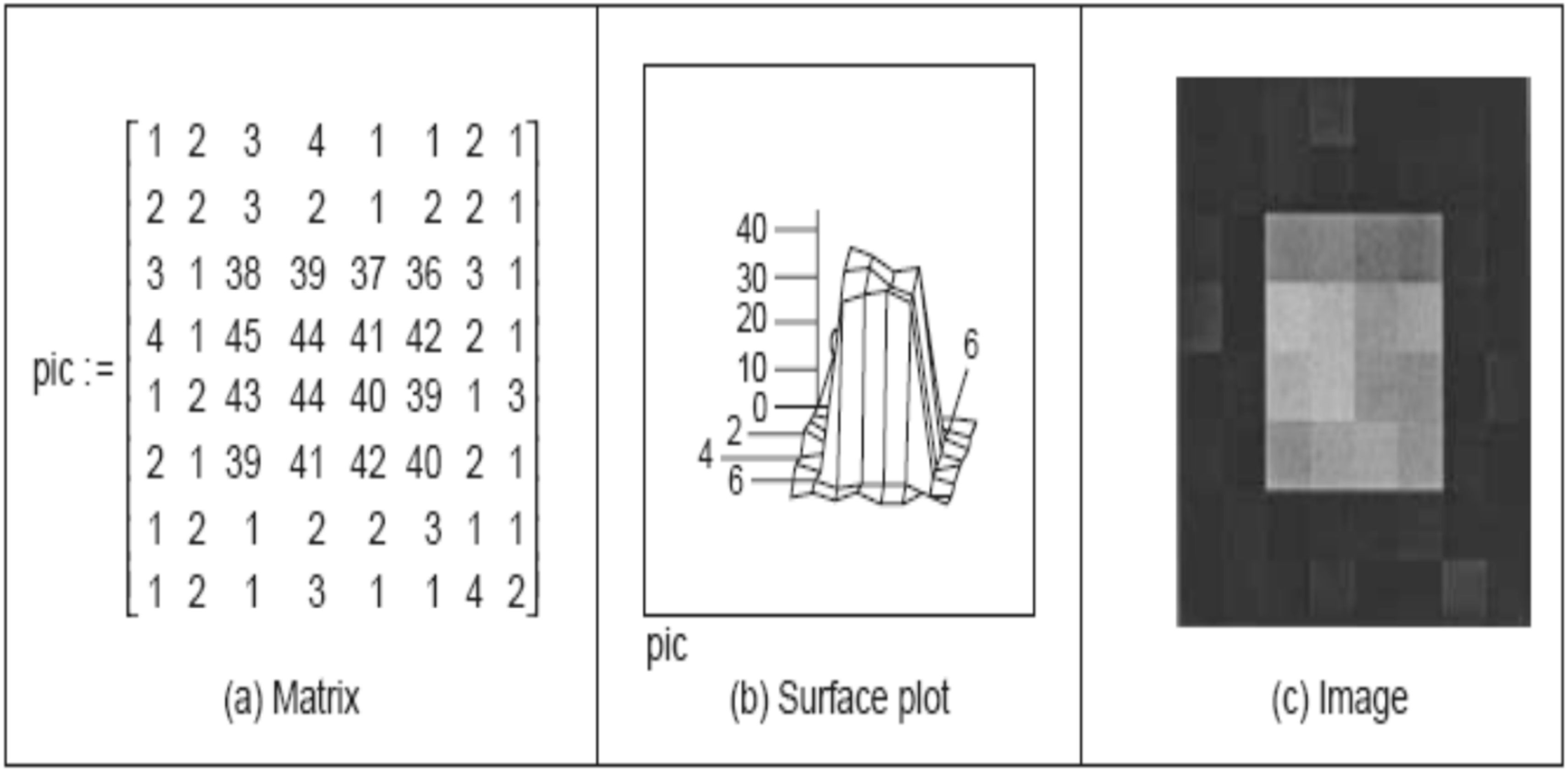
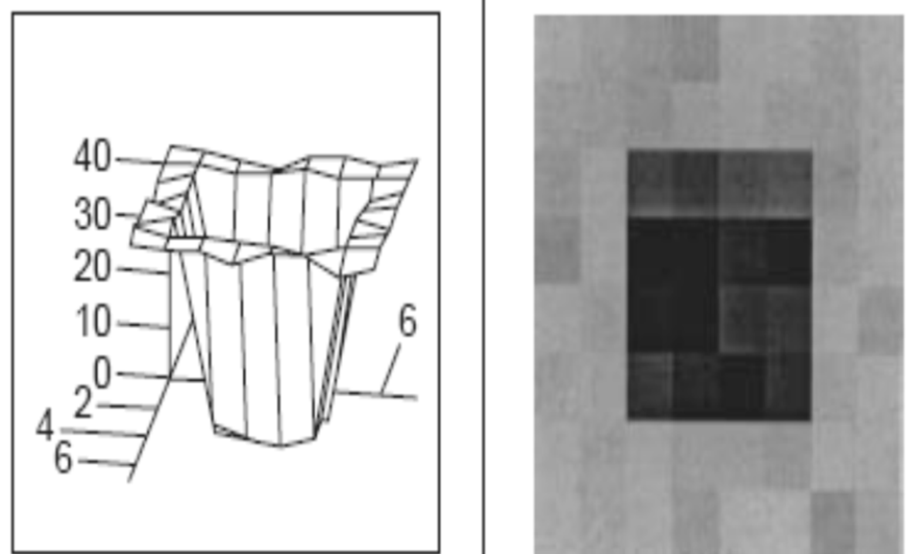


Figure 1.13 Synthesised image of a square

Representing Digital Images

$$
new\_pic = \begin{bmatrix}
44 & 43 & 42 & 41 & 44 & 44 & 43 & 44 \\
43 & 43 & 42 & 43 & 44 & 43 & 43 & 44 \\
42 & 44 & 7 & 6 & 8 & 9 & 42 & 44 \\
41 & 44 & 0 & 1 & 4 & 3 & 43 & 44 \\
44 & 43 & 2 & 1 & 5 & 6 & 44 & 42 \\
43 & 44 & 6 & 4 & 3 & 5 & 43 & 44 \\
44 & 43 & 44 & 43 & 43 & 42 & 44 & 44 \\
44 & 43 & 44 & 42 & 44 & 44 & 41 & 43
\end{bmatrix}
$$

(a) Matrix



new_pic

(b) Surface plot

(c) Image

Figure 1.14 Image of a square after inversion

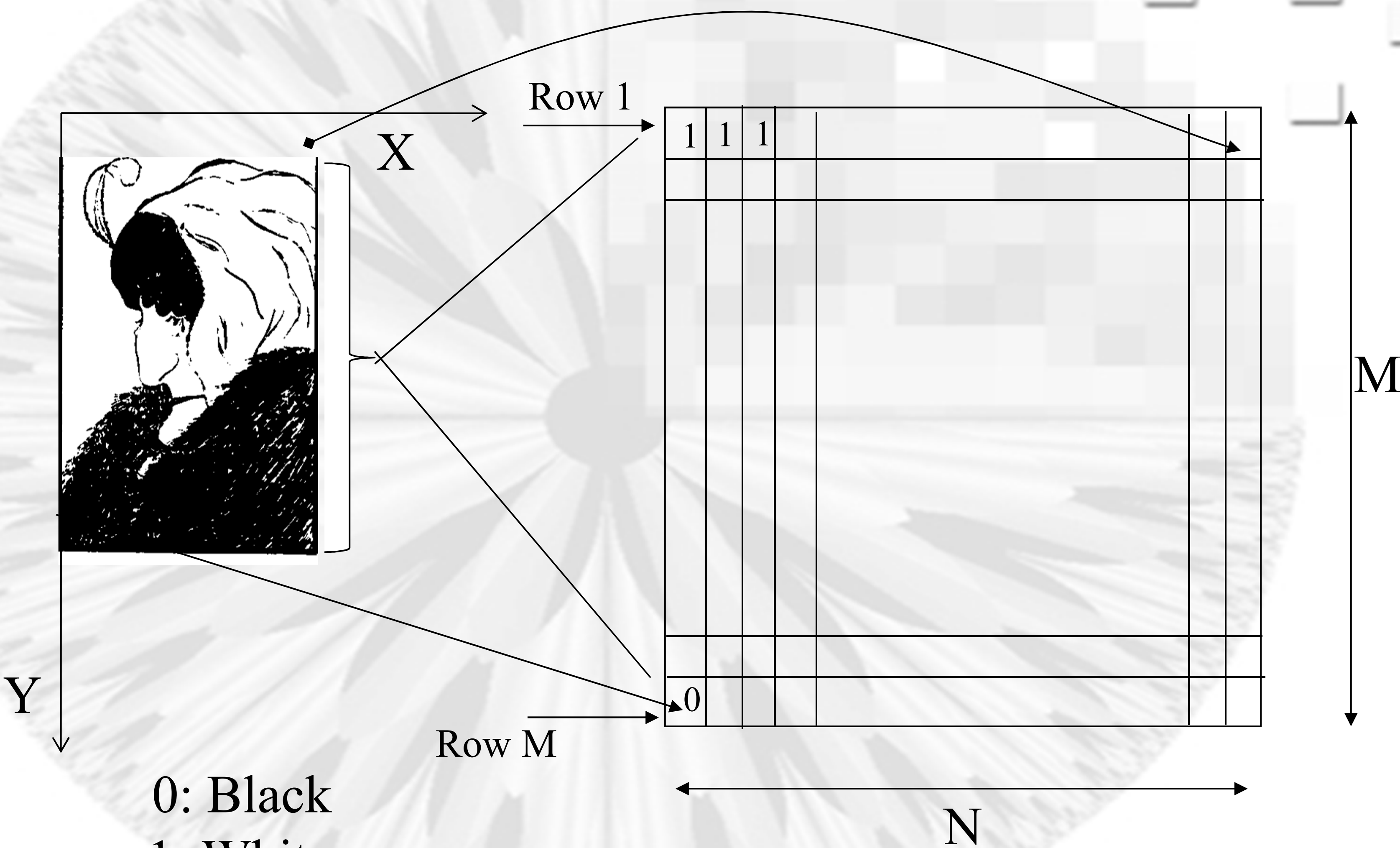
Dealing with Images

Color

Gray Scale

Binary

Binary Image



0: Black
1: White

A Simple Image Formation Model

The term image refers to a two-dimensional light-intensity function, denoted by f(x, y),

where the value or amplitude of f at spatial (time) coordinates (x, y) give the intensity (brightness) of the image at that point.

Since light is a form of energy, f(x, y) must be nonzero and finite, that is,

$$0 < f(x, y) < \infty$$

A Simple Image Formation Model (cont.)

The basic nature of f(x, y) may be considered as being characterized by two components.

1. **Illumination i(x, y), which is the amount of source light incident on the scene being viewed, and**
2. **Reflectance r(x, y), which is the amount of light reflected by the objects in the scene.**

A Simple Image Formation Model (cont.)

- **The function l(x,y) and r(x,y) combine as a product to form f(x,y)**

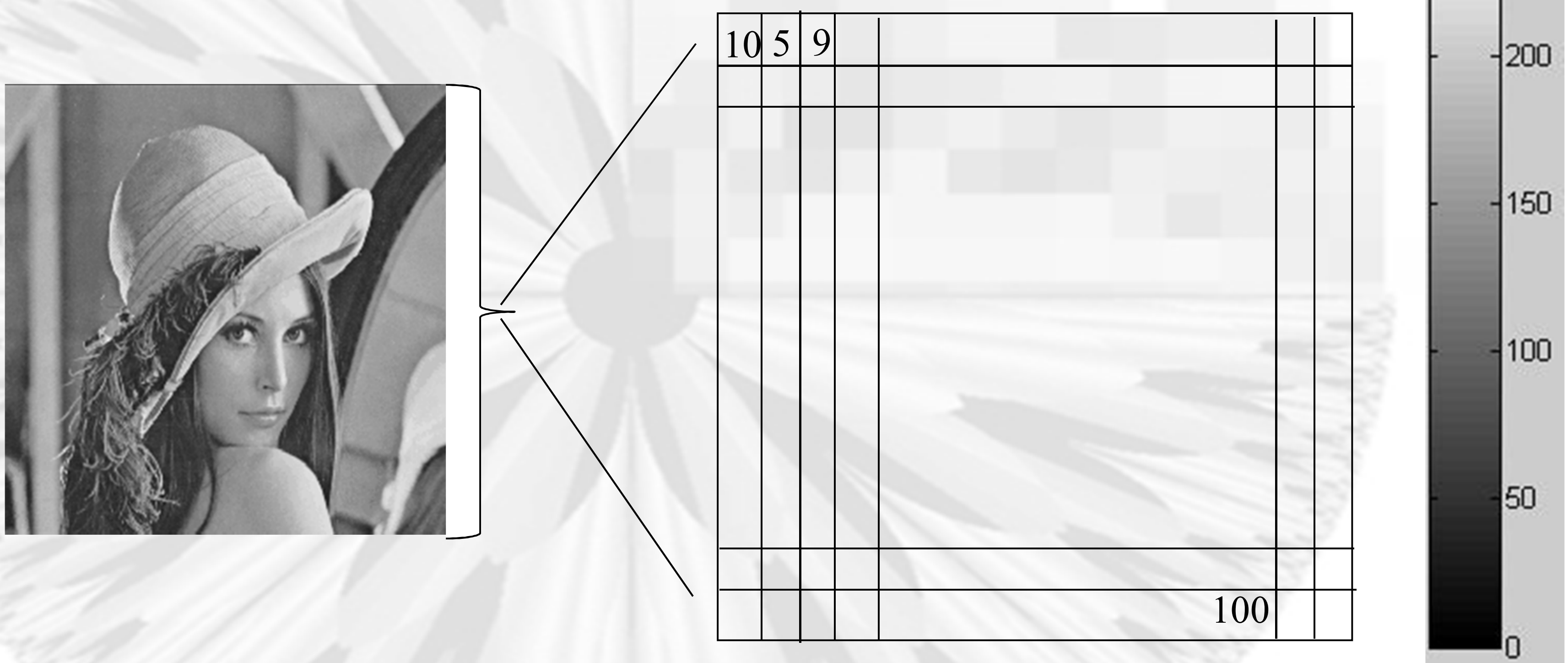
$$f(x,y) = l(x,y)*r(x,y),$$

Where :

- $0 < l(x,y) < \infty$, **and**
- $0 < r(x,y) < 1$,
- **0 (total absorption) and 1 (total reflectance).**

The nature of l(x,y) is determined by the light source, while r(x,y) determined by the characteristics of the objects.

Gray Scale Image



Gray Scale Image

- **Each element of the array is referred to as an image element, or picture element, or pixel.**
- **The term's " image " and " pixels " will be used to denote a digital image and its elements.**
- **The above digitization process requires that a decision be made on a value for N as well as on the number of discrete levels (L) allowed for each pixel.**
- **It is common practice in digital image processing to let these quantities be integer powers of two, that is,**

  $N = 2^n$, $M= 2^m$ $L = 2^k$.
- **The number , b , of bits required to store a digitized image is given by :** $b = M \times N \times k$.

Gray Scale Image

Example:

A 128x128 image with 64 gray levels requires 98,304 bits of storage. Calculation number of bits as:

M= 128

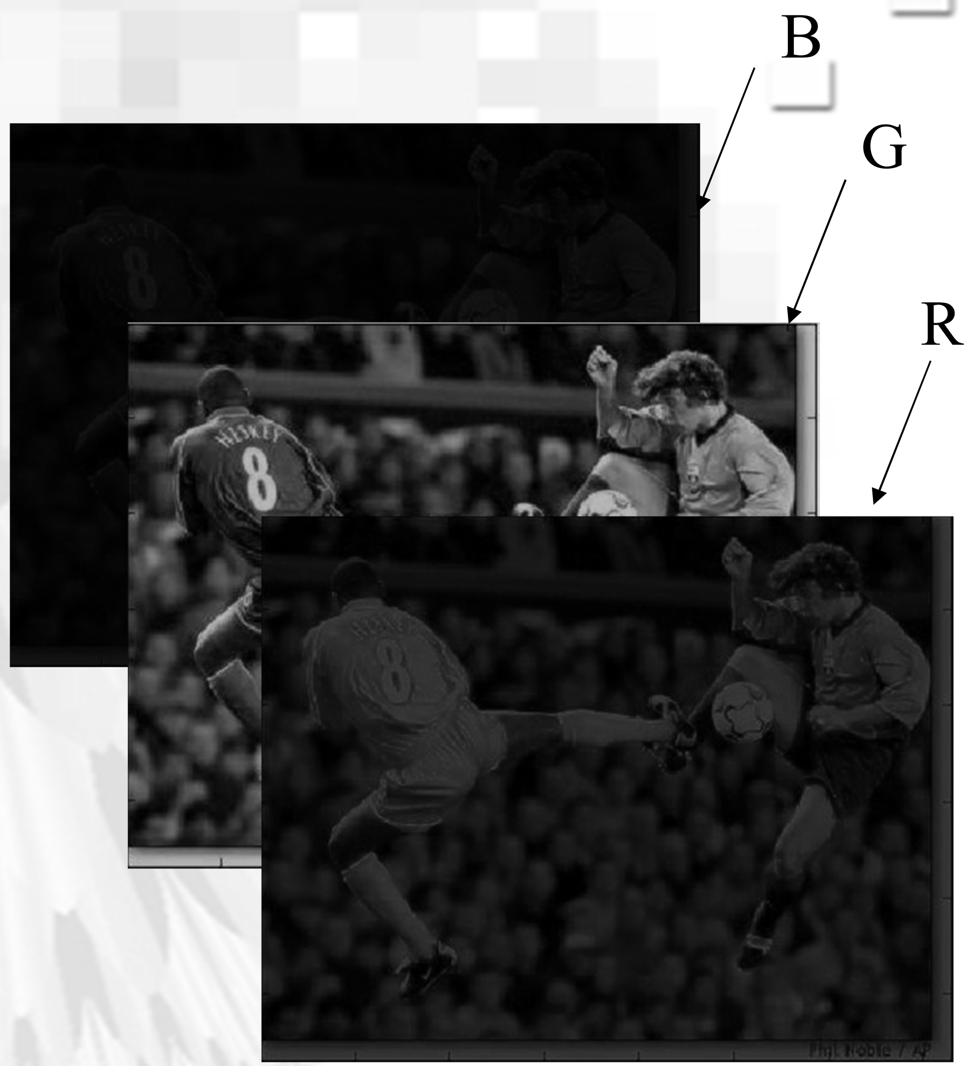
N= 128

L = gray level = 64 = 2^k, then k = 6 (64 = 2^6)

Then

P = M x N x k = 128 x 128 x 6 = 98,304.

Color Image (RGB)



Problem 2.9 page 72 in text book)

A common measure of transmission for digital data is the ***baud rate***, defined as : **the number of bits transmitted per second**. Generally, transmission is accomplished in packets consisting of a **start bit**, a byte (8 bits) of information, and a stop bit. Using these facts, answer the following:

(a) How many minutes would it take to transmit a 1024*1024 image with 256 gray levels using a 56K baud modem?

(b) What would the time be at 750K baud, a representative speed of a phone DSL (digital subscriber line) connection?

Solution:

- **(a)** The total amount of data (including the start and stop bit) in an 8bit, 1024 x1024 image, is
- **(1024 x 1024) x [8 + 2]** bits.
- The total time required to transmit this image over a At 56K baud link is
- **(1024 x 1024) x [8 + 2]/56000** = **187.246** sec or about **3.12 min**.
- **(b)** At 750K this time goes down to about = **(1024)2 x [8 + 2]/750000** = **14 sec.**

The Resolution

- **The resolution(i.e, the degree of details) of an image is strongly dependent on both M, N and k.**
- **The more these parameters are increased, the closer the digitized array will approximate the original image.**

Spatial and Gray-Level Resolution

- **Sampling** is the principal factor determining the *spatial resolution* of an image.
- **Spatial resolution** is the smallest discernible detail in an image.
- ***Gray-level resolution*** similarly refers to the smallest discernible change in gray level.

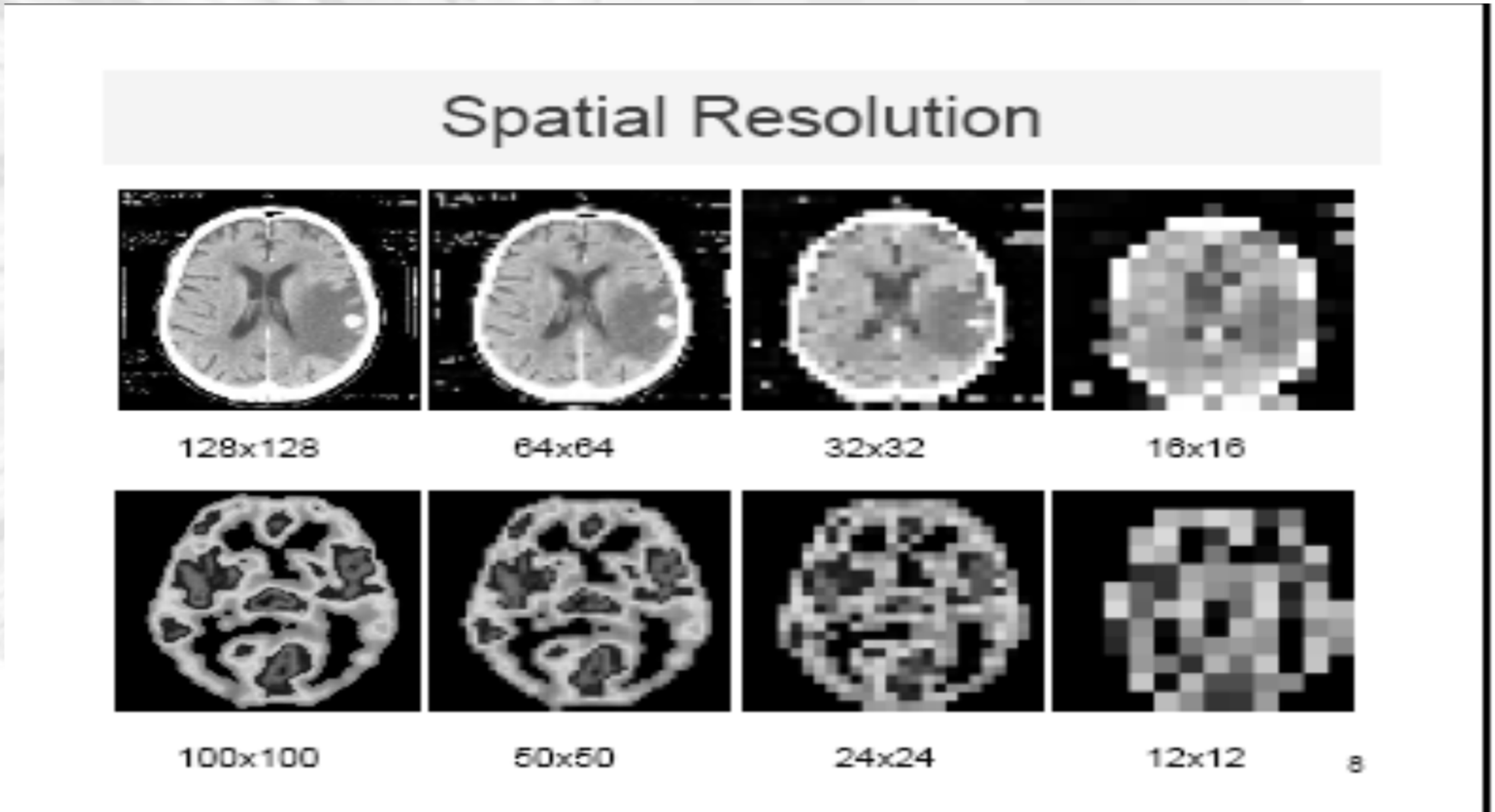
Spatial and Gray-Level Resolution

- **Figure 2.19 shows** an image of size 1024*1024 pixels whose gray levels are represented by 8 bits. The other images are the results of sub sampling the 1024*1024 image. The sub sampling was accomplished by deleting the appropriate number of rows and columns from the original image.
- **For example**, the 512*512 image was obtained by deleting every other row and column from the 1024*1024 image.

Spatial Resolution

The spatial resolution of an image is The physical size of a pixel in an image.

Basically it is the smallest discernable detail in an image**.**



Quantization

- **N** is usually an integral power of two
- ***k*** is the number of bits used for quantization
- Typically *k* = 8 L= 256 possible gray levels.
- If ***k***=1, then there are only two values: 0 and 1 This image is known as a **BINARY** image.
- Sometimes the range of values spanned by the gray levels is called the ***dynamic range*** of an image.

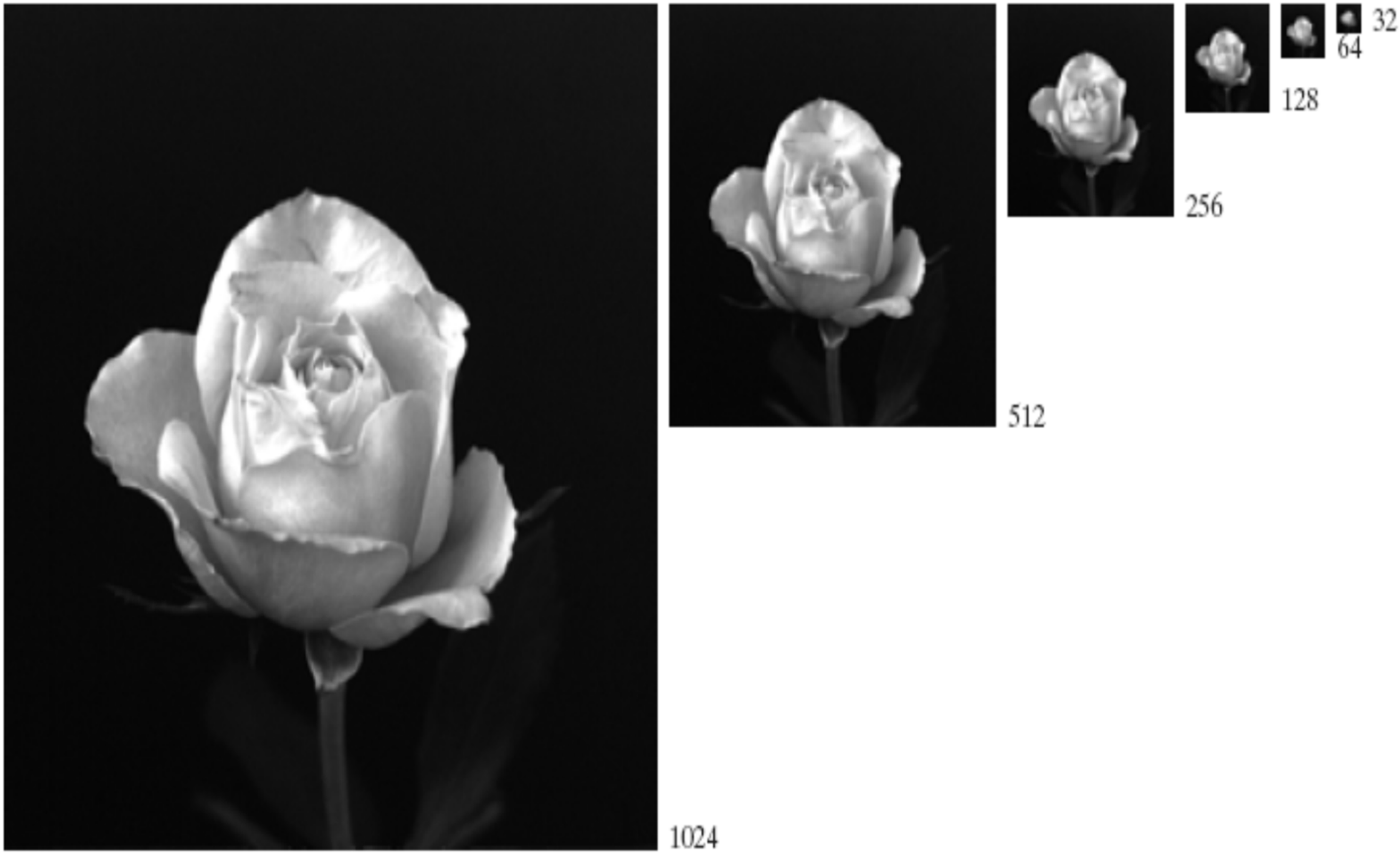


FIGURE 2.19 A 1024 × 1024, 8-bit image subsampled down to size 32 × 32 pixels. The number of allowable gray levels was kept at 256.

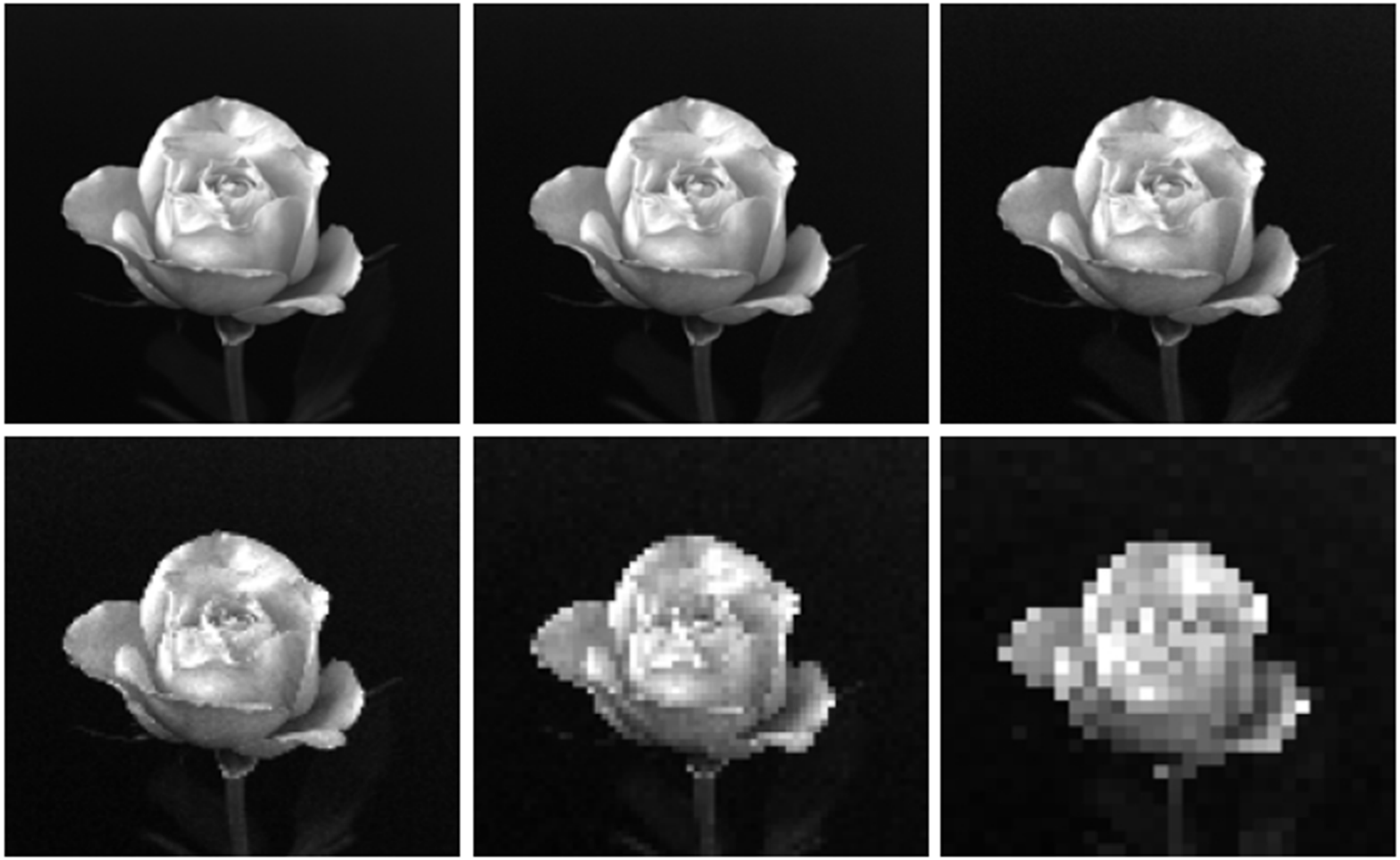


FIGURE 2.20 (a) 1024 × 1024, 8-bit image. (b) 512 × 512 image resampled into 1024 × 1024 pixels by row and column duplication. (c) through (f) 256 × 256, 128 × 128, 64 × 64, and 32 × 32 images resampled into 1024 × 1024 pixels.