Digital Image Fundamentals

B.SC(HONOURS) SEM 5 2020-2021

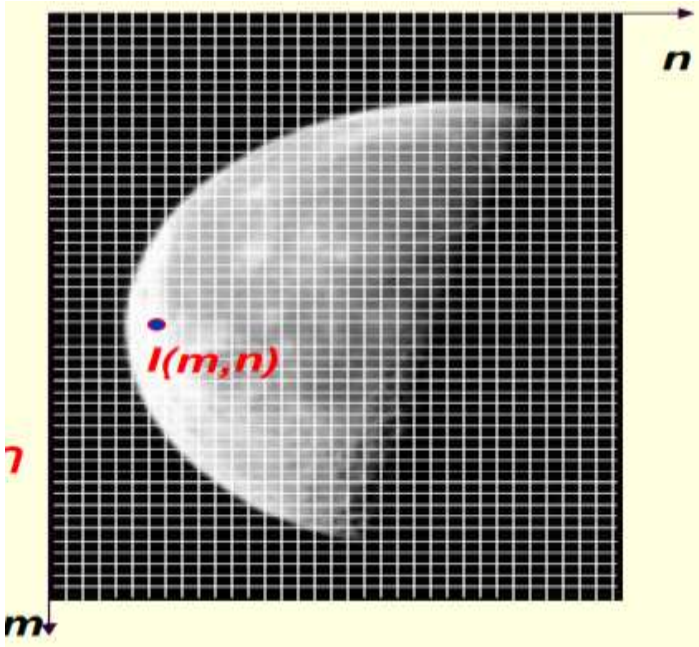
LECTURE 2

WHAT IS DIGITAL IMAGE?

- A real image can be represented as a two dimensional continuous light intensity function g(x,y) where x and y denote the spatial coordinates and the value of g is proportional to the brightness (or gray level) of the image at that point.

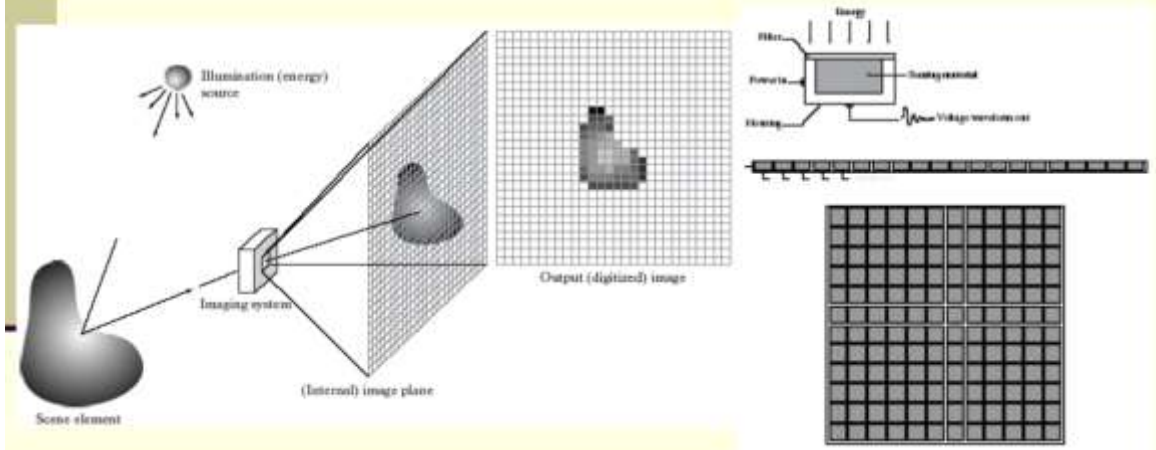
DIGITAL IMAGE

- A digital image is the sampling and quantization of a two-dimensional real image both in spatial coordinates and brightness.
- A digital image I(m,n) = samples of g(x,y); where m and n are integers, and I is the intensity at m and n .

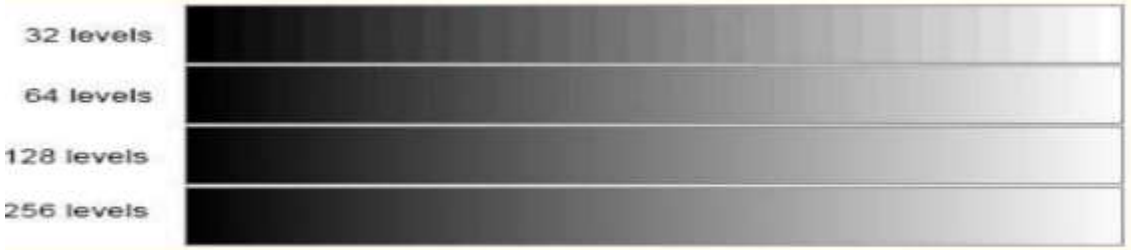


DIGITAL IMAGE ACQUISITION

- A digital imaging system (digital camera).

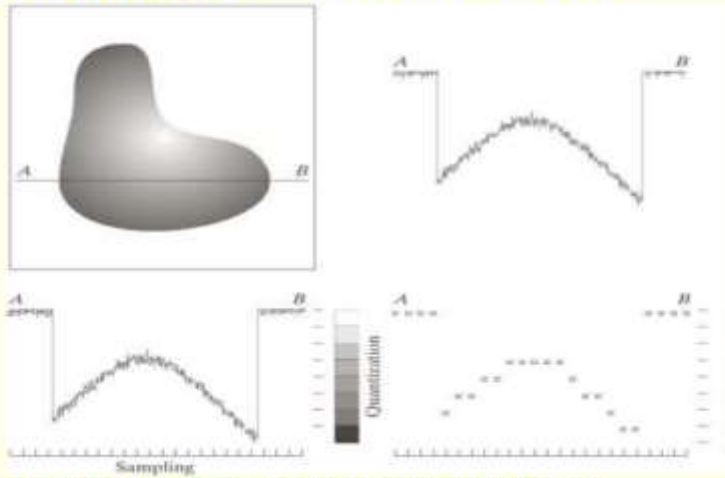


- What is the best *quantization* level ?



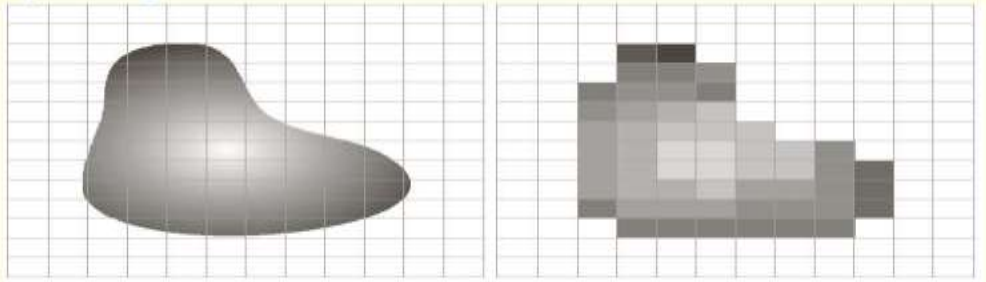
- Digital images are typically quantized to 256 gray levels.

- 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.

Sampling & Quantization



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

DIGITAL IMAGE REPRESENTATION

- **A digital image can be represented as a two-dimensional matrix.**

$$I(mn) = \begin{pmatrix} i(1,1) & i(1,2) & \ldots\ldots & i(1, n-1) \\ i(2,1) & i(2,2) & \ldots\ldots & i(2, n-1) \\ \vdots & & & \vdots \\ \cdots & \cdots & \cdots & \cdots \\ \vdots & & & \vdots \\ i(m-1,1) & i(m-1,2) & \ldots & i(m-1, n-1) \end{pmatrix}$$

- Each element is called a ***pixel*** (picture element).
- A color (RGB) image is represented by a 3-dimensional matrix I(mxnx3)

n

IMAGE SIZE

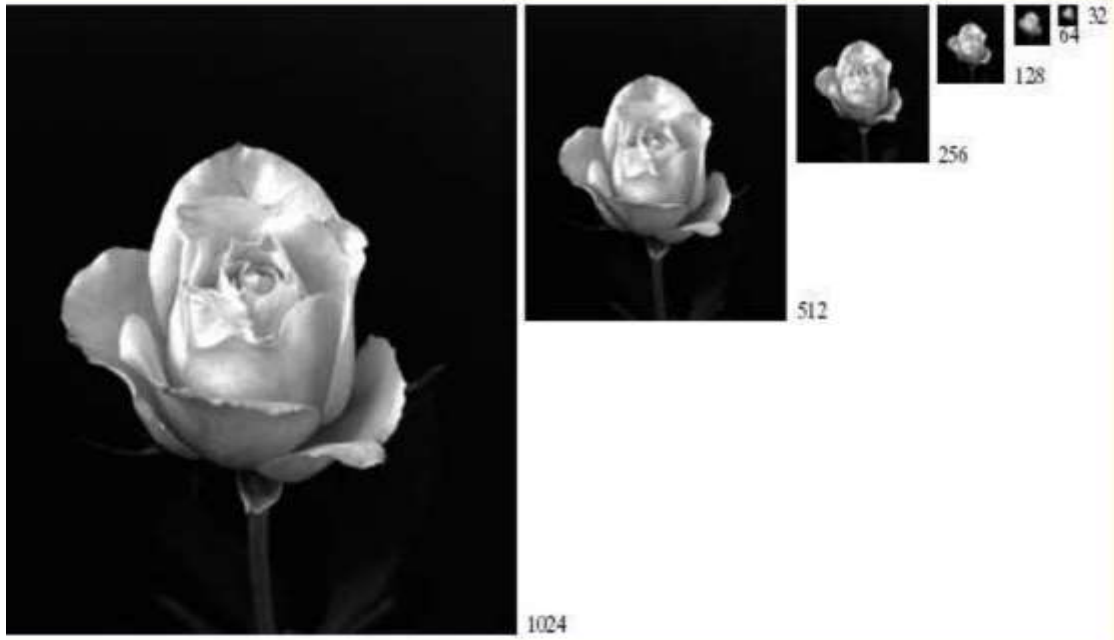
The size of a digital image is determines by its dimensions (*M x N*) multiplied by the number of bits *b* required to store the intensity levels ($L = 2^b$).

image size = *M x N x b* (bits)

b = 1	**black and white (binary) images**
b = 8	**grayscale (256 gray levels), or indexed color images**
b = 24	**RGB color image.**

IMAGE RESOLUTION

Digital image resolution is determined by the number of pixels (samples) in the image.



Digital image with low resolution has low quality.

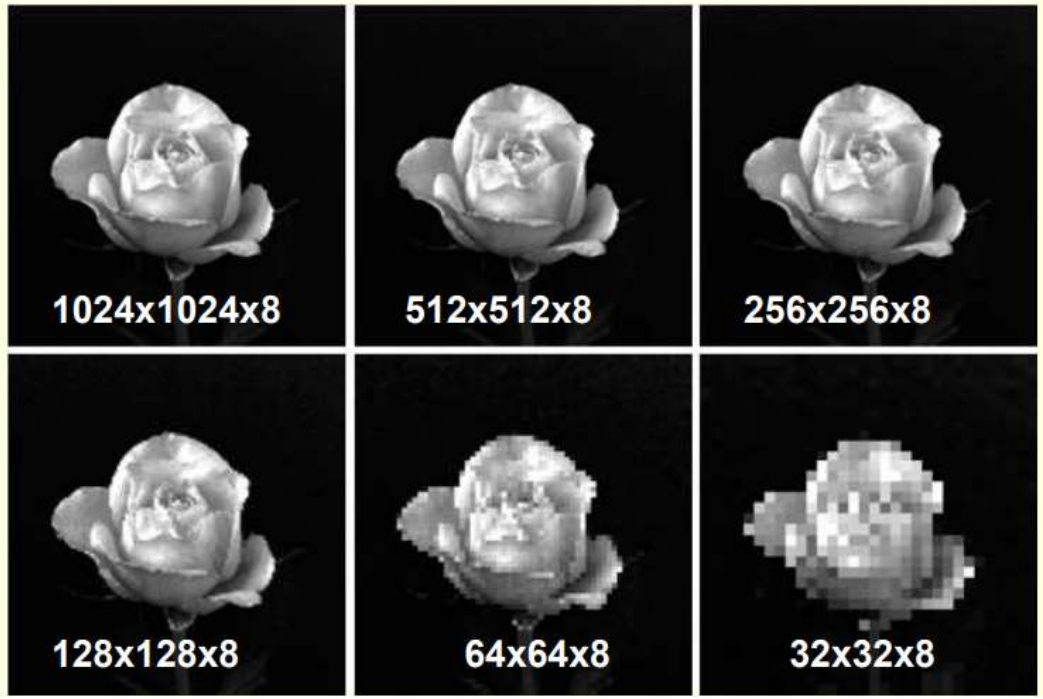


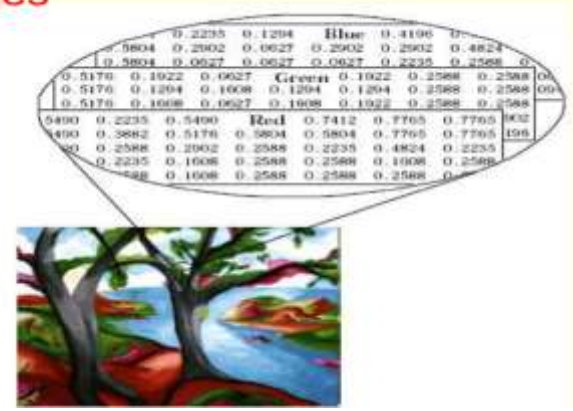
IMAGE TYPES

RGB (Color) Images

Each pixel is a mixture of three values of Red, Geen, and Blue.

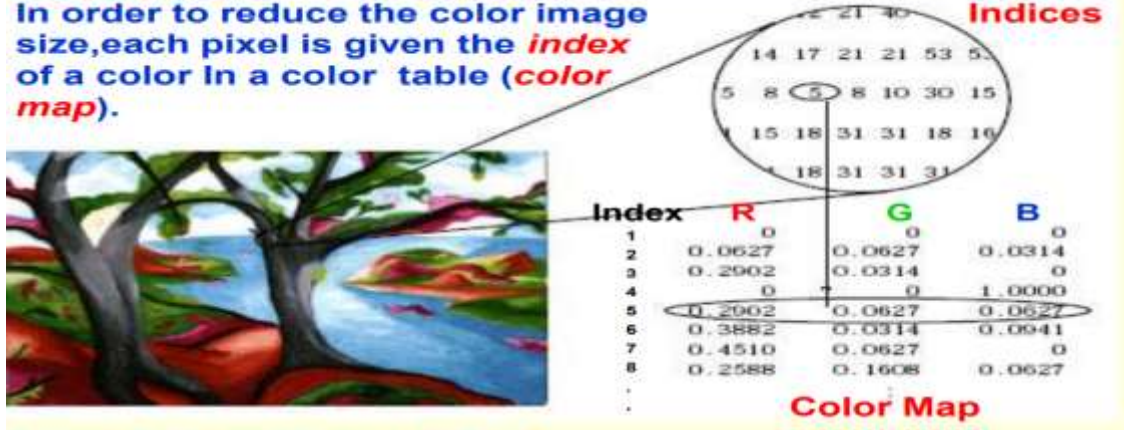
R,G,B = {0-255, 0-255, 0-255}
0 = Black
255 = White

In normalized values:
R,G,B = {0-1, 0-1, 0-1}
0 = Black
1 = White



Indexed (Color) Images

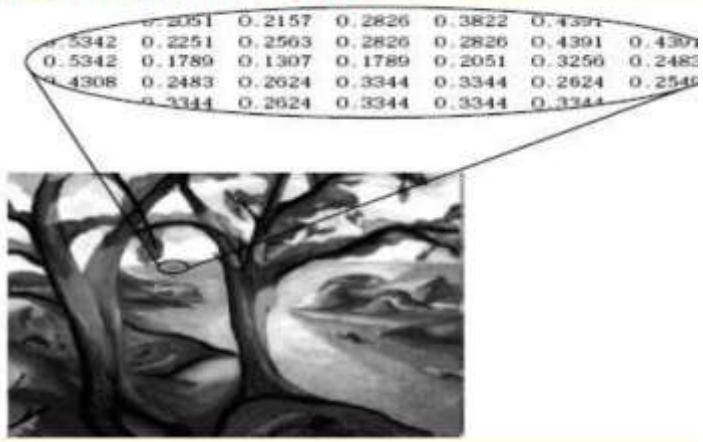
In order to reduce the color image size,each pixel is given the *index* of a color In a color table (*color map*).



Grayscale (Intensity) Images

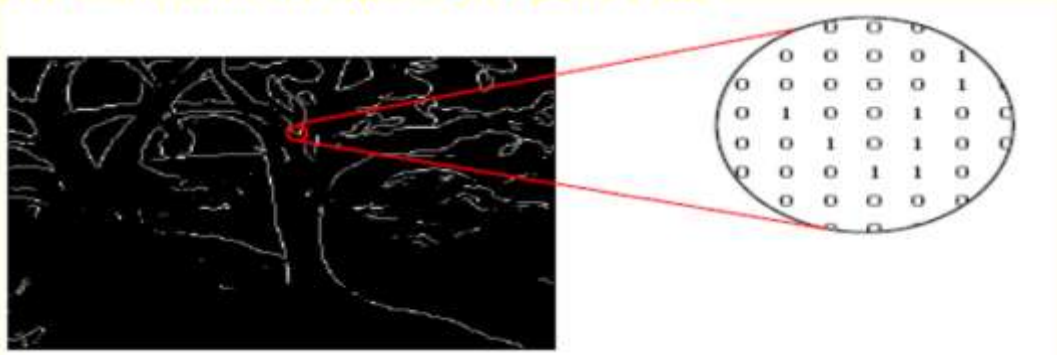
Each pixel is given a gray level value between 0 – 255 or between 0 – 1.

We need 8 bits to store a grayscale value.



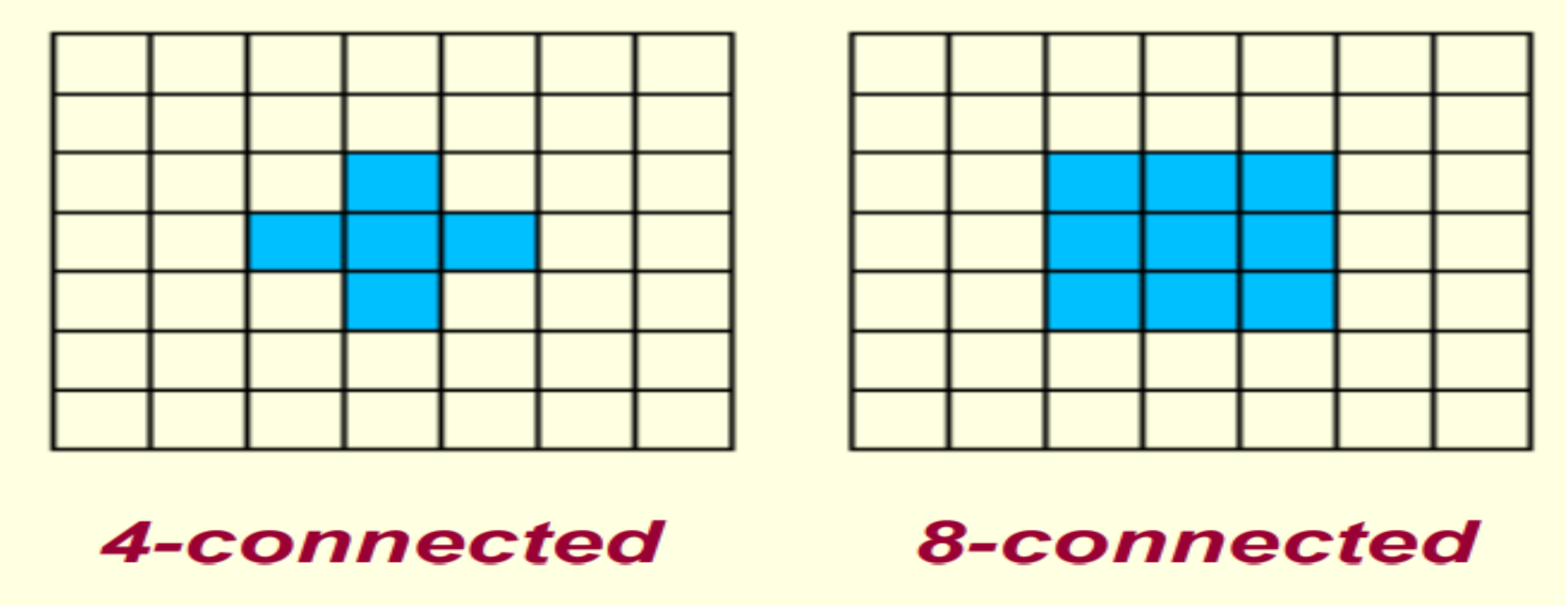
Black and white (Binary) Images

- Each pixel has one of two gray levels either black (0) or white (1).
- We need 8 bits to store a grayscale value.



Types of Pixel Neighborhoods

- 4-connected and 8-connected neighborhood.



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