Image Types

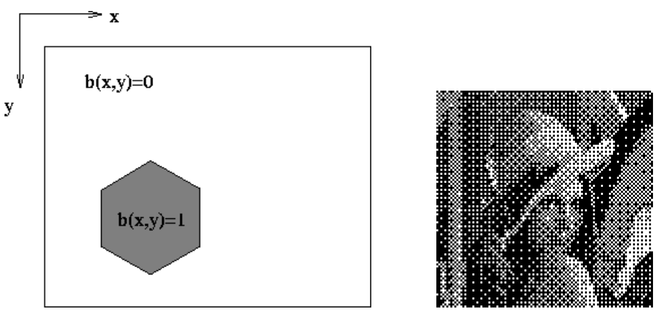
The image types we will consider are:

1. Binary Images

Binary images are the simplest type of images and can take on two values, typically black and white, or ‘0’ and ‘1’. A binary image is referred to as a 1 bit/pixel image because it takes only 1 binary digit to represent each pixel. These types of images are frequently used in computer vision application where the only information required for the task is general shapes, or outlines information. For example, to position a robotics gripper (ذراع الروبوت)to grasp an object or in optical character recognition (OCR).

Binary images are often created from gray-scale images via a threshold value is turned white (‘1’), and those below it are turned black (‘0’). We define the characteristic function of an object in an image to be

$$b(x,y)\begin{cases} = 1 & \text{for points on the object} \\ = 0 & \text{for background points.} \end{cases}$$



(a) (b)

Figure(1) (a) binary image representation (b) binary Lenna image

- Each pixel is stored as a single bit (0 or 1)
- A 640 x 480 monochrome image (صورة احادية اللون) requires 37.5 KB of storage.

2-Gray Scale Images

They contain brightness information only, no color information. The number of different brightness level available. The typical image contains 8 bit/pixel , which allows us to have (0-255) different brightness (gray) levels. The 8 bit representation is typically due to the fact that the byte, which corresponds to 8-bit of data, is the standard small unit in the world of digital computer.

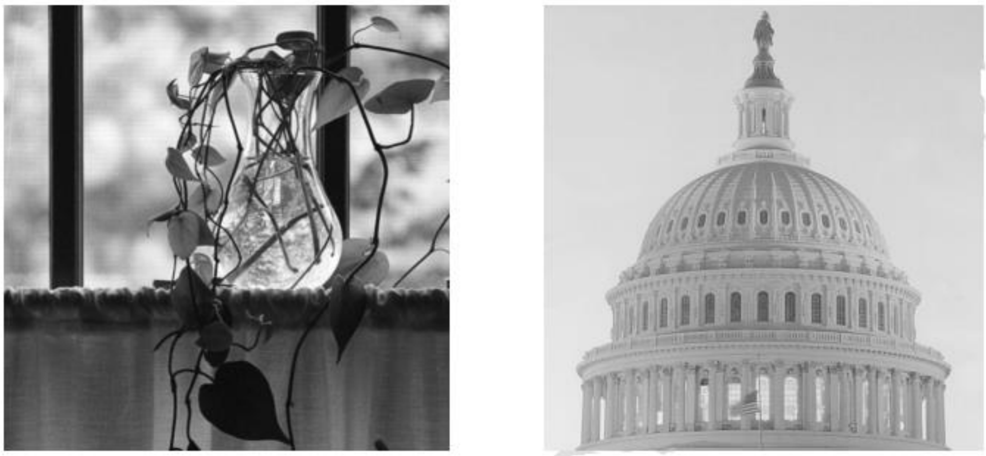


Figure Examples of gray-scale images

- Each pixel is usually stored as a byte (value between 0 to 255)
- A 640 x 480 greyscale image requires over 300 KB of storage.

Figure 3 shows a grayscale image and a 6 × 6 detailed region, where brighter pixels correspond to larger values.

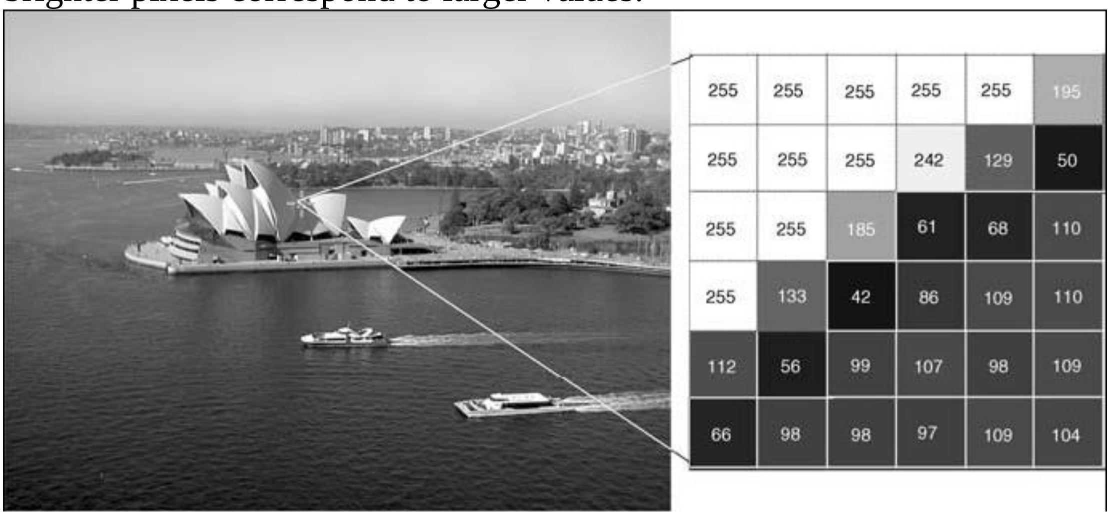


FIGURE 3 A grayscale image and the pixel values in a 6 × 6 neighborhood.

3. Color Images

Representation of color images is more complex and varied. The two most common ways of storing color image contents are:

1)RGB representation—in which each pixel is usually represented by a 24-bit number containing the amount of its red (R), green (G), and blue (B) components.

2) **Indexed representation**—where a 2D array contains indices to a color palette (or lookup table - (LUT)).

24-Bit (RGB) Color Images Color images can be represented using three 2D arrays of same size, one for each color channel: red (R), green (G), and blue (B) (Figure 4). Each array element contains an 8-bit value, indicating the amount of red, green, or blue at that point in a [0, 255] scale. The combination of the three 8-bit values into a 24-bit number allows 2^{24} (16,777,216 usually referred to as 16 million or 16 M) color combinations. An alternative representation uses 32 bits per pixel and includes a fourth channel, called the alpha channel, that provides a measure of transparency (الشفافية) for each pixel and is widely used in image editing effects. In the figure 4 we see a representation of a typical RGB color image.

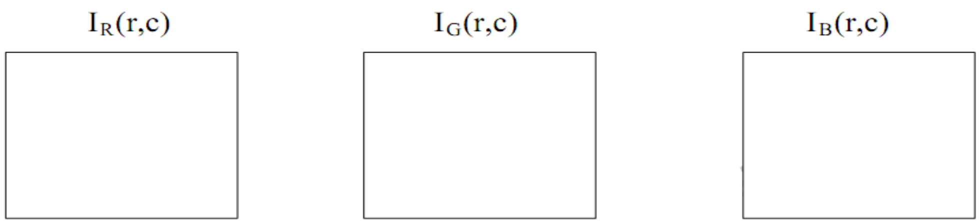


Figure ( ) Typical RGB color image can be thought as three separate images $I_R(r,c)$,$I_G(r,c)$,$I_B(r,c)$ [1]

Figure 5 illustrate that in addition to referring to arrow or column as a vector, we can refer to a single pixel red ,green, and blue values as a color pixel vector –(R,G,B).

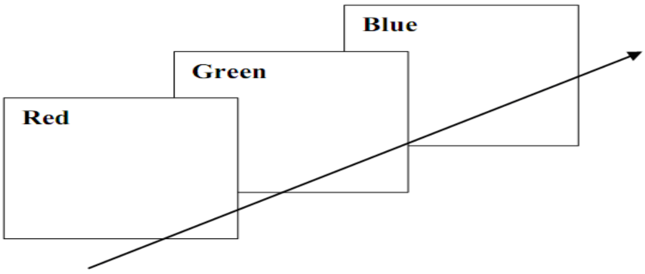


Figure ( ) A color pixel vector consists of the red, green and blue pixel values (R, G, B) at one given row/column pixel

Example of 24-Bit Colors Image

- Each pixel is represented by three bytes (e.g., RGB)
- Supports 256 x 256 x 256 possible combined colors (16,777,216)
- A 640 x 480 24-bit color image would require 921.6 KB of storage

<u>Indexed Color Images</u>: A problem with 24-bit color representations is backward compatibility(انسجام) with older hardware that may not be able to display the 16 million colors simultaneously(معا). A solution devised before 24-bit color displays and video cards were widely available consisted of an indexed representation, in which a 2D array of the same size as the image contains indices (pointers) to a *color palette* (or *color map*) of fixed maximum size (usually 256 colors). The color map is simply a list of colors used in that image. Figure 6 shows an indexed color image and a 4 × 4 detailed region, where each pixel shows the index and the values of R, G, and B at the color palette entry that the index points to.

- One byte for each pixel
- Supports 256 out of the millions s possible, acceptable color quality
- Requires Color Look-Up Tables (LUTs)
- A 640 x 480 8-bit color image requires 307.2 KB of storage (the same as 8-bit grayscale)

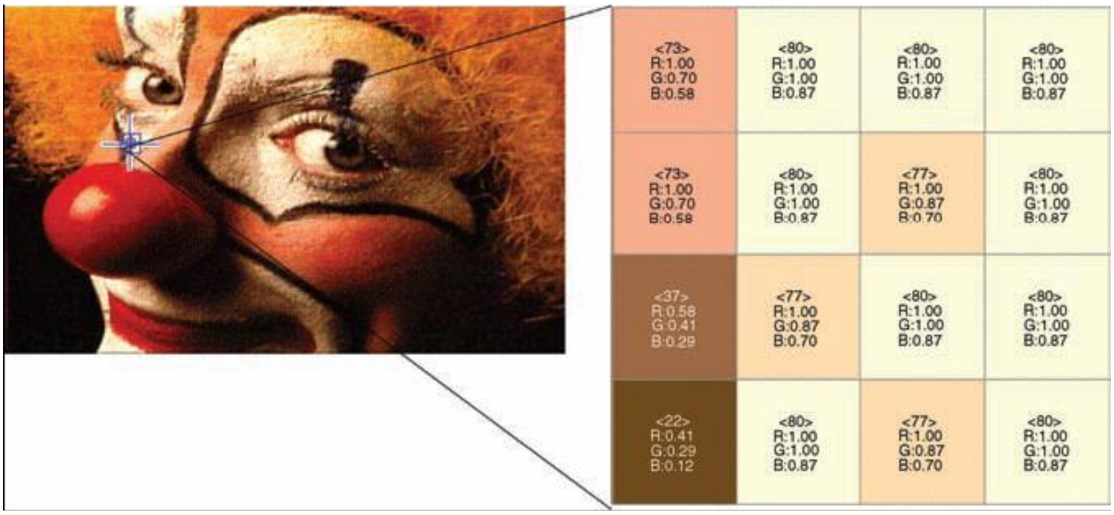


FIGURE 2.5 An indexed color image and the indices in a 4 × 4 neighborhood. Original image

Digital Image File Format

Why do we need so many different types of image file format?

- The short answer is that there are many different types of images and application with varying requirements.

• A more complete answer, also considers market share proprietary information, and a lack of coordination within the imaging industry.

Note: Many image format types can be converted to one of other type by easily available image conversion software. Field related to computer imaging is that **computer graphics**.

Computer graphics is a specialized field within that refers to the computer science realm that refers to the reproduction of visual data through the use of computer.

In computer graphics, types of image data are divided into two primarily categories:

1. **Bitmap image (or raster image):** can represented by our image model I(r, c), where we have pixel data and corresponding brightness values stored in some file format.
2. **Vector images:** refer to the methods of representing lines, curves shapes by storing only the key points. These key points are sufficient to define the shapes, and the process of turning theses into an image is called rending after the image has been rendered, it can be thought of as being in bit map format where each pixel has specific values associated with it.

Most the type of file format fall into category of bitmap images. In general, these types of images contain both header information and the raw pixel data. The **header information** contain information regarding:

(1)The number of rows(height),

(2) The number of columns(Width),

(3)The number of bands,

(4) The number of bit per pixel,

(5) the file type , Additionally, with some of the more complex file formats, the header may contain information about the type of compression used and other necessary parameters to create the image, I(r,c)).

Image File Formats :

1. BMP format:

It is the format used by the windows, it's a compressed format and the data of image are located in the field of data while there are two fields , one for header (54 byte) that contains the image information such as (height ,width , no. of bits per pixel, no of bands , the file type).

The second field is the color map or color palette for gray level image, where its length is 0-255).

2. BIN file format:

It is the raw image data I(r,c) with no header information.

3. PPM (Portable Pix Map) file format :

It contain raw image data with simplest header, the PPM format, include PBM(binary),PGM(gray),PPM (color), the header contain a magic number that identifies the file.

4. **TIFF(Tagged Image File Format) and GIF(Graphics Interchange Format):** They are used on World Wide Web (WWW). GIF files are limited to a maximum of 8 bits/pixel and allows for a type of compression called LZW. The GIF image header is 13 byte long & contains basic information.

5. JPEG (Joint photo Graphic Experts Group):

It is simply becoming standard that allows images compressed algorithms to be used in many different computer platforms.

JPEG images compression is being used extensively on the WWW. It's, flexible, so it can create large files with excellent image equality.

Image analysis

Image analysis involves manipulating the image data to determine exactly the information necessary to help solve a computer imaging problem.

System model

The image analysis process, illustrated in fig.(1), can be broken down into three primary stages:

1. Preprocessing.
2. Data Reduction.
3. Features Analysis.

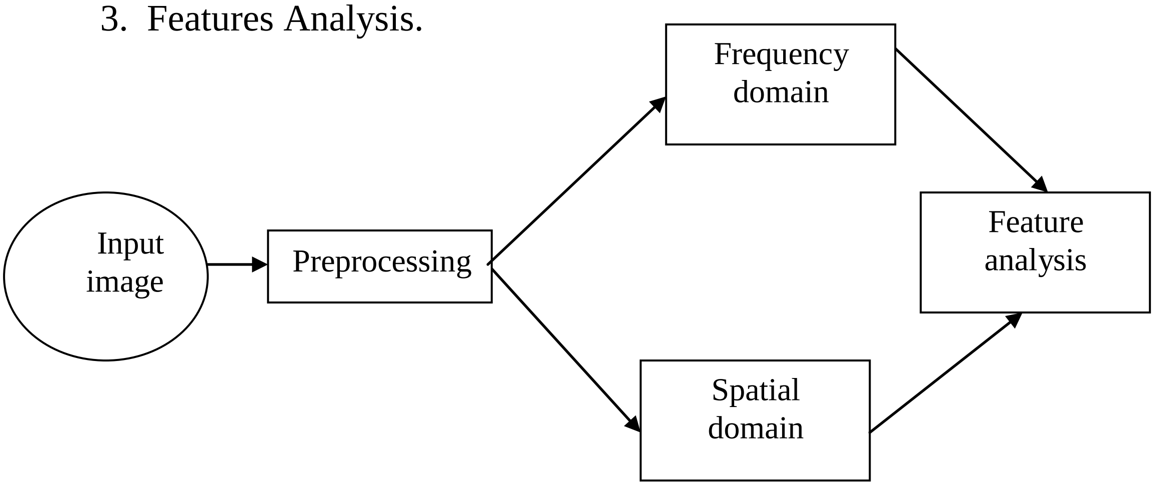


Fig.(1) image analysis domain

Preprocessing Is used to remove noise and eliminate irrelevant, visually unnecessary information. Noise is unwanted information that can result from the image acquisition process; other preprocessing steps might include Gray –level or spatial quantization (reducing the number of bits per pixel or the image size).or finding regions of interest for further processing.

The preprocessing algorithm, techniques and operators are used to perform initial processing that makes the primary data reduction and analysis task easier. They include operations related to:

- Extracting regions of interest.
- Performing basic algebraic operation on image.
- Enhancing specific image features.
- Reducing data in resolution and brightness.

Data Reduction Is the second stage of image analysis. It involves either reducing the data in the spatial domain or transforming it into another domain called the frequency domain, and then extraction features for the analysis process.

In the third stage, Features Analysis, The features extracted by the data reduction process are examine and evaluated for their use in the application.

Preprocessing: Region –of-Interest Image Geometry

Often, for image analysis we want to investigate more closely a specific area within the image, called region of interest (ROI). To do this we need operation that modifies the spatial coordinates of the image, and these are categorized as image geometry operations. The image geometry operations discussed here include:

Crop, Zoom, enlarge, shrink, translate and rotate.

The image crop process is the process of selecting a small portion of the image, a sub image and cutting it away from the rest of the image.

Example: Lenna.bmp image was cropped at points p1(40,40),p2(100,100)

Lenna.bmp

Cropped part

After we have cropped a sub image from the original image we can zoom in on it by enlarge it. The zoom process can be done in numerous ways:

1. Zero-Order Hold.
2. First _Order Hold.
3. Convolution.