

Graphics and Image Data Types

3.1 Graphic/Image Data Representation

In **multimedia**, an image is a visual representation of information that conveys meaning, ideas, or emotions through static graphics. It is one of the fundamental media elements along with text, audio, video, and animation used to create rich, interactive multimedia content.

In digital imaging, an **image** is two-dimensional (2D), composed of pixels (picture elements). Each pixel contains information about color.

3.2 Image characteristics:

The **characteristics of a digital image** describe its properties and how it represents visual information. The main characteristics include:

1. **Pixel** is the smallest unit of a digital image, containing intensity (grayscale) or color information. The image quality depends on the number of pixels.
2. **Resolution:** is the number of pixels in an image, usually expressed as width × height. Higher resolution means more detail in the image.
3. **Color Depth (Bit Depth):** determines the number of possible colors or shades in an image.
4. **Format:** digital images are stored in different formats (JPEG, PNG, BMP, GIF, and TIFF).

3.3 Types of Digital Images

Depending on whether represent images as pixel grids or mathematical shapes. There are:

1. **Bitmaps (raster graphics)**
2. **Vector graphics**

3.1 Bit-map images (also called **Raster Graphics**)

Images are made up of tiny dots called **pixels**, a matrix of dots with different colors. Each pixel has a specific color and position in the grid. Bitmap images are defined by their dimension in pixels as well as by the number of colors they represent, Figure (3.1). For example, a 640 x 480 image contains 640 pixels and 480 pixels' in horizontal and vertical direction respectively.

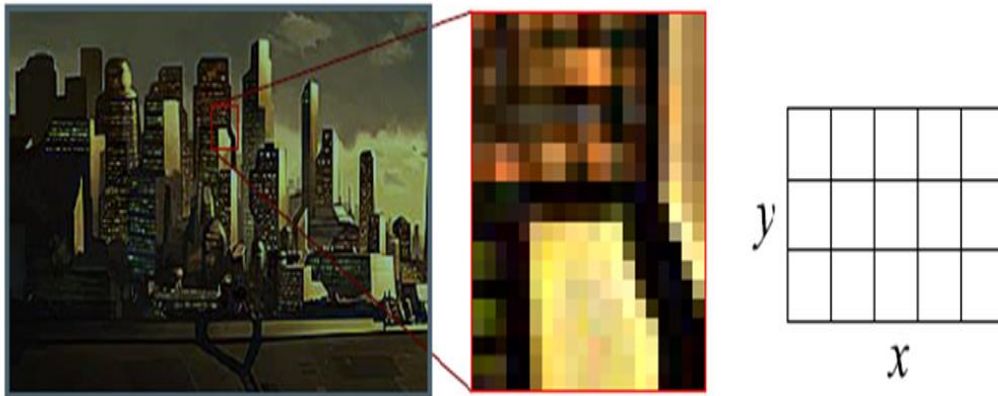


Figure (3.1): Bitmap image

Each of the small pixels can be a shade of gray or a color. Using 24-bit color, each pixel can be set to any one of 16 million colors. Bitmap image is good for detailed and realistic images like photographs. All digital photographs and paintings are bit-mapped, and any other kind of image can be saved or exported into a bitmap format. In fact, when you print any kind of image on a laser or ink-jet printer, it is first converted by either the computer or printer into a bitmap form so it can be printed with the dots the printer uses. Bitmap images have large file sizes, to reduce this problem, some graphic formats such as GIF and JPEG are used to store images in compressed format.

3.2 Vector Graphics

They are a list of graphical objects such as lines, rectangles, ellipses, or curves called primitives (Figure (3.2)). Images are made up of mathematical equations and geometric shapes (lines, curves, polygons). Common formats: SVG, EPS, PDF. Images are scalable to any size without losing quality. But this type is not suitable for complex, detailed images like photos. Draw programs, also called vector graphics programs, are used to create and edit these vector graphics.

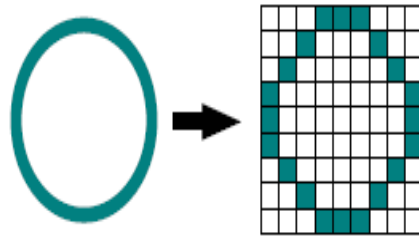


Figure (3.2): Vector graphics

These programs store the primitives as a set of numerical coordinates and mathematical formulas that specify their shape and position in the image. This format is widely used by computer-aided design programs to create detailed engineering and design drawings. It is also used in multimedia when 3D animation is desired.

Draw programs have a number of advantages over paint-type programs. These include:

1. Precise control over lines and colors.
2. Ability to skew and rotate objects to see them from different angles or add perspective.
3. Ability to scale objects to any size to fit the available space.
4. Vector graphics always print at the best resolution of the printer you use, no matter what size you make them.
5. Color blends and shadings can be easily changed.
6. Text can be wrapped around objects

3.4 The types of Bitmaps (raster graphics)

1-Bit Image

Images consist of pixels' picture elements in digital images. Each pixel is stored as a single bit (0 or 1), 0 represents black and 1 represents white. Hence, such an image is also referred

to as a **binary** image. It is also sometimes called a 1-bit **monochrome** image, since it contains no color (Figure (3.3)).



Figure (3.3): 1-bit (Binary) image

1-bit images can be satisfactory for pictures containing only simple graphics and text. Moreover, fax machines use 1-bit data, so in fact 1-bit images are still important even though storage capacities have increased enough to permit the use of imaging that carries more information.

8-Bit Gray-Level Images

It is an 8-bit image, each pixel is stored using 8 bits per pixel (1byte), allowing it to represent different shades of gray (0-255) as shown in Figure (3.4), a dark pixel might have a value of 10, and a bright one might be 230.



Figure (3.4): Gray-Scale image

24-bit Color Images

In a color 24-bit image, each pixel is represented by 24 bits (three bytes), usually representing RGB. Since each value is in the range 0–255, this format supports $256 \times 256 \times 256$, or a total of 16,777,216, possible combined colors. However, such flexibility does result in a storage penalty: a 640×480 24-bit color image would require 921.6 kB of storage without any compression. An important point to note is that many 24-bit color images are

actually stored as 32-bit images, with the extra byte of data for each pixel storing an α (*alpha*) value representing special-effect information. The image *forestfire.bmp*, in Figure (3.5) a 24-bit image in Microsoft Windows BMP format.

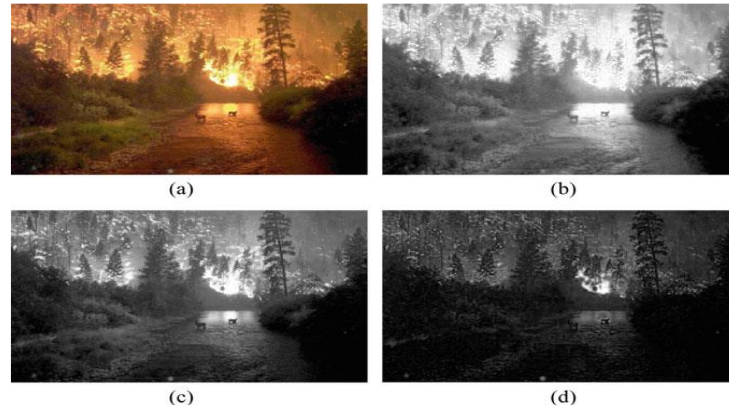


Figure (3.5): High-resolution color and separate R, G, B color channel images. a) original color image; b), c), and d) R, G, and B color channels for this image.

3.5 Image Resolution

Image resolution refers to the spacing of pixels in an image and is measured in pixels per inch, **ppi**, sometimes called dots per inch, **dpi**. The higher the resolution, the more pixels in the image. A printed image that has a low resolution may look pixelated or made up of small squares, with jagged edges and without smoothness. Image size refers to the physical dimensions of an image. Because the number of pixels in an image is fixed, increasing the size of an image decreases its resolution and decreasing its size increases its resolution.