

Chapter 3

Graphics/Image Data Representation

The number of file formats used in multimedia continues to proliferate.

3.1 Graphics/Image Data Types/Structures

A digital image consists of many picture elements, termed **pixels**. The number of pixels that compose a monitor image determine the quality of the image (**resolution**). Higher resolution always yields better quality.

1) 1-bit Images

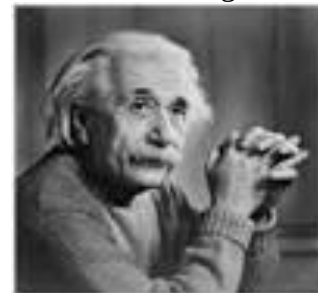
Each pixel is stored as a single bit (0 or 1), so also referred to as **binary image**. Such an image is also called a 1-bit **monochrome bit map** image since it contains no color. Fig. given to the right shows a 1-bit monochrome image. A 640 x 480 monochrome image requires 37.5 KB of storage. Only simple graphics and text is possible.



2) 8-bit Gray-Level Images

Each pixel has a gray-value between 0 and 255. Each pixel is represented by a single byte (8 bits). A dark pixel might have a value of 10, and a bright one might be 230. It is known as **bitmap**: i.e. the two-dimensional array of pixel values that represents the graphics/image data. A **bitmap** representation stores the graphic/image data in the same manner that the computer monitor contents are stored in video memory.

Image resolution refers to the number of pixels in a digital image. Here, fairly high resolution for such an image might be 1600 x 1200; where as lower resolution might be 640 x 480. So a 640 x 480 grayscale image requires 307.2 KB of storage.



3) 8-bit Color Images

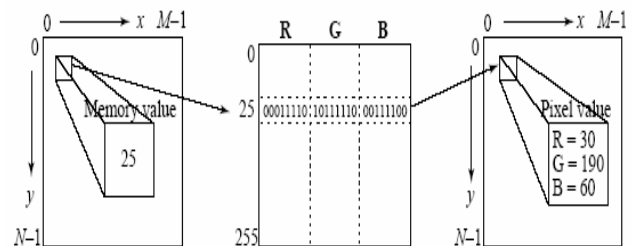
An example 8-bit color image is illustrated in Fig. below.



- Here each pixel is represented by one byte.
- Supports 256 out of the millions 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 gray scale)

Color Look Up Table (LUT)

8-bit color images use the concept of a **lookup table to store color information**. Basically, the image stores not color, but instead just a set of bytes, each of which is actually an index into a table with 3-byte values that specify the color for a pixel. If a pixel stores the value 25, the meaning is to go to row 25 in a color



4) 24-bit Color Images

Here each pixel is represented by three bytes (e.g., RGB). It supports 256 x 256 x 256 possible combined colors. i.e. (16,777,216). Most 24-bit images are 32-bit images, the extra byte of data for each pixel is used to store an *alpha* value representing special effect information. In a color 24-bit image,

each pixel is represented by three bytes, usually representing RGB. However such flexibility does result in a storage penalty: A 640 x 480 24-bit color image would require 921.6 KB of storage without any compression. An example 24-bit color image is illustrated below:



3.2 Popular Graphic/Image File Formats

This section introduces some of the most common graphics and image file formats. Some of them are restricted to particular hardware/operating system platforms; others are **cross-platform** independent formats. While not all formats are cross-platform, there are conversion applications that will recognize and translate formats from other systems. Most image formats incorporate some variation of a *compression* technique due to the large storage size of image files. Compression techniques can be classified into either **lossless** or **lossy**.

❖ Standard System Independent Formats

1. GIF

Graphics Interchange Format (GIF) was devised by the UNISYS Corp. and CompuServe. Initially it was for transmitting graphical images over phone lines via modems. It uses the Lempel-Ziv Welch algorithm (a form of Huffman Coding), modified slightly for image scan line packets (line grouping of pixels). It is limited to only 8-bit (256) color images and suitable for images with few distinctive colors (e.g., graphics drawing). It supports *interlacing* (successive display of pixels in widely spaced rows by a four-pass display process). GIF comes in two variations GIF87a and GIF89a. GIF actually comes in two flavors:

1. **GIF87a:** The original specification.
2. **GIF89a:** The later version. Supports simple animation via a Graphics Control Extension block in the data, provides simple control over delay time, a transparency index, etc.

2. JPEG

A standard for photographic image compression created by the **Joint Photographics Experts Group (JPEG)**. It takes advantage of limitations in the human vision system to achieve high rates of compression (Eye-Brain system cannot see extremely fine details). Lossy compression allows

user to set the desired level of quality/compression. It can be applied to an input that has 24 bits per pixel. It can achieve 10:1 compression. It is used in digital cameras and Web.

3. TIFF

Tagged Image File Format (TIFF), stores many different types of images (e.g., monochrome, grayscale, 8-bit & 24-bit RGB, etc. It was developed by the Aldus Corp. in the 1980's and later supported by the Microsoft. TIFF is a lossless format. It does not provide any major advantages over JPEG and is not as user-controllable. It appears to be declining in popularity.

4. PNG

Portable Network Graphics was developed from the popularity of Internet for more system – independent image formats. PNG was created as an improved, non-patented replacement for Graphics Interchange Format (GIF), and is the most used lossless image compression format on the Internet. PNG supports palette-based images (with palettes of 24-bit RGB or 32-bit RGBA colors), grayscale images (with or without alpha channel), and full-color non-palette-based RGB[A] images (with or without alpha channel).

5. Graphics Animation Files

- ✓ FLC - main animation or moving picture file format, originally created by Animation Pro
- ✓ FLI - similar to FLC
- ✓ GL - better quality moving pictures, usually large file sizes

Note: The FLIC file formats most known in the extension .FLI and .FLC, used to store animation files. It is similar to animated GIF. The FLIC animation format was originally developed by Autodesk for use with Autodesk Animator (FLI) and Autodesk Animator Pro (FLC).

6. Exif

Exchangeable image file format (Exif) is a standard that specifies the formats for images, sound, and ancillary tags used by digital cameras (including smart phones), scanners and other systems handling image and sound files recorded by digital cameras.

7. Postscript (PS) /Encapsulated Postscript

PostScript (PS) is a vector based computer language for creating graphics rather than pixel-based (page element definitions are essentially in terms of vectors). It is an important language for typesetting which includes text as well as vector/structured graphics and bit-mapped images. It is used in several popular graphics programs (Illustrator, FreeHand). It does not provide compression, files are often large. It is best known for its use as a page description language in the electronic and desktop publishing areas. Many high-end printers have a Postscript interpreter built into them. Encapsulated postscript files add some additional information for inclusion of Postscript files in another document. Postscript page description language itself does not provide compression; in fact, Postscript files are just stored as ASCII.

8. Portable Document Format (PDF)

Portable Document Format (PDF) is a file format used to represent documents in a manner independent of application software, hardware, and operating system. Each PDF file encapsulates a complete description of a fixed-layout flat document, including the text, fonts, graphics, and other information needed to display it. In 1991, Adobe Systems co-founder John Warnock outlined a system called "Camelot" that evolved into PDF. LZW compression is used. Another text + figures language has begun to supersede or at least parallel Postscript: Adobe Systems Inc. includes LZW compression in its Portable Document Format (**PDF**) file format. PDF files that do not include images have about the same compression ratio, 2:1 or 3:1, as do files compressed with other LZW-based compression tools.

9. System Dependent Formats

Many graphical/imaging applications create their own file format particular to the systems they are executed upon. The following are a few popular system dependent formats.

- ✓ **Microsoft Windows: BMP**
 - A system standard graphics file format for Microsoft Windows
 - Used in PC Paintbrush and other programs
 - It is capable of storing 24-bit bitmap images
- ✓ **Microsoft Windows: WMF**
 - The native vector file format for the Microsoft Windows operating environment.
 - It consists of a collection of GDI (Graphics Device Interface), Function calls, also native to the Windows environment.
 - When a WMF file is "played" (typically using the Windows Play Meta File() function) the described graphics is rendered
 - WMF files are ostensibly device-independent and are unlimited in size.
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- ✓ **Macintosh: PAINT and PICT**
 - PAINT was originally used in Mac Paint program, initially only for 1-bit monochrome images.
 - PICT format is used in MacDraw (a vector based drawing program) for storing structured graphics
- ✓ **X-windows: XBM**
 - Primary graphics format for the X-Window system
 - Supports 24-bit color bitmap
 - Many public domain graphic editors, e.g., xv
 - Used in X Windows for storing icons, pixmaps, backdrops, etc.