Fundamentals of Multimedia

2nd Edition 2014
Ze-Nian Li
Mark S. Drew
Jiangchuan Liu

Chapter 3 :

Graphics and Image Data Representations

❖ Content:

3-1: Graphics/Image Data Types

3-2: Popular File Formats.

❖Objectives:

- This chapter introduces:
  - how best to represent the graphics and image data since it is of crucial importance in the study of multimedia.
  - The specifics of file formats for storing such images are also discussed

3.1 Graphics/Image Data Types

- Table 3.1 shows a list of file formats used in the popular product Adobe Premiere.

- We concentrate on GIF and JPG image file formats, since the **GIF** file format is one of the simplest and contains several fundamental features,

- and the **JPG** file format is arguably the most important overall.

3.1 Graphics/Image Data Types

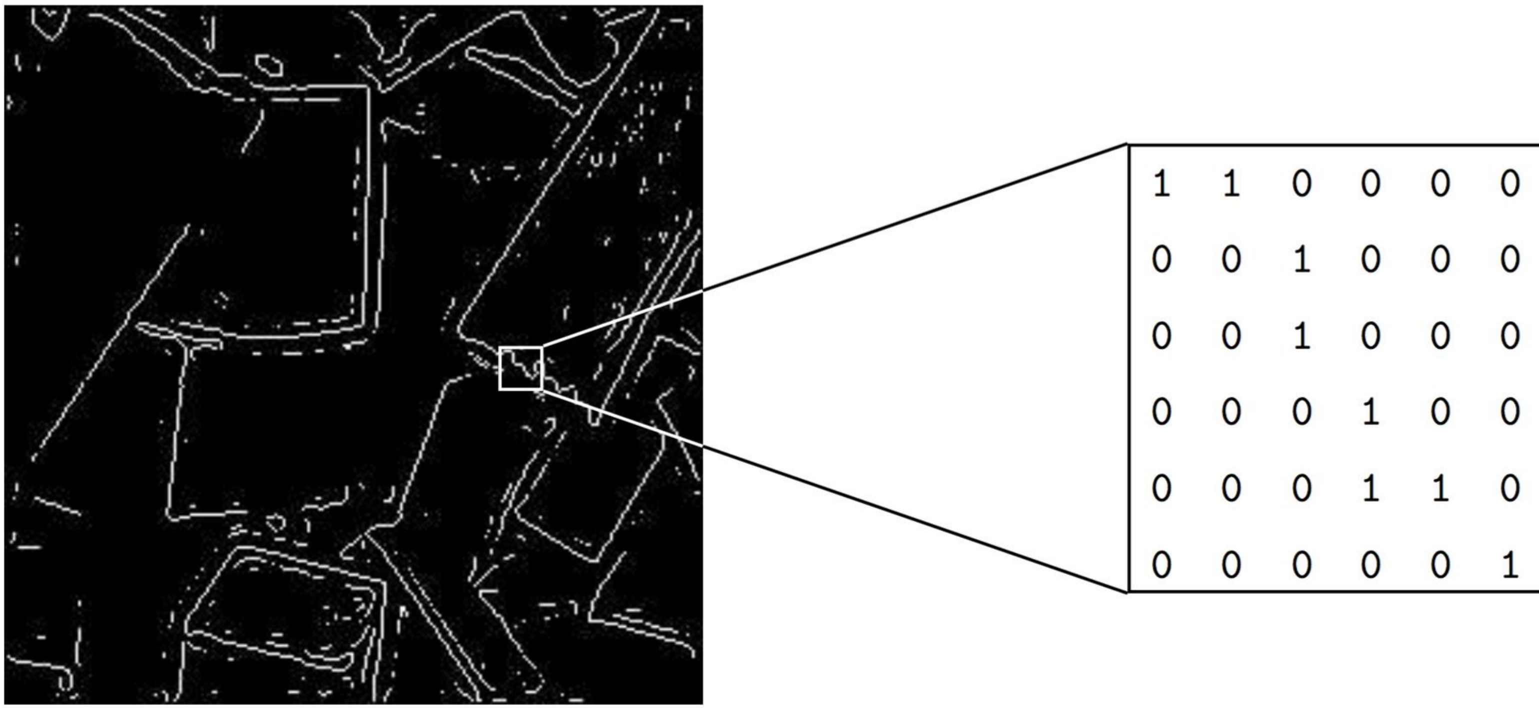
Table 3.1 Adobe Premiere file formats

Image	Sound	Video
BMP,	AIFF,	AVI, MOV,
GIF, JPG,	AAC, AC3,	DV, FLV,
EPS, PNG,	MP3, MPG,	MPG,
PICT, PSD,	M4A, MOV,	WMA, WMV,
TIF, TGA	WMA	SWF, M4V, MP4, MXF

3.1.1 1-Bit Images

- Images consist of pixels (picture elements in digital images).
- A 1-bit image (also called **binary image**) consists of on and off bits only and thus is the simplest type of image.
- Each pixel is stored as a single bit (0 or 1)
- It is also sometimes called a *1-bit monochrome (called Lena image by multimedia scientists)* image since it contains no color. See Figures in next two slides.
- Monochrome
- 1-bit images can be satisfactory for pictures containing only simple graphics and text.
- 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.

3.1.1 1-Bit Images



A binary image

Monochrome 1-bit Lena image

A 640×480 monochrome image requires 38.4 kB of storage

A 640 × 480 monochrome image requires 38.4 kilobytes (kB) of storage

{[(640 × 480)Bits /8] = 38400 Bytes} / 1000 = 38.4 Kilobytes.

3.1.2 8-Bit Gray-Level Images

- 8-bit image is one for which each pixel has a *gray value* between 0 and 255.

- Each pixel is represented by a single byte.
- The entire image can be thought of as a two-dimensional array of pixel values referred to as a *bitmap*, a representation of the graphics/image data that parallels the manner in which it is stored in video memory.

- *Image resolution* refers to the number of pixels in a digital image (higher resolution always yields better quality but increases size)

3.1.2 8-Bit Gray-Level Images

230	229	232	234	235	232	148
237	236	236	234	233	234	152
255	255	255	251	230	236	161
99	90	67	37	94	247	130
222	152	255	129	129	246	132
154	199	255	150	189	241	147
216	132	162	163	170	239	122

A greyscale image

Grayscale image of Lena

640×480 grayscale image requires 300kB of storage

640×480 grayscale image requires 300kB of storage

[(640 × 480) = 38400 Bytes] / 1000 = 307.2 Kilobytes.

3.1.4 24-Bit Color Images

- In a color 24-bit image, each pixel is represented by three bytes, usually representing RGB.
- Since each value is in the range 0–255, this format supports 256×256×256, or a total of 16,777,216, possible combined colors; which increases storage size.
- a 640 × 480 24-bit color image would require 921.6 kB of storage. (without any compression applied)
- Compression is used to decrease the image size by simply grouping pixels effectively. (chapter 7).

3.1.4 24-Bit Color Images

49	55	56	57	52	53
58	60	60	58	55	57
58	58	54	53	55	56
83	78	72	69	68	69
88	91	91	84	83	82
69	76	83	78	76	75
61	69	73	78	76	76

Red

64	76	82	79	78	78
93	93	91	91	86	86
88	82	88	90	88	89
125	119	113	108	111	110
137	136	132	128	126	120
105	108	114	114	118	113
96	103	112	108	111	107

Green

66	80	77	80	87	77
81	93	96	99	86	85
83	83	91	94	92	88
135	128	126	112	107	106
141	129	129	117	115	101
95	99	109	108	112	109
84	93	107	101	105	102

Blue

A true colour image

24-bit color image forestfire.bmp

Microsoft Windows BMP format

3.1.5 Higher Bit-Depth Images

- In some fields such as medicine (security cameras, satellite imaging) more accurate images are required to see the patient's liver, for example.

- To get such images, special cameras that view more than just 3 colors (RGB) are used.

- Such images are called *multispectral* (more than three colors) or *hyperspectral* (224 colors for satellite imaging).

3.1.6 8-Bit Color Images

- Reasonably accurate color images can be obtained by *quantizing* the color information to collapse it.
- Color quantizing example: reducing the number of colors required to represent a digital image makes it possible to reduce its file size.
- 8-bit color image (so-called 256 colors. Why?) files use the concept of a *lookup table (LUT)* to store color information.
- For example,:
  - if exactly 23 pixels have RGB values (45, 200, 91)
  - then store the value 23 in a three-dimensional array, at the element indexed by the index values [45, 200, 91].
- This data structure is called a *color histogram.*
- *color histogram:* is a very useful tool for image transformation and manipulation in Image Processing.

Notice that the difference between Fig. 3.5a, the 24-bit image, and Fig. 3.7, the 8-bit image, is reasonably small.

Fig. 3.5a, the 24-bit image

Fig. 3.7, the 8-bit image

Another example for difference between Fig. 3.5a, the 24-bit image, and Fig. 3.7, the 8-bit image, is reasonably small.

Fig. 3.5a, the 24-bit image

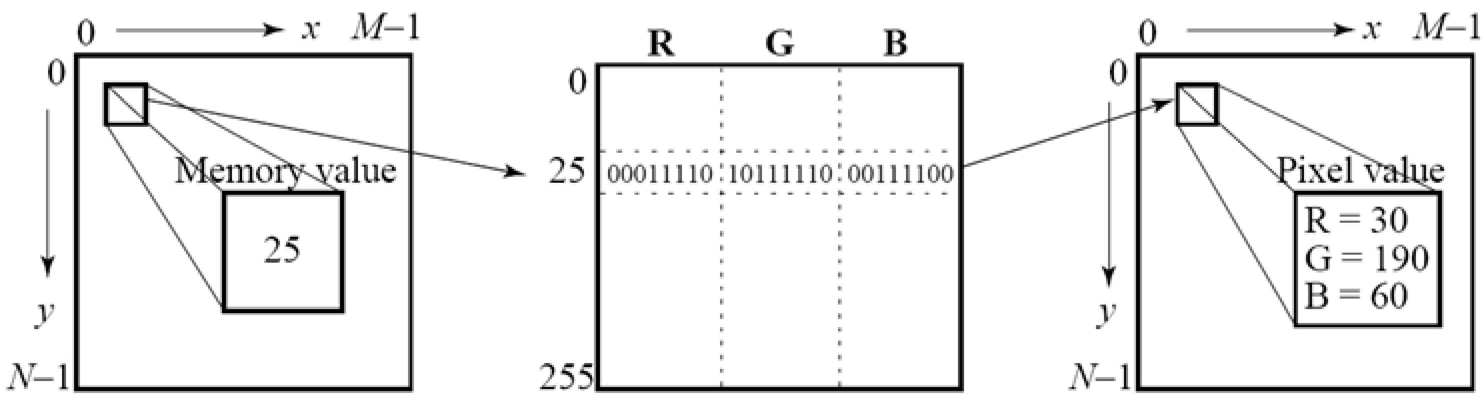
Fig. 3.7, the 8-bit image

3.1.6 8-Bit Color Images

- Note the great savings in space for 8-bit images over 24-bit ones:
- a 640 × 480 8-bit color image requires only 300 kB of storage,
- compared to 921.6 kB for a color image (again, without any compression applied).

3.1.7 Color Lookup Tables

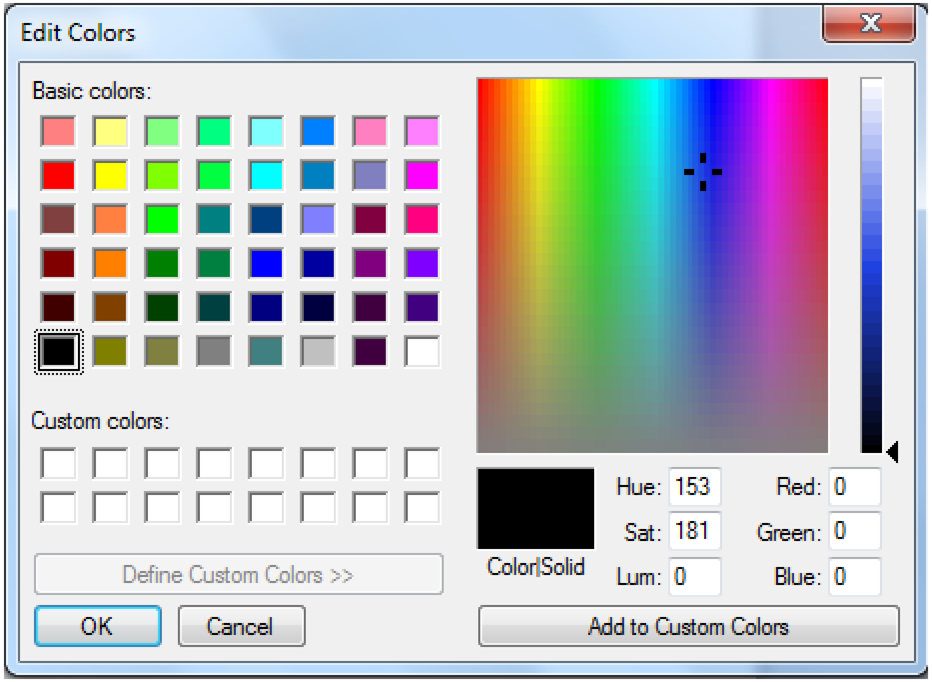
- The LUT is often called a *palette*.
- The idea is to store only the index, or code value, for each pixel.
- if a pixel stores, say, the value 25 (Figure 3.8), the meaning is to go to row 25 in a color lookup table (LUT).



•A **Color-picker** consists of an array of fairly large blocks of color (or a semi-continuous range of colors) such that a mouse-click will select the color indicated.

- In reality, a color-picker displays the palette colors associated with index values from 0 to 255.

- Fig. 3.9 (next slide) displays the concept of a color-picker: if the user selects the color block with index value 2, then the color meant is cyan, with RGB values (0, 255, 255).



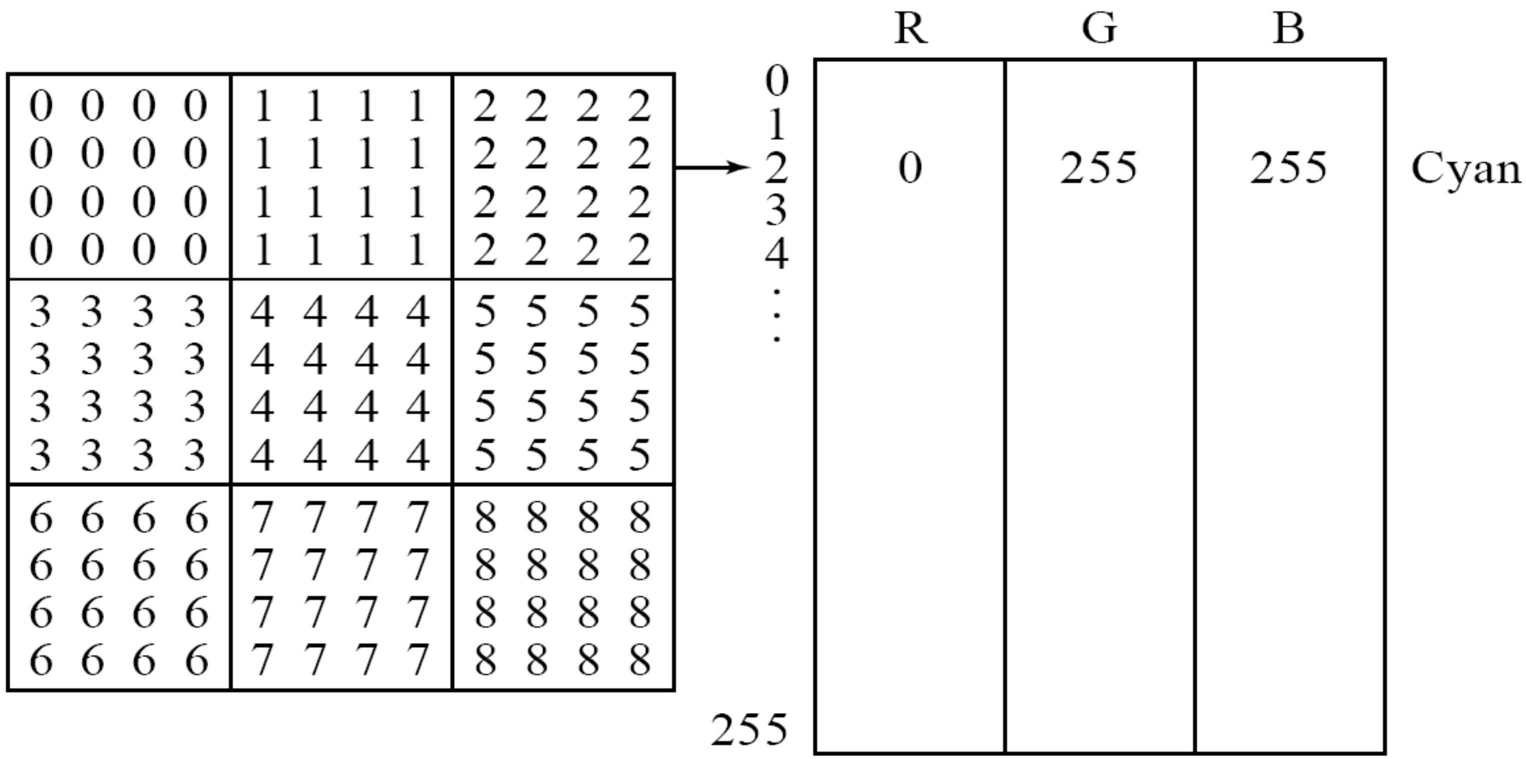


Fig. 3.9: Color-picker for 8-bit color: each block of the color-picker corresponds to one row of the color LUT

3.2 Popular File Formats

- **8-bit GIF(Graphics Interchange Format)** :
- It's one of the simplest, easily understood format.
- It's also one of the most important formats because of its historical connection to the WWW and HTML markup language as the first image type recognized by net browsers.

- However,
- **JPEG**: currently the most important common file format

3.2.1 GIF

- **GIF standard (Graphics Interchange Format)**: (We examine GIF standard because it is so simple!)was devised initially for transmitting graphical images over phone lines via modems.
- The GIF standard uses the **Lempel-Ziv-Welch** algorithm (a form of compression—see Chap. 7)
- Limited to 8-bit (256) color images only, which, while producing acceptable color images, is best suited for images with few distinctive colors (e.g., graphics or drawing 'Logos'). [1]
- GIF standard supports **interlacing** — successive display of pixels in widely-spaced rows by a 4-pass display process. (Figure 3.16)
- **interlacing** allows a quick sketch to appear when a web browser displays the image, followed by more detailed fill-ins.
- The JPEG standard (below) has a similar display mode, denoted *progressive mode*. *Assignment*
- GIF has two formats GIF87 (standard) and GIF89 supports simple animation.

Software such as Corel Draw allows access to and editing of GIF images.

3.2.1 GIF

3.2.1 GIF

	On the first pass, a very rough image is displayed. This at least provides an idea to the visitor of what is going to be displayed.
	On the second pass, more lines are added to the image.
	The third pass makes the image more clear.
	The fourth pass completes the image display.

GIF87

- For the standard specification, the general file format of a GIF87 file is as in Fig. 3.12.
- The *Signature is six bytes* GIF87a;
- the *Screen Descriptor is a seven-byte set of flags*
- *Local Color Map (if does not exist*

A global color map can be defined)

- A GIF87 file can contain more than one image

definition, usually to fit on several different parts

of the screen.

Therefore each image can contain its own

Local Color Map, for mapping 8 bits into 24-bit RGB values.

- *actual raster data itself is first*

compressed using the LZW compression

scheme (see Chap. 7) before being stored.

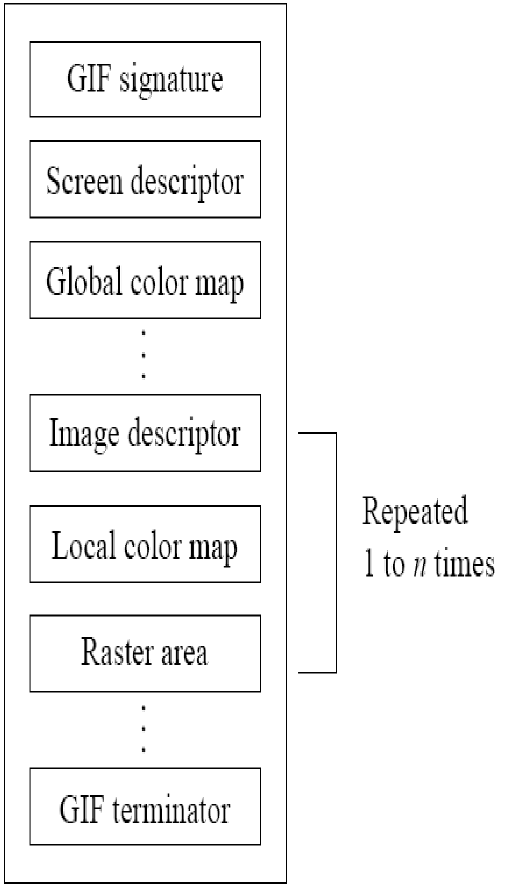


Fig. 3.12: GIF file format.

- **Screen Descriptor** comprises a set of attributes that belong to every image in the file. According to the GIF87 standard, it is defined as in Fig. 3.13.
- LSB/ MSB :

Least/Most Significant Byte

- Bit 7 is filled with zeros

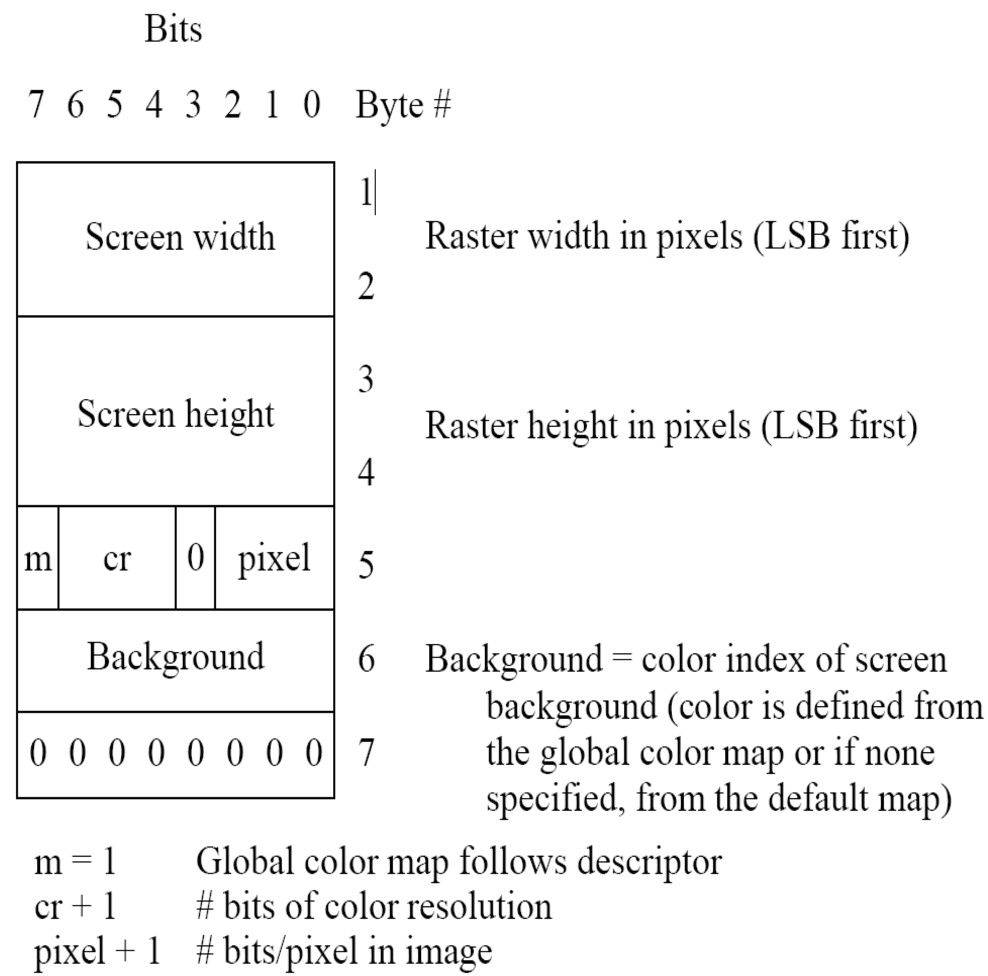


Fig. 3.13: GIF screen descriptor.

- **Color Map** is set up in a very simple fashion as in Fig. 3.14. However, the actual length of the table equals $2^{(pixel+1)}$ as given in the Screen Descriptor.

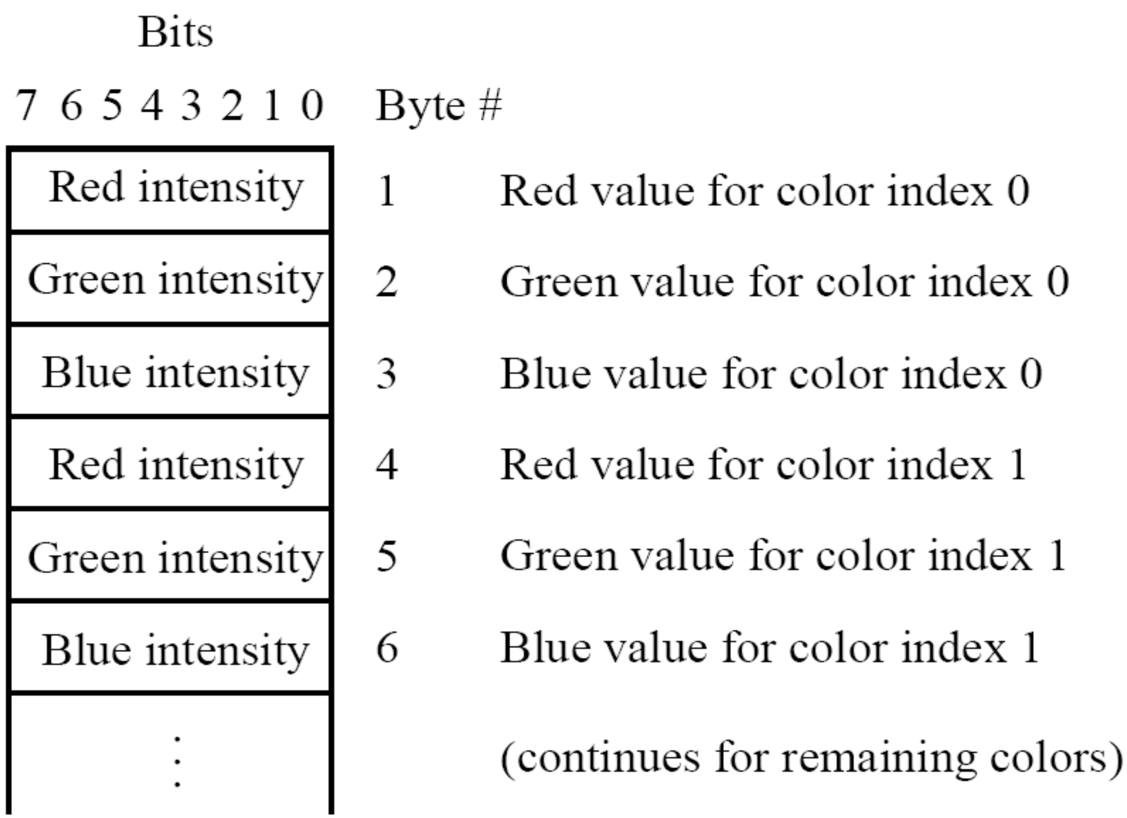


Fig. 3.14: GIF color map.

- Each image in the file has its own **Image Descriptor**, defined as in Fig. 3.15.

Bits 7 6 5 4 3 2 1 0	Byte #	
0 0 1 0 1 1 0 0	1	Image separator character (comma)
Image left	2 3	Start of image in pixels from the left side of the screen (LSB first)
Image top	4 5	Start of image in pixels from the top of the screen (LSB first)
Image width	6 7	Width of the image in pixels (LSB first)
Image height	8 9	Height of the image in pixels (LSB first)
m | i | 0 | 0 | 0 | pixel	10	m = 0 Use global color map, ignore 'pixel' m = 1 Local color map follows, use 'pixel' i = 0 Image formatted in Sequential order i = 1 Image formatted in Interlaced order pixel + 1 # bits per pixel for this image

Fig. 3.15: GIF image descriptor.

interlace

- If the *interlace* bit is set to (1), then the local Image Descriptor, the rows of the image are displayed in a four-pass sequence, as in Fig. 3.16. (next slide)
- Here, the first pass displays rows 0 and 8, the second pass displays rows 4 and 12, and so on.

Image row	Pass 1	Pass 2	Pass 3	Pass 4	Result
0	*1a*				*1a*
1				*4a*	*4a*
2			*3a*		*3a*
3				*4b*	*4b*
4		*2a*			*2a*
5				*4c*	*4c*
6			*3b*		*3b*
7				*4d*	*4d*
8	*1b*				*1b*
9				*4e*	*4e*
10			*3c*		*3c*
11				*4f*	*4f*
12		*2b*			*2b*
⋮					

Fig. 3.16: GIF 4-pass interlace display row order.

3.2.2 JPEG

- **JPEG (Joint Photographic Experts Group)**: The most important current standard for image compression (.jpg, .jpeg, .jpe).

- The human vision system has some specific limitations (The eye–brain system cannot see extremely fine detail; those are dropped) and JPEG takes advantage of these to achieve high rates of compression.

- JPEG allows the user to set a desired level of quality, or compression ratio (input divided by output).

- As an example, Fig. 3.17 shows our **forestfire** image, with a quality factor Q=10%.
  - - This image is a mere 1.5% of the original size.
  - In comparison, a JPEG image with Q=75% yields an image size 5.6% of the original, whereas a GIF version of this image compresses down to 23.0% of uncompressed image size.

A photo of a flower compressed with successively more lossy compression ratios from left to right.

Fig. 3.17: JPEG image with low quality specified by user.

PNG

- **PNG format**: standing for **Portable Network Graphics** — meant to supersede the GIF standard, and extends it in important ways.

- Special features of PNG files include:

1. Support for up to 48 bits of color information — a large increase.

16 bits per pixel in each color channel.

2. Files may contain gamma-correction information for correct display of color images, as well as alpha-channel information for such uses as control of transparency.

3. The display progressively displays pixels in a 2-dimensional fashion by showing a few pixels at a time over seven passes through each 8 X 8 block of an image.

PNG

4.It supports both lossless and lossy compression with performance better than GIF.

5.PNG is widely supported by various web browsers and imaging software.

TIFF

- **TIFF**: stands for **Tagged Image File Format**.

- The support for attachment of additional information (referred to as "tags") provides a great deal of flexibility.

  1. The most important tag is a format signifier: what type of compression etc. is in use in the stored image.

  2. TIFF can store many different types of image: 1-bit, grayscale, 8-bit color, 24-bit RGB, etc.

  3. TIFF was originally a lossless format but now a new JPEG tag allows one to opt for JPEG compression.

  4. The TIFF format was developed by the Aldus Corporation in the 1980's and was later supported by Microsoft.

3.2.9 PS and PDF

- PostScript is an important language for typesetting, and many high-end printers have a PostScript interpreter built into them.
- PostScript is a vector-based, rather than pixel based, picture language: page elements are essentially defined in terms of vectors.
- PostScript includes vector/structured graphics as well as text
- Several popular graphics programs, such as Adobe Illustrator, use PostScript.
- Note, however, that the PostScript page description language does not provide compression; in fact, PostScript files are just stored as ASCII.

3.2.9 PS and PDF

- Therefore, another text + figures language has largely superseded PostScript is *Portable Document Format (PDF) file format* that includes LZW (see Chap. 7) compression.

- 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, such as the Unix compress or gzip, or the PC-based winzip (a variety of pkzip) or WinRAR.

- while

- For files containing images, PDF may achieve higher compression ratios by using separate JPEG compression for the image content

End of Chapter 3

Kingdom of Saudi Arabia
Ministry of Education
Umm AlQura University
Adam University College
Computer Science Department

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This Summary is an Online Content from this Book:

Ze-Nian Li and Mark S Drew, Fundamentals of Multimedia, 1/e, Prentice-Hall, 2004

It is edited for
Multimedia Systems Course 6803316-3
by:

T.Mariah Sami Khayat

Teacher Assistant @ Adam University College

For Contacting:

mskhayat@uqu.edu.sa