Image File Format In a Quick Look

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Digital Image file formats

Are standardized means of organizing and storing images. This entry is about digital image formats used to store photographic and other images; (for disk-image file formats see Disk image). Image files are composed of either pixel or vector (geometric) data that are rasterized to pixels when displayed (with few exceptions) in a vector graphic display. The pixels that compose an image are ordered as a grid (columns and rows); each pixel consists of numbers representing magnitudes of brightness and color.

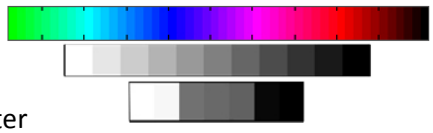
Digital Image File Types Explained

JPG, GIF, TIFF, PNG, BMP. What are they, and how do you choose? These and many other file types are used to encode digital images. The choices are simpler than you might think.

Part of the reason for the plethora of file types is the need for *compression*. Image files can be quite large, and larger file types mean more disk usage and slower download. Compression is a term used to describe ways of cutting the size of the file. Compression schemes can by *lossy* or *lossless*.

Another reason for the many file types is that images differ in the number of colors they contain. If an image has few colors, a file type can be designed to exploit this as a way of reducing file size.

Number of colors



Images start with differing numbers of colors in them. The simplest images may contain only two colors, such as black and white, and will need only 1 bit to represent each pixel. Many early PC video cards would support only 16 fixed colors. Later cards would display 256 simultaneously, any of which could be chosen from a pool of 2^{24}, or 16 million colors. New cards devote 24 bits to each pixel, and are therefore capable of displaying 2^{24}, or 16 million colors without restriction. A few display even more. Since the eye has trouble distinguishing between similar colors, 24 bit or 16 million colors is often called True Color.

Image resolution

Describes the detail an image holds. The term applies equally to digital images, film images, and other types of images. Higher resolution means more image detail.

Image resolution can be measured in various ways. Basically, resolution quantifies how close lines can be to each other and still be visibly resolved. Resolution units can be tied to physical sizes (e.g. lines per mm, lines per inch) or to the overall size of a picture (lines per picture height, also known simply as lines, or TV lines). Furthermore, line pairs are often used instead of lines. A line pair is a pair of adjacent dark and light lines, while lines counts both dark lines and light lines. A resolution of 10 lines per millimeter means 5 dark lines alternating with 5 light lines, or 5 line pairs per millimeter. Photographic lens and film resolution are most often quoted in line pairs per millimeter.

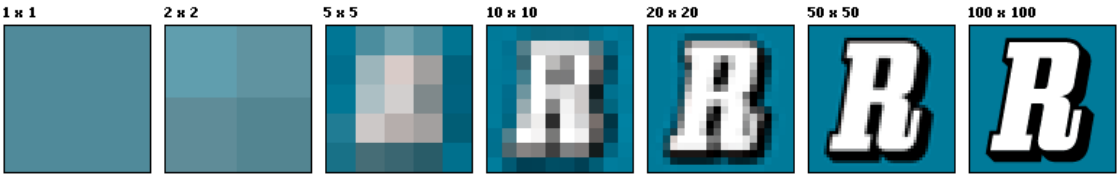
Image file sizes

Image file size—expressed as the number of bytes—increases with the number of pixels composing an image, and the colour depth of the pixels. The greater the number of rows and columns, the greater the image resolution, and the larger the file. Image compression uses algorithms to decrease the size of a file. High resolution cameras produce large image files, ranging from hundreds of kilobytes to megabytes, per the camera's resolution and the image-storage format capacity. High resolution digital cameras record 8 megapixel (1MP = 1,000,000 pixels / 1 million) images, or more, in truecolor. For example, an image recorded by an 8 MP camera; since each pixel uses 3 bytes to record truecolor, the uncompressed image would occupy 24,000,000 bytes of memory—a great amount of digital storage for one image, given that cameras must record and store many images to be practical. Faced with large file sizes, both within the camera and a storage disc, image file formats were developed to store such large images. An overview of the major graphic file formats follows below.

Pixel resolution

The term *resolution* is often used as a pixel count in digital imaging, even though American, Japanese, and international standards specify that it should not be so used, at least in the digital camera field. An image of N pixels high by M pixels wide can have any resolution less than N lines per picture height, or N TV lines. But when the pixel counts are referred to as resolution, the convention is to describe the *pixel resolution* with the set of two positive integer numbers, where the first number is the number of pixel columns (width) and the second is the number of pixel rows (height), for example as *640 by 480*. Another popular convention is to cite resolution as the total number of pixels in the image, typically given as number of megapixels, which can be calculated by multiplying pixel columns by pixel rows and dividing by one million. Other conventions include describing pixels per length unit or pixels per area unit, such as pixels per inch or per square inch. None of these *pixel resolutions* are true resolutions, but they are widely referred to as such; they serve as upper bounds on image resolution.

Below is an illustration of how the same image might appear at different pixel resolutions, if the pixels were poorly rendered as sharp squares (normally, a smooth image reconstruction from pixels would be preferred, but for illustration of pixels, the sharp squares make the point better).



An image that is 2048 pixels in width and 1536 pixels in height has a total of 2048×1536 = 3,145,728 pixels or 3.1 megapixels. One could refer to it as 2048 by 1536 or a 3.1-megapixel image. As the megapixels of a camera increase so does the ability of a camera to produce a larger image; a 5 megapixel camera is capable of capturing a larger image than a 3 megapixel camera.

Larger monitor screens usually have higher screen resolution, measured in pixels

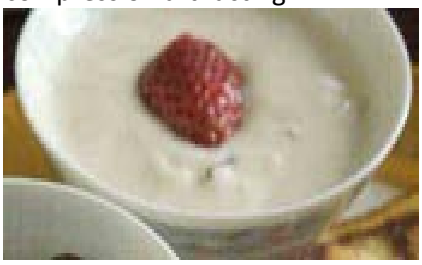
Image file compression

There are two types of **image file compression** algorithms: lossless and lossy.

Lossless compression algorithms reduce file size without losing image quality, though they are not compressed into as small a file as a lossy compression file. When image quality is valued above file size, lossless algorithms are typically chosen.

Lossy compression algorithms take advantage of the inherent limitations of the human eye and discard invisible information. Most lossy compression algorithms allow for variable quality levels (compression) and as these levels are increased, file size is reduced. At the highest compression levels, image deterioration becomes noticeable as "compression artifacting".

Lossless Image Compression



Lossy Image Compression

The file types

JPEG

JPEG (Joint Photographic Experts Group) files are (in most cases) a lossy format; the DOS filename extension is **JPG** (other operating systems may use **JPEG**). Nearly every digital camera can save images in the JPEG format, which supports 8 bits per color (red, green, blue) for a 24-bit total, producing relatively small files. When not too great, the compression does not noticeably detract from the image's quality, but JPEG files suffer generational degradation when repeatedly edited and saved. Photographic images may be better stored in a lossless non-JPEG format if they will be re-edited, or if small "artifacts" (blemishes caused by the JPEG's compression algorithm) are unacceptable. The JPEG format also is used as the image compression algorithm in many Adobe PDF files.

The Exif (Exchangeable image file) format is an algorithm incorporated in the JPEG software used in most cameras. Its purpose is to record and to standardize the exchange of data between digital cameras and editing and viewing software. The data is recorded for individual images and includes such things as: camera settings, time and date, shutter speed, exposure, image size, compression, name of camera, color information, etc. When images are viewed or edited by image editors, such as Paint Shop Pro, all of this image information can be displayed

GIF

GIF (Graphics Interchange Format) is limited to an 8-bit palette, or 256 colors. This makes the GIF format suitable for storing graphics with relatively few colors such as simple diagrams, shapes, logos and cartoon style images. The GIF format supports animation and is still widely used to provide image animation effects. It also uses a lossless compression that is more effective when large areas have a single color, and ineffective for detailed images or dithered images.

BMP

BMP file format (Windows bitmap) handles graphics files within the Microsoft Windows OS. Typically, BMP files are uncompressed, hence they are large; the advantage is their simplicity, wide acceptance, and use in Windows programs.

TIFF

TIFF (Tagged Image File Format) is a flexible format that normally saves 8 bits or 16 bits per color (red, green, blue) for 24-bit and 48-bit totals, respectively, using either the **TIFF** or the **TIF** filenames. The TIFF's flexibility is both blessing and curse, because no single reader reads every type of TIFF file. TIFFs are lossy and lossless; some offer relatively good lossless compression for bi-level (black&white) images. Some digital cameras can save in TIFF format, using the LZW compression algorithm for lossless storage. The TIFF image format is not widely supported by web browsers. TIFF remains widely accepted as a photograph file standard in the printing business. The TIFF can handle device-specific colour spaces, such as the CMYK defined by a particular set of printing press inks. OCR (Optical Character Recognition) software packages commonly generate some (often monochromatic) form of TIFF image for scanned text pages.

PNG

The PNG (Portable Network Graphics) file format was created as the free, open-source successor to the GIF. The PNG file format supports truecolor (16 million colours) while the GIF supports only 256 colours. The PNG file excels when the image has large, uniformly coloured areas. The lossless PNG format is best suited for editing pictures, and the lossy formats, like JPG, are best for the final distribution of photographic images, because JPG files are smaller than PNG files. Many older browsers currently do not support the PNG file format, however, with Internet Explorer 7, all contemporary web browsers now support all common uses of the PNG format, including full 8-bit translucency (Internet Explorer 7 may display odd colors on translucent images ONLY when combined with IE's opacity filter). The Adam7-interlacing allows an early preview, even when only a small percentage of the image data has been transmitted. PNG, an extensible file format for the lossless, portable, well-compressed storage of raster images. PNG provides a patent-free replacement for GIF and can also replace many common uses of TIFF. Indexed-color, grayscale, and truecolor images are supported, plus an optional alpha channel. PNG is designed to work well in online viewing applications, such as the World Wide Web, so it is fully streamable with a progressive display option. PNG is robust, providing both full file integrity checking and simple detection of common transmission errors. Also, PNG can store gamma and chromaticity data for improved color matching on heterogeneous platforms.

Samples

File Type:
Tiff, uncompressed
Size: 901 k

File Type:
Tiff, LZW lossless compression
Size: 928k (yes, its actually bigger)

File Type:
JPG, High quality
Size: 319k

File Type:
JPG, medium quality
Size: 188 k

File Type:
JPG, my usual web quality
Size: 109k

File Type:
JPG, low quality / high compression
Size: 50 k

File Type:
JPG, absurdly high compression
Size: 18 k

File Type:
PNG, lossless compression
Size: 741 k

File Type:
GIF, lossless compression
Size: 286 k but only 256 colors

Image File Header Formats

BMP, PCX, JPEG, FLI/FLC, and AVI files include headers that define the image size, number of colors, and other information needed to display the image. Fastgraph provides functions for reading the image headers and retrieving their more useful items. However, there may be times when you need additional information stored in the file header. This section provides full details about the structure of the image file headers. In the tables that follow, we'll assume all offsets start at zero, all field sizes are in bytes, and all numeric values are stored with the least significant byte first.

JPEG Header Format

offset	Size (byte)	description
0	2	JPEG SOI marker (FFD8 hex)
2	2	image width in pixels
4	2	image height in pixels
6	1	number of components (1 = grayscale, 3 = RGB)
7	1	horizontal/vertical sampling factors for component 1
8	1	sampling factors for component 2 (if RGB)
9	1	sampling factors for component 3 (if RGB)

BMP Header Format

offset	Size (byte)	**description**
0	2	signature, must be 4D42 hex
2	4	size of BMP file in bytes (unreliable)
6	2	reserved, must be zero
8	2	reserved, must be zero
10	4	offset to start of image data in bytes
14	4	size of BITMAPINFOHEADER structure, must be 40
18	4	image width in pixels
22	4	image height in pixels
26	2	number of planes in the image, must be 1
28	2	number of bits per pixel (1, 4, 8, or 24)
30	4	compression type (0=none, 1=RLE-8, 2=RLE-4)
34	4	size of image data in bytes (including padding)
38	4	horizontal resolution in pixels per meter (unreliable)
42	4	vertical resolution in pixels per meter (unreliable)
46	4	number of colors in image, or zero
50	4	number of important colors, or zero

GIF Header Format

offset	Size (byte)	**description**
0	3	"GIF"
3	3	"87a" or "89a"
6	2	<Logical Screen Width>
8	2	<Logical Screen Height>
10	1	bit 0: Global Color Table Flag (GCTF) bit 1..3: Color Resolution bit 4: Sort Flag to Global Color Table bit 5..7: Size of Global Color Table: 2^(1+n)
11	1	<Background Color Index>
12	1	<Pixel Aspect Ratio>
13	?	<Global Color Table(0..255 x 3 bytes) if GCTF is one>
	?	<**Blocks**>
	1	<Trailer> (0x3b)

References

- Dr. Samir H. Abdul-Jauwad home page
- http://www.onicos.com/staff/iz/formats/gif.html
- http://www.wfu.edu/~matthews/misc/graphics/formats/formats.html
- http://en.wikipedia.org/wiki/Image_file_formats