

# Image File Formats - Which format should I use, and when should I use it ?

## Outline:

To help you decide which image file format is the most appropriate for a particular use, you need to consider:

- How images are represented,
- How images can be manipulated,
- The concepts of file compression,
- What image formats are available,
- Which image file formats are most appropriate for specific uses.

## How images are represented:

- Images we are discussing are static (*ie. not changing in time, exclude video*)
- Images are different to *Graphics* (*ie. not geometric models*)
- Main raw digital image type is *Bit-mapped images*
- Digital images are created by **sampling a continuous image** at **discrete intervals**. The discrete points at which the image is sampled are known as **picture elements** or **pixels**
- Images are usually sampled with a rectangular sampling grid of pixels spaced along two sides of a grid. Distance between the grid affects the **accuracy** that the original image is represented (*ie. the resolution of the image*) Optical scanning is usually in "samples per inch".
- The scanning / sampling process quantizes the **intensity values** of the image at the sampled points into **discrete levels**. (*ie. the intensity of each pixel is represented by an integer.*) The number of intensity values used relates to the **quality of the image**.

**Example:** A matrix of 225x170 pixels, where each pixel is represented by an 8-bit integer would allow 256 intensity levels. Hence this image would require an array of 38,250 x 8-bit numbers, a total of 306,000 bits.

## Colours may be specified using different **colour models** and **colour depth**

- **Colour models** (*ie. RGB, CMYK, CIE, HSB, YUV*)  
These *colour models* use 3 or 4 **channels** to represent colour (*ie. RGB=Red Green Blue uses 3, CMYK=Cyan Magenta Yellow Black uses 4, hence 3x8 = 24-bit colour, 4x8 = 32-bit colour.*) Note: computer displays and cameras often use RGB, printers often use CMYK, hence differences in what you see and get printed.
- **Colour depth** is represented by the number of bits per pixel (*ie, 1, 4, 8, 16, 24 or 32*) Pixels with 8-bits can display 256 colours; 24-bits 16.7 million colours; 32-bits billions of colours
- Storage layout of 3 or 4 **channel** colour may either be:
  - **separate:** all R values for all pixels stored, then all G, then all B, etc.
  - **interlaced:** RGB stored for the first pixel, then RGB for next pixel, etc.

## **Compression:**

- **Large amounts of storage space** are required for digital images - eg. A4 24 bit colour (8 bits for RGB) scanned at 300 pixels per inch = 20Mb image.
- **Compression** techniques will **reduce** the **storage space** required, **reduce** the time to **electronically send it**, but will **increase** the **time for processing** the image for display.
- Compression methods can either be **lossy** or **lossless**
- Whilst **lossy** means that some information is lost, the compression algorithms are designed to ensure that the eye, either does not detect the loss, or can fill in any missing details.
- **Compression** methods are usually related to image type. Most types have different standards and saving options. (eg. GIF89a has transparency options, palette options, interlacing options; JPG has compression options, including progressive encoding)
- **Compression** methods often includes optional compression ratio selection. (ie. the higher the compression the greater might be the "loss")

## **Display / Printing device limitations:**

- **Colour Shift** may occur if the Display / Printing device has a limited **colour palette**. (eg. 8-bit device can only display 256 colours at once. Thus, the colours in an image may be shifted by the device.)
- **Dithering** involves approximating colours that are unavailable on a system by grouping pixels of the available colours. (eg. scanning black and white line images will produce many "grays" not just black and white pixels.)
- **Distortion** may occur if **pixel aspect ratio** of devices are different. (eg. Scanner ratio is different to the monitor.) **Pixel aspect ratio** refers to the ratio of pixel width to height. Usually this is square, but some scanners use rectangular pixels.

## **Other Considerations:**

- **Always size the image for the purpose.** Photos can be scanned / rescaned to exactly the size you want, or be resized / resampled in your graphics program.
- **Scanning formulas:**  
screen size (pixels) / nominal photo size (inches) = scan resolution (pixels/inch)  
finished print size / nominal photo size x printer (dpi) = max. scan resolution (pixels/inch)
- **Accessibility:** How easily / how often can you scan / rescan the image?
- **Editing:** How often are you going to edit the scanned image? (Leading to more loss?)
- **Always size images for final web page display, email viewing**  
If your web page is trying to display a picture at 170 x 222, yet your image is actually 1020 x 1500 pixels (over 100 Kb in size), then the web page will load very slowly as the browser tries to resize the image "on the fly". The appearance of the image shown on the web page will not be as clear as if you had created the image at 170 x 222 in the first place. Think about how many pixels there are on a computer screen (800x600) and scale accordingly.  
(Hint: Keep the total size of any webpage (HTML plus images) down to 50 - 60Kb maximum.)

## Common Image Formats:

File types are indicated by the file extension. Different formats have different characteristics.

File Format:	Type and characteristics
.bmp .pbm	<b>Bit maps</b> No compression, raw data, large files
.tif .tiff	<b>Tagged Image Format File</b> Compression is lossless. Use for repeated editing. 24-bit colour <b>Note:</b> big differences between TIFF-RGB (red, green, blue) and TIFF-YC (luminance and chrominance) file size ratio about 1.5:1
.gif	<b>Graphics Interchange Format</b> Compression is lossless ( <i>patented form of LZW2 compression method.</i> ) 8-bit colour ( <i>ie. 256 colours only</i> ). Excellent for small number of plain colours. <i>eg maps, line drawings cartoons, etc.</i> Supports interlacing, transparency and animation. Patent has now expired. <b>Caution:</b> .gif compression may make complex image files bigger!
.jpg .jpeg .jif .jp2	<b>Joint Photographics Expert Group</b> Compression is usually lossy. High compression is possible (50:1) Excellent for continuous tone images such as photographs. 24-bit colour. Progressive encoding is provided - image is progressively built up on the screen. <b>exif 2.2</b> heading <b>meta data</b> has been added to JPEG to include data such as camera, time & date the image was taken, exposure (ISO, shutter, aperture) and other extended camera details. <b>Note:</b> <i>There are 3 levels of definitions within the jpeg standard. Whilst the usual 2 formats are lossy, one level is lossless.</i> <b>New format: JPEG2000 .jp2</b> uses improved compression technique
.png	<b>Portable Network Graphics</b> New standard adopted for the Web. Unlike GIF is not patented. Better lossless compression than GIF, but 24-bit colour. Like GIF supports transparency and interlacing.
.pcd	<b>Photo CD</b> Used by Kodak for Photo CDs. Different image sizes: Base ( <i>ie. 512 x 768</i> ), Base/4, Base/16, Base*4, Base*16 24-bit colour.
.fpx	<b>Flashpix</b> Standard which includes zoomable / scalable images. Designed for storing multiple scaled images in one file.
.wmf .emf	<b>Windows Meta File</b> (Vector graphics format) <b>Extended windows Meta File</b> (Vector graphics format)
.svg	<b>Scalable Vector Graphics</b> (Vector graphics format.) Will become more widely used in the future for scalable web graphics and GPS devices.

## Recommended Formats:

- .tif** for lossless compressed images that will be stored for later editing.
- .jpg** for "finished" colour photographs.  
Use on web pages, with progressive encoding.  
Can print through bureaus. (*eg. Kodak, Rabbit*)
- .gif** for maps and drawings, with few colours. Use on web pages.
- .png** for maps and drawings, with full colours. Use on web pages.