Introduction

Images are made of tiny elements called pixels (picture elements). The higher the number of pixels the higher the resolution of the image will be, hence, more memory is occupied by the image. Image files can be bitmaps or vectors. In this article, we learn about the different types of images, its properties such as colour depth and resolution, how an image is stored in a computer, how images are displayed, and metadata of an image.

Types of image format

There are two types of image files: Bitmaps and vectors. The key difference between bitmaps images and vector graphics is illustrated in the following figure.

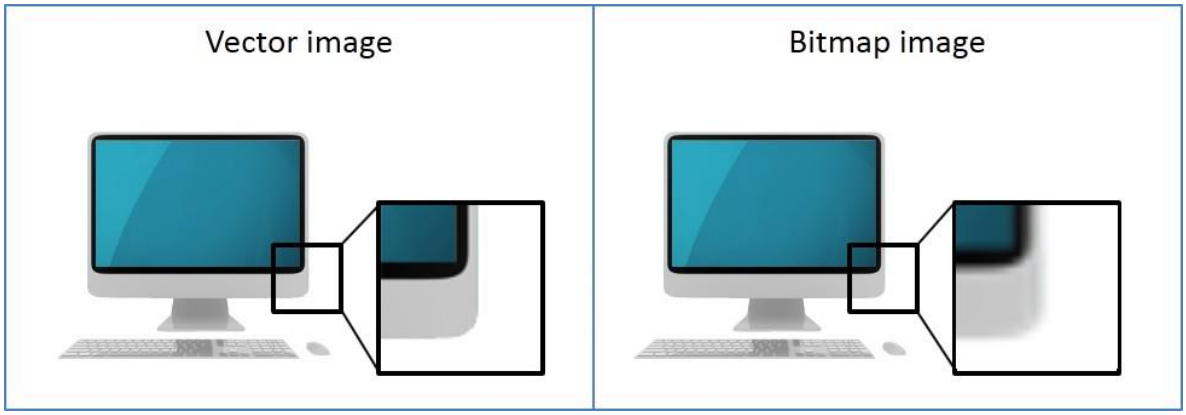


Figure 1: Types of image format

a) Bitmaps

Bitmap images, also known as pixel maps or raster graphics, are made of an organised grid of coloured squares called pixels. When bitmaps are enlarged or zoomed in, the pixels are over-stretched and the image loses quality. JPEG, GIF and PNG are a few examples of bitmaps. These file formats are widely used in digital cameras and smartphones. The colour of each pixel in an image is stored as a binary value. For a black-and-white image, the colour white is represented using the binary value 0 and black is represented using 1.

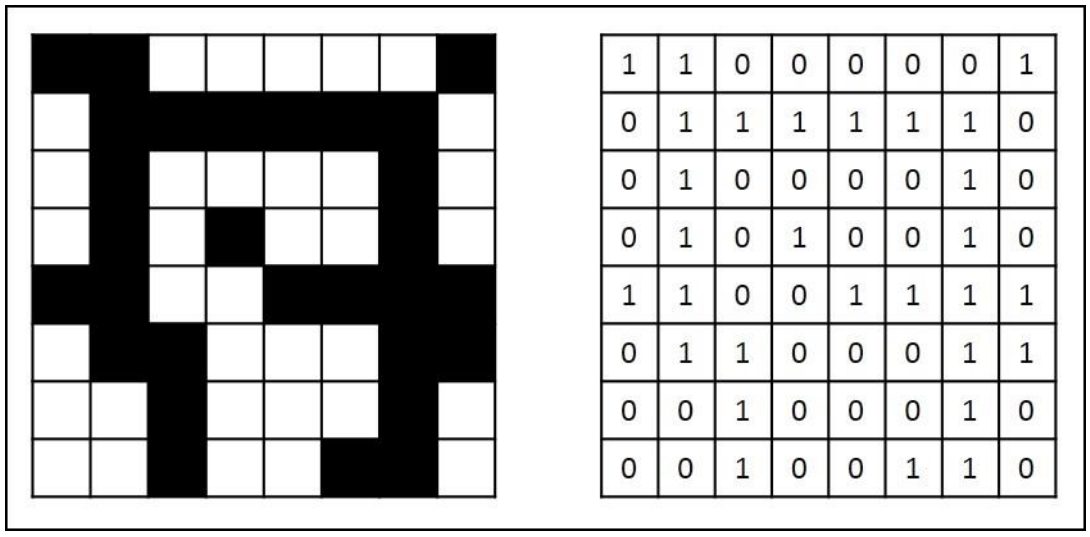
b) Vectors

A vector uses coordinates and geometrical shapes such as lines and curves to define an image. Hence, a vector image is more efficient than a bitmap image, as it needn't store a binary value for each pixel. Vector images do not lose resolution when scaled. Scalable Vector Graphics (SVG) is an example of a vector image. It is an open standard. Vector graphics are widely used in animated movies, Adobe Portable Document Format (PDF), AutoShapes in MS-Office, etc.

Storing and displaying images

Irrespective of the type of image, all images are displayed as a grid of pixels when the output is through a monitor or printer. A vector image is rasterised or converted to a grid of pixels for display.

Let us consider a black-and-white image carrying 8 bytes of data as shown in the figure below. The computer stores binary value 0 for white and binary value 1 for black for each row of the image.



1	1	0	0	0	0	0	1
0	1	1	1	1	1	1	0
0	1	0	0	0	0	1	0
0	1	0	1	0	0	1	0
1	1	0	0	1	1	1	1
0	1	1	0	0	0	1	1
0	0	1	0	0	0	1	0
0	0	1	0	0	1	1	0

Figure 2: Storing a black and white image

This process looks simpler for this 8 byte black and white image. In real-time, this process becomes complex when the number of rows and columns of the image increases and different colours are included.

a) Colour Depth

Colour depth is the number of bits used to indicate the different colours of a pixel. In case of a black-and-white image, the colour depth is 1. A 2-bit colour depth can represent four different colours.

Binary code	Colour
00	White
01	Light grey
10	Dark grey
11	Black

As the number of bits increases, more colours can be used. An image with colour depth n can represent 2^n different colours. Most computer systems and digital systems use a 24-bit system that can represent over 16 million colours per pixel. The following image shows a comparison of two images with two different colour depths.

Figure 3: Effect of colour depth

With an increase in colour depth, the size of the file also increases.

b) Resolution

Resolution (also called pixel density) of an image is measured in dots per inch or pixel per inch. It is the number of pixels or dots in a unit. Magazines and books have higher resolution compared to the images on a computer screen. An image on a website usually has a resolution of 72 dpi. An image in a book has a resolution of 300 or even 600 dpi. An image with a resolution of 300 dpi contains a grid of 300 pixels wide and 300 pixels high in a grid.

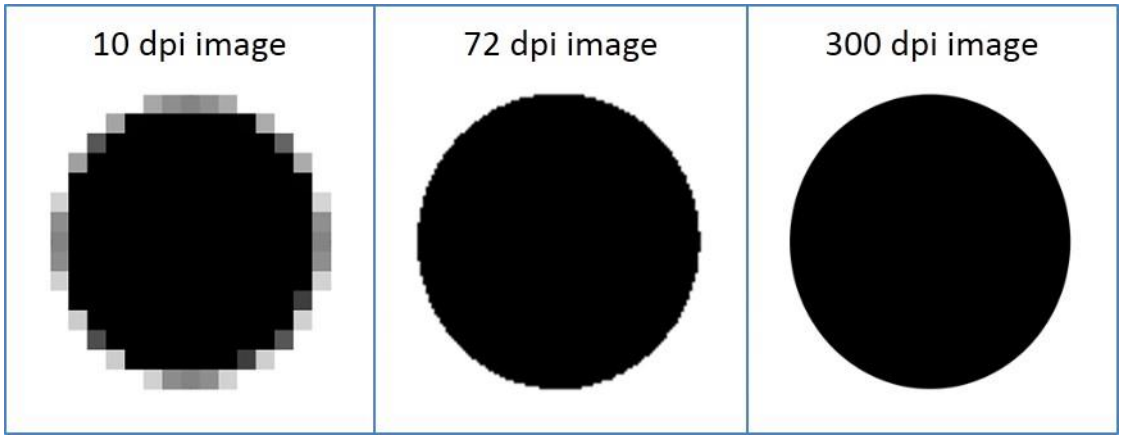


Figure 4: Effect of image resolution

Estimating the size of image file

The size of an image file is estimated by multiplying the width and height of the image in pixels and colour depth in bits per pixel. Let us consider an image with a height of 1010 pixels, width of 562 pixels and colour depth of 8 bits. The file size is 1010 × 562 × 8 = 4540960 bits. This is equal to 4540960 ÷ 8 = 567620 bytes = 0.567 megabytes.

Even though the calculated file is 0.5 MB, the actual file size is considerably less when an image is stored in the form of jpg. This is because of file compression. Large areas of similar data are compressed.

Metadata

Metadata is 'data about data'. An image file has metadata that stores information such as:

- Filename and format
- Dimensions, resolution & colour depth of the image
- Date and place when the photo was taken
- Time and date when the photo was changed
- Camera settings when the photo was taken

A part of the metadata of an image stored in a laptop is shown in the figure below.

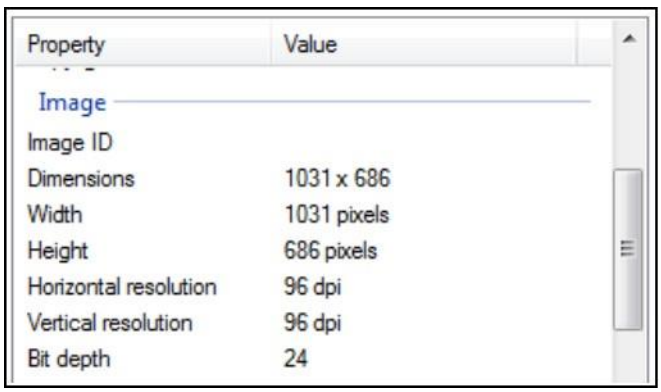


Figure 5: Metadata of an image

Photos captured using a mobile phone when GPS is ON, automatically stores the location exactly where this photo is taken. With an image's metadata, we can find the date, time and location where a photo was captured.