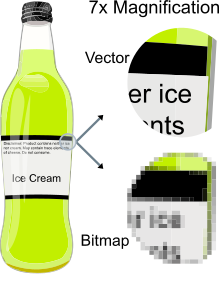
Digital image

A digital image is an image composed of picture elements, also known as pixels, each with finite, discrete quantities of numeric representation for its intensity or gray level that is an output from its two-dimensional functions fed as input by its spatial coordinates denoted with x, y on the x-axis and y-axis, respectively. Depending on whether the image resolution is fixed, it may be of **vector** or **raster** type. By itself, the term "digital image" usually refers to raster images or bitmapped images (as opposed to vector images).

**Vector graphics** are computer graphics images that are defined in terms of points on a Cartesian plane, which are connected by lines and curves to form polygons and other shapes. Vector graphics have the unique advantage over raster graphics in that the points, lines, and curves may be scaled up or down to any resolution with no aliasing. The points determine the direction of the vector path; each path may have various properties including values for stroke color, shape, curve, thickness, and fill.

Vector graphics are commonly found today in the SVG, EPS, PDF or AI types of graphic file formats, and are intrinsically different from the more common raster graphics file formats such as JPEG, PNG, APNG, GIF, and MPEG4.

In computer graphics and digital photography, a **raster graphic** is a dot matrix data structure that represents a generally rectangular grid of pixels (points of color), viewable via a computer display, paper, or other display medium. Raster images are stored in image files with varying dissemination, production, generation, and acquisition formats.

The printing and prepress industries know raster graphics as contones (from "continuous tones"). The opposite of contones is "line work", usually implemented as vector graphics in digital systems.

A **bitmap image** is a rectangular grid of pixels, with each pixel's color being specified by a number of bits. A bitmap might be created for storage in the display's video memory or as a device-independent bitmap file. A raster is technically characterized by the width and height of the image in pixels and by the number of bits per pixel.

**Common pixel** formats are monochrome, gray scale, pelletized, and full color, where color depth determines the fidelity of the colors represented and color space determines the range of color coverage (which is often less than the full range of human color vision). High-resolution digital images are storage intensive, especially at high color-depths.

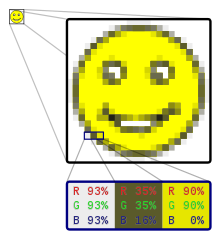
**Raster images** have a finite set of digital values, called picture elements or pixels. The digital image contains a fixed number of rows and columns of pixels. Pixels are the smallest individual element in an image, holding antiquated values that represent the brightness of a given color at any specific point.

Typically, the **pixels are stored** in computer memory as a raster image or raster map, a two-dimensional array of small integers. These values are often transmitted or stored in a compressed form.

**Raster images** can be created by a variety of input devices and techniques, such as digital cameras, scanners, coordinate-measuring machines, seismographic profiling, airborne radar, and more. They can also be synthesized from arbitrary non-image data, such as mathematical functions or three-dimensional geometric models; the latter being a major sub-area of computer graphics. The field of digital image processing is the study of algorithms for their transformation.

# Digital image processing

Digital image processing is the use of a digital computer to process digital images through an algorithm. As a subcategory or field of digital signal processing, digital image processing has many advantages over analog image processing. It allows a much wider range of algorithms to be applied to the input data and can avoid problems such as the build-up of **noise and distortion** during processing.

**Distortion** is the alteration of the original shape (or other characteristic) of something. In communications and electronics it means the alteration of the waveform of an information-bearing signal, such as an audio signal representing sound or a video signal representing images.

In signal processing, **noise** is a general term for unwanted (and, in general, unknown) modifications that a signal may suffer during capture, storage, transmission, processing, or conversion.

**Image resolution** is the detail an image holds. The term applies to raster digital images, film images, and other types of images. Higher resolution means more image detail.

**Image resolution can be measured in various ways.** 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), to the overall size of a picture (lines per picture height, also known simply as lines, TV lines, or TVL), or to angular subtense**. Line pairs** are often used instead of lines; a line pair comprises a dark line and an adjacent light line. A line is either a dark line or a light line. A resolution of 10 lines per millimeter means 5 dark lines alternating with 5 light lines, or 5 line pairs per millimeter (5 LP/mm).

The term **resolution is often considered equivalent to pixel count** in digital imaging, though international standards in the digital camera field specify it should instead be called "Number of Total Pixels" in relation to image sensors, and as "Number of Recorded Pixels" for what is fully captured.

An image of N pixels height 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 7680 × 6876.

Image resolution is typically described in PPI, which refers to how many pixels are displayed per inch of an image. Higher resolutions mean that there more pixels per inch (PPI), resulting in more pixel information and creating a high-quality, crisp image.

### Spatial resolution

The measure of how closely lines can be resolved in an image is called spatial resolution, and it depends on properties of the system creating the image, not just the pixel resolution in pixels per inch (ppi). For practical purposes the clarity of the image is decided by its spatial resolution, not the number of pixels in an image. In effect, spatial resolution refers to the number of independent pixel values per unit length. The spatial resolution of consumer displays range from 50 to 800 pixel lines per inch.

### Temporal resolution

Temporal resolution (TR) refers to the precision of a measurement with respect to time. Movie cameras and high-speed cameras can resolve events at different points in time. The time resolution used for movies is usually 24 to 48 frames per second (frames/s), whereas high-speed cameras may resolve 50 to 300 frames/s, or even more.

Temporal resolution for a continuous capture system such as video, this is the number of images captured in a given time period. It is commonly quoted in frames per second (fps), where each individual image is referred to as a video frame (e.g. commonly broadcast TV operates at 25 fps; 25-30 fps is suitable for most visual surveillance; higher frame-rate cameras are available for specialist science/engineering capture).

**Bit resolution**

This defines the number of possible intensity/color values that a pixel may have and relates to the quantization of the image information. For instance a binary image has just two colors (black or white), a grey-scale image commonly has 256 different grey levels ranging from black to white whilst for a colour image it depends on the colour range in use. The bit resolution is commonly quoted as the number of binary bits required for storage at a given quantization level, e.g. binary is 2 bit, grey-scale is 8 bit and colour (most commonly) is 24 bit. The range of values a pixel may take is often referred to as the dynamic range of an image.