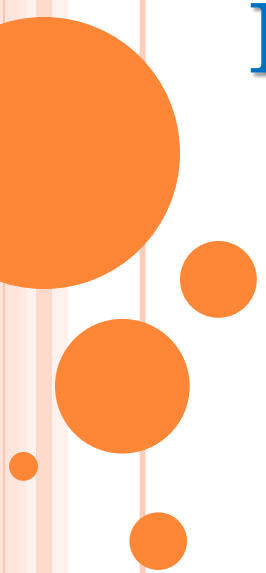
# Image processing

## Introduction



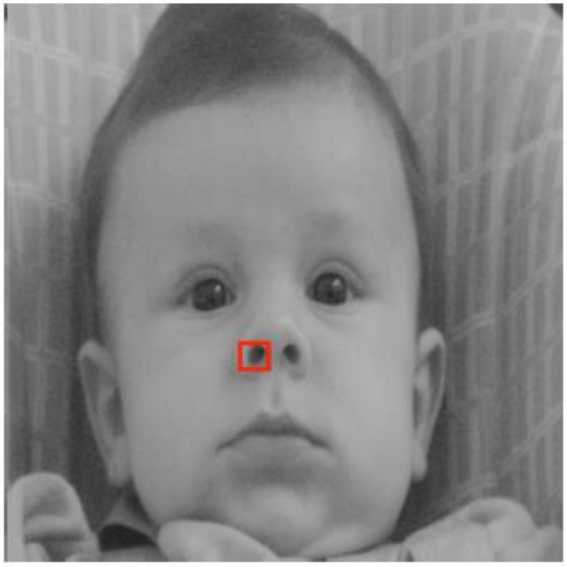
## Ch1-Part 2

# Image Resolution

In computers, resolution is the number of pixels (individual points of color) contained on a display monitor, expressed in terms of the number of pixels on the horizontal axis and the number on the vertical axis. The sharpness of the image on a display depends on the resolution and the size of the monitor. The same pixel resolution will be sharper on a smaller monitor and gradually lose sharpness on larger monitors because the same numbers of pixels are being spread out over a larger number of inches.

Still pictures which (uncompressed) are represented as a bitmap (a grid of pixels). Pixels are the building blocks of every digital image. Clearly defined squares of light and color data are stacked up next to one another both horizontally and vertically. Each picture element (pixel for short) has a dark to light value from 0 (solid black) to 255 (pure white). (Figure 1.9)

# Image Resolution



| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 99 | 71 | 61 | 51 | 49 | 40 | 35 | 53 | 86 | 99 |
| 93 | 74 | 53 | 56 | 48 | 46 | 48 | 72 | 85 | 102 |
| 101 | 69 | 57 | 53 | 54 | 52 | 64 | 82 | 88 | 101 |
| 107 | 82 | 64 | 63 | 59 | 60 | 81 | 90 | 93 | 100 |
| 114 | 93 | 76 | 69 | 72 | 85 | 94 | 99 | 95 | 99 |
| 117 | 108 | 94 | 92 | 97 | 101 | 100 | 108 | 105 | 99 |
| 116 | 114 | 109 | 106 | 105 | 108 | 108 | 102 | 107 | 110 |
| 115 | 113 | 109 | 114 | 111 | 111 | 113 | 108 | 111 | 115 |
| 110 | 113 | 111 | 109 | 106 | 108 | 110 | 115 | 120 | 122 |
| 103 | 107 | 106 | 108 | 109 | 114 | 120 | 124 | 124 | 132 |

Figure 1.9: Represent each pixel part of Image by digits Between (0-255).

The Image as a input it's scanned for photographs or pictures using a digital scanner or from a digital camera and May also be generated by programs similar to graphics or animation programs, Analog sources will require digitizing.

# Image Resolution

A display with 240 pixel columns and 320 pixel rows would generally be said to have a resolution of 240×320. Resolution can also be used to refer to the total number of pixels in a digital camera image. For example, a camera that can create images of 1600x1200 pixels will sometimes be referred to as a 2 megapixel resolution camera since 1600 x 1200 = 1,920,000 pixels, or roughly 2 million pixels. Where a megapixel (that is, a million pixels) is a unit of image sensing capacity in a digital camera. In general, the more megapixels in a camera, the better the resolution when printing an image in a given size.

There are three types of resolution measuring different aspects of the quality, detail and size of an image:

- Color resolution
- Image resolution
- Display resolution

# Image Resolution

There are three types of resolution measuring different aspects of the quality, detail and size of an image:

- Color Resolution / Color Depth: Color depth describe the number of bits used to represent the color of a single pixel.
- Image Resolution: The term resolution often associated with an image's degree of detail or quality.
- Display Resolution: Resolution also can refer to quality capability of graphic output (monitor).

# Image Representation

The digital image I (r, c) is represented as a two- dimensional array of data, where each pixel value corresponds to the brightness of the image at the point (r, c). in linear algebra terms , a two-dimensional array like our image model I( r, c ) is referred to as a matrix , and one row ( or column) is called a vector. The image types we will consider are:

- **Binary Image**
- **GrayScale Image**
- **Color Image**
- **Multispectral Images**

# Binary Image

These images have two possible values of pixel intensities: black and white.

Also called 1-bit monochrome image, since it contains only black and white.

Typical applications of binary images include office/business documents, handwritten text, line graphics, engineering graphics etc. The scanned output contains a sequence of black or white pixels. Binary 0 represents a black pixel and binary 1 represents a white pixel.(Figure 1.10)

Figure 1.10: Example of Binary Image.

# Grayscale Image

They contain several shades of grey. The number of different brightness level available. (0) value refers to black color, (255) value refers to white color, and all intermediate values are different shades of gray varying from black to white.

Typical applications of grayscale images include newspaper photographs (non-color), magnetic resonance images and cat-scans.

An uncompressed grayscale image can be represented by n bits per pixel, so the number of gray levels supported will be $2^n$.

For example, 8-bit Grayscale Image. It consists of 256 gray levels. A dark pixel might have a pixel value of 0, a bright one might be 255. (Figure 1.11)

Figure 1.11: Example of Grayscale Image.

# Color Image

They are characterized by the intensity of three primary colors (RGB).The actual information stored in the digital image data is brightness information in each spectral band. When the image is displayed, the corresponding brightness information is displayed on the screen by picture elements that emit light energy corresponding to that particular color.

For example, 24-bit image or 24 bits per pixel. There are 16,777,216 (224) possible colors. In other words, 8 bits for R(Red), 8 bits for G(Green), 8 bits for B(Blue). Since each value is in the range 0-255, this format supports 256 x 256 x 256 or 16,777,216 different colors. (Figure 1.12 & 1.13)

Figure 1.12: Example of color Image.

# Color Image

For many applications, RGB color information is transformed into mathematical space that decouples the brightness information from the color information.

The hue/saturation /lightness (HSL) color transform allows us to describe colors in terms that we can more readily understand.

The lightness is the brightness of the color, and the hue is what we normally think of as "color" and the hue (ex: green, blue, red, and orange). The saturation is a measure of how much white is in the color (ex: Pink is red with more white, so it is less saturated than a pure red).

**An important point:** many 24-bit color images are actually stored as 32-bit images, with the extra byte of data for each. These are Called RGBA / 32-bit images.

Allows RGBA color scheme; Red, Green, Blue, Alpha.
8Pixel used to store an alpha value representing the degree of "transparency".

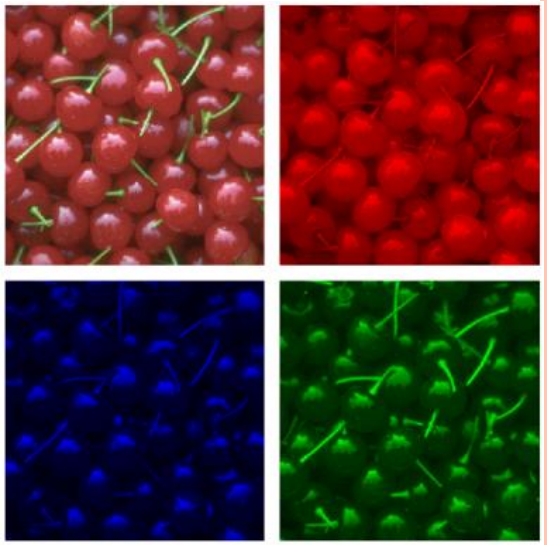


Figure 1.13:Typical RGB color image can be thought as three separate images.

# Multispectral Images

A multispectral image is one that captures image data within specific wavelength ranges across the electromagnetic spectrum. The wavelengths may be separated by filters or by the use of instruments that are sensitive to particular wavelengths, including light from frequencies beyond the visible light range, i.e. infrared and ultra-violet. Spectral imaging can allow extraction of additional information the human eye fails to capture with its receptors for red, green and blue. It was originally developed for space-based imaging.( Figure 1.14)

Figure 1.14: Example of multispectral Image.

# Computer Graphics

There are two kinds of computer graphics depend on types of Image data:

1. Bitmap image (or raster image): can represented by the image model I(r, c). Bitmap is a simple matrix of the tiny dots called pixel that forms a raster or bitmap image. Each pixel data is corresponding to brightness value stored in file format.
2. Vector images: refer to the methods of representing lines, curves shapes by storing only the key points. These key points are sufficient to define the shapes, and the process of Turing theses into an image is called rending after the image has been rendered, it can be thought of as being in bit map format where each pixel has specific values associated with it.

# BITMAP-FILE STRUCTURE

The bitmap file structure is very simple and consists of a bitmap-file header, a bitmap-information header, a color table, and an array of bytes that define the bitmap image. The file has the following form:

**File Header Information**
**Image Header Information**
**Colour Table (if present)**

The bitmap file header contains information about the type, size, and layout of a bitmap file and permits a check as to the type of file the user is reading.

The bitmap-information header specifies the dimensions, compression type, and color format for the bitmap.

The final entries in the bitmap information section are the number of color map entries and the number of significant colors.

Additionally, with some of the more complex file formats, the header may contain information about the type of compression used and other necessary parameters to create the image, I(r,c).

# Image File Format

Image file formats are standardized means of organizing and storing digital images. Image files are composed of digital data in one of these formats that can be rasterized for use on a computer display or printer. An image file format may store data in uncompressed, compressed, or vector formats. Once rasterized, an image becomes a grid of pixels, each of which has a number of bits to designate its color equal to the color depth of the device displaying it.

Here are some of the most important types of image file formats

**1-BMP file format:**

Windows bitmap handles graphic files within the Microsoft Windows OS. Typically, BMP files are uncompressed, and therefore large and lossless; their advantage is their simple structure and wide acceptance in Windows programs.

**2-GIF file format:**

(Graphic Interchange Format) is an uncompressed file format that supports only 256 distinct colors. Best used with web clip art and logo type images. GIF is not suitable for photographs because of its limited color support.

# Image File Format

**3-PNG file format:**

The PNG (Portable Network Graphics) file format was created as a free, open-source alternative to GIF. The PNG file format supports eight-bit paletted images (with optional transparency for all palette colors) and 24-bit truecolor (16 million colors) or 48-bit truecolor with and without alpha channel - while GIF supports only 256 colors and a single transparent color.

PNG is designed to work well in online viewing applications like web browsers and can be fully streamed with a progressive display option. PNG is robust, providing both full file integrity checking and simple detection of common transmission errors.

**4-JPEG file format:**

Joint Photographic Expert Group is a compressed file format that supports 24 bit color (millions of colors). This is the best format for photographs to be shown on the web or as email attachments. This is because the color informational bits in the computer file are compressed (reduced) and download times are minimized

# Image File Format

**5-TIFF file format:**

Format Tag Image File is an uncompressed file format with 24 or 48 bit color support. Uncompressed means that all of the color information from your scanner or digital camera for each individual pixel is preserved when you save as TIFF. TIFF is the best format for saving digital images that you will want to print. Tiff supports embedded file information, including exact color space.