

# Digital image processing

## (Introduction & Fundamentals)

Digital image processing is an area characterized by the need for extensive experimental work to establish the viability of proposed solution to a given problem. Digital image processing is concerned with computer processing of pictures, or more generally, images that have been converted into a numeric form.

**Image sources:** The basic function of an image source is to represent the distribution of light energy in an image as an electronic signal which may be communicated to a computer for storage and subsequent analysis or enhancement. These images that have been sources, for example digital cameras, scanner, satellite sensors, Sources may be classified as:

- Area scan or line scan. The linear array itself may be progressively moved across a static object as in the case of document scanner.
- Standard scan formats from broadcast television system or non-standard scan format include moonshot operation and multi-frame scanning
- Visible sources are covered on cameras, or non-visible spectral responsive to infrared-red, ultra-violet, X-ray radiation

### Picture & image:

**Picture:** An individual painting, drawing or other representation on a surface of an objects such a representation as a work of art.

**Image:** A digital representation of an optical scene logos or graphs.

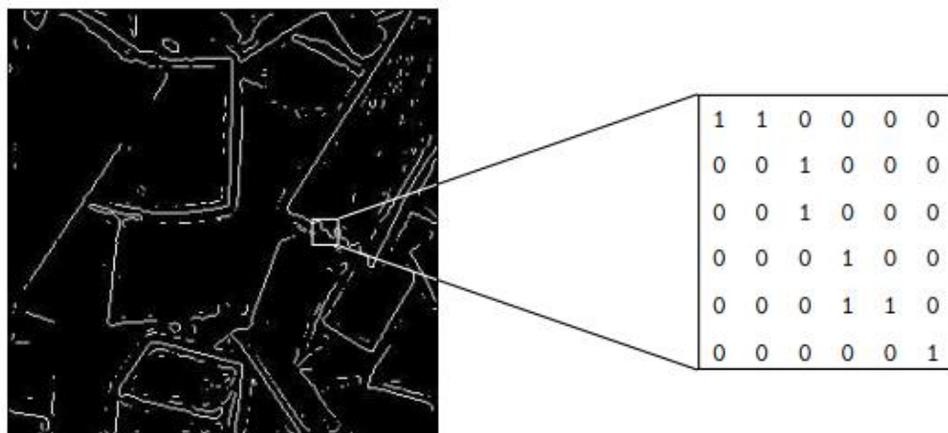
## Image representation:

- \*Image usually represented as a matrix of cells called pixel.
- \*Every pixel in image has the same particular strong size.
- \*Depending on pixel's strong size images can be classified.
- \*Spectral resolution also depends on size of a pixel.

## Types of image (Image classified):

### A-Single band image:

- \* Binary image (1 bit for one pixel) (color value 0 or 1). See Fig. (1)
- \*Intensity image pixel (8 bits for one pixel) (color value 0-255). See Fig.(2)
- \*Intensity image pixel can be more than 8 bits for example 16 or 32 bits, and that depends on spectral resolution.



**Figure (1): Binary Image.**

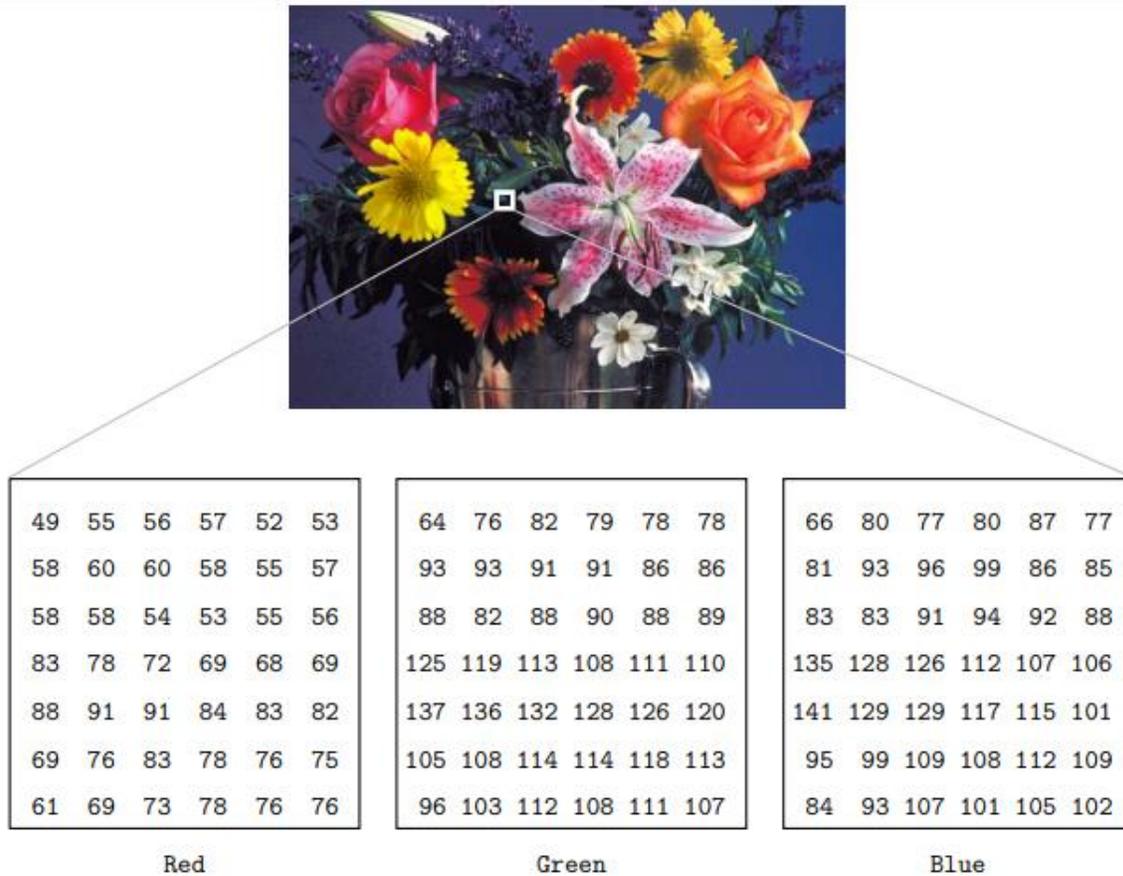


**Figure (2): A greyscale image**

### **B-Multi band images:**

\*Three bands (red, green, and blue(RGB)) (3x8 bits for one pixel) (color value 0-255 for each band of pixel). This gives a total of  $256^3 = 16777216$  different possible colors in the image. See Fig.(3)

\*Number of bands can be more than three such as data of the USGS (the united states geological survey) for example land sat which has 8 bands.



**Figure (3):\_A true color image**

### **Digital Image Basics:**

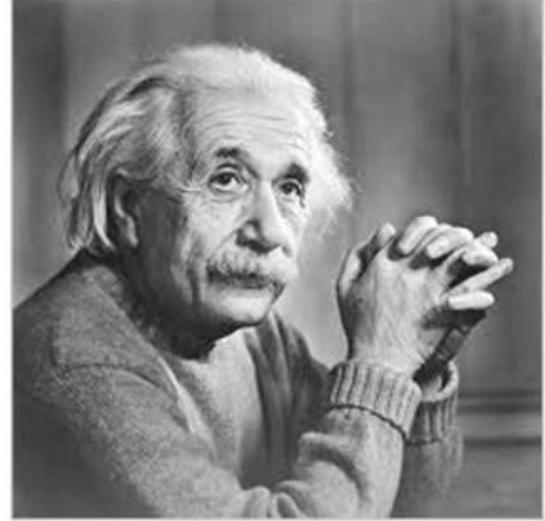
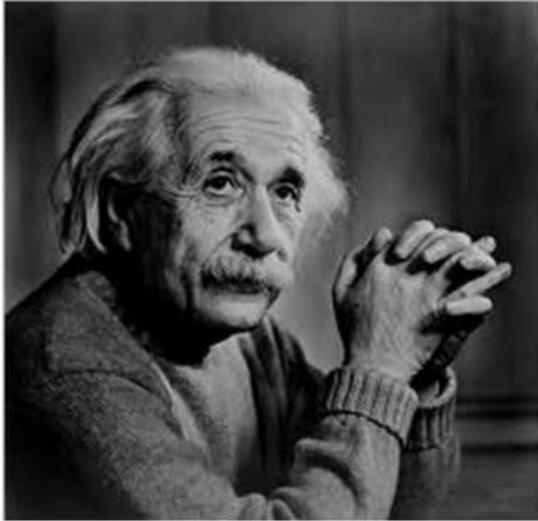
- An image may be define as a two dimensional function  $f(x,y)$ , where  $x$  and  $y$  are spatial coordinates and the amplitude at any pair of coordinates  $(x,y)$  is called intensity or gray level of the image at that point. When  $x$ ,  $y$  and the amplitude values of all are finite discrete quantities, we call the image digital image.
- A digital image is composed of a finite number of elements each of which has a particular location or value. These elements are referred to as pixels or image elements or picture elements or pixels elements.

- Gray level refers to a scalar measure of intensity that ranges from black to grays and finally to white or refer to the intensity of monochromic images.
- Color images are formed by a combinations of individual 2-D images. For examples, in the RGB color system, a color image consists of three individual component images.
- An image may be continuous with respect to the x and y – coordinates and also in amplitude. See Figure (4).



**Figure (4): Continuously varying intensities**

- Converting such an image to digital form requires that the coordinates as well as the amplitude be digitizes.
- Digitization the coordinate values is called **sampling**; Digitization the amplitude values is called **quantization**.
- The range of values spanned by the gray scale is called **dynamic range of an image**. Image will have high contrast, if the dynamic range is high and image will have dull washed out gray look if the dynamic range is low.
- The spatial coordinates of a digital image (x,y) are proportional to brightness. Brightness is a relative term. It depends on your visual perception. Since brightness is a relative term, so brightness can be defined as the amount of energy output by a source of light relative to the source we are comparing it to. In some cases we can easily say that the image is bright, and in some cases, its not easy to perceive



- We can easily see, that the image on the right side is brighter as compared to the image on the left.
- But if the image on the right is made more darker then the first one, then we can say that the image on the left is more brighter then the left.
- in DIP “intensity” is a numerical value which represents a pixel, i.e. for a 8-bit gray scale image the value of a pixel can be in the range of  $[0,255]$ , where (generally) numerical “0” represents black color and numerical “255” represents white color. Therefore, the higher the value of a pixel, i.e. intensity, the pixel will appear to be more whiter.
- Whereas, “brightness” is a relative term which can be understood visually. If two pixels (say, pixel1 and pixel2) of an image have intensity values, 125 and 210 respectively, then pixel2 is brighter than pixel1.
- Brightness of an object is the perceived luminance of the surround.
- Two objects with different surroundings would have identical luminance but different brightness.
- Luminance measured in lumens (lm), gives a measure of the amount of energy an observer perceives from a light source.

- **Illumination** is the amount of source light incident on the scene. It is represented as  $i(x, y)$ . **Reflectance** is the amount of light reflected by the object in the scene. It is represented by  $r(x, y)$ .
- **Subjective brightness** means intensity as preserved by the human visual system. **Brightness adaptation** means the human visual system can operate only from scotopic to glare limit. It cannot operate over the range simultaneously. It accomplishes this large variation by changes in its overall intensity.
- Machband effect means the intensity of the stripes is constant. Therefore it preserves the brightness pattern near the boundaries, these bands are called as **Machband effect**.
- **Shrinking of image** may be viewed as under sampling. To shrink an image by one half, we delete every row and column. To reduce possible aliasing effect, it is a good idea to blue an image slightly before shrinking it.
- **Hue** is a color attribute that describes a pure color where **saturation** gives a measure of the degree to which a pure color is diluted by white light.
- **Resolution** is defined as the smallest number of discernible detail in an image. Spatial resolution is the smallest discernible detail in an image and gray level resolution refers to the smallest discernible change is gray level.
- Every pixel has number of bits (k)
- The number of bits required to store a digital image is:

$$S=N \times M \times k$$

$N \times M$ : Number of pixels

$L$  is max of gray levels. the number of gray levels typically is an integer power of 2 i.e.  $L = 2^k$ . See table (1).

- Measure unit in digital image Ppi or Dpi i.e the number of pixels in determine area (one inch).
- Image resolution =(150-300 )Ppi in design print of paper.

- Image resolution =69Ppi to store the image and display on the computer screen.
- Image resolution =72Ppi to post the image in internet.
- Convert the image resolution from pixels to inch:
- Length the image in inch=image length in pixel/Ppi
- width the image in inch=image width in pixel/Ppi
- Zooming may be viewed as over sampling. It involves the creation of new pixel locations and the assignment of gray levels to those new locations.
- The real image compressed to keep memory before it be stored using algorithms, that depend on encoding technique (PCX, Bmp, TGA , TIFF, JPG,....).

Table (1)

Number of storage bits for various values of  $N$  and  $k$ .

$N/k$	1 ( $L = 2$ )	2 ( $L = 4$ )	3 ( $L = 8$ )	4 ( $L = 16$ )	5 ( $L = 32$ )	6 ( $L = 64$ )	7 ( $L = 128$ )	8 ( $L = 256$ )
32	1,024	2,048	3,072	4,096	5,120	6,144	7,168	8,192
64	4,096	8,192	12,288	16,384	20,480	24,576	28,672	32,768
128	16,384	32,768	49,152	65,536	81,920	98,304	114,688	131,072
256	65,536	131,072	196,608	262,144	327,680	393,216	458,752	524,288
512	262,144	524,288	786,432	1,048,576	1,310,720	1,572,864	1,835,008	2,097,152
1024	1,048,576	2,097,152	3,145,728	4,194,304	5,242,880	6,291,456	7,340,032	8,388,608
2048	4,194,304	8,388,608	12,582,912	16,777,216	20,971,520	25,165,824	29,369,128	33,554,432
4096	16,777,216	33,554,432	50,331,648	67,108,864	83,886,080	100,663,296	117,440,512	134,217,728
8192	67,108,864	134,217,728	201,326,592	268,435,456	335,544,320	402,653,184	469,762,048	536,870,912