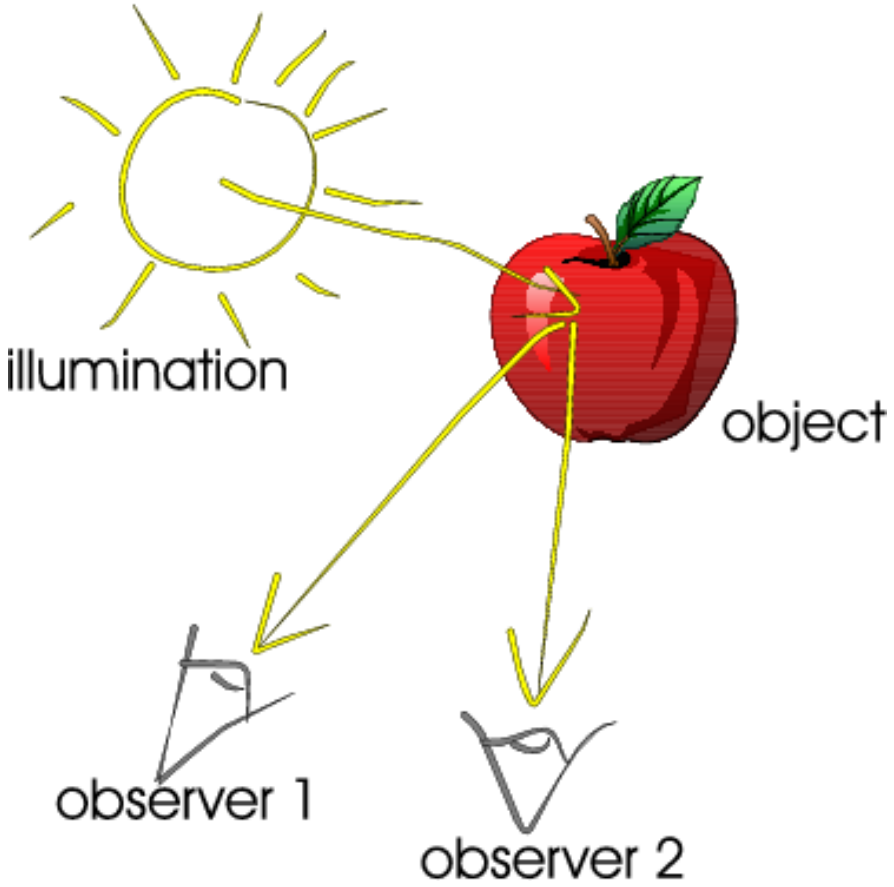
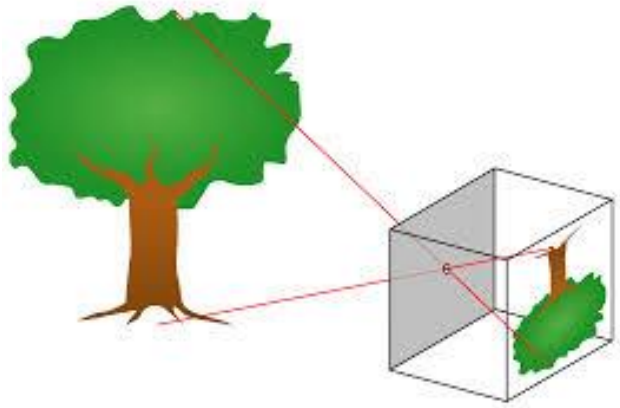
Image Formation and Representation

DUANGPEN JETPIPATTANAPONG

Digital Image Formation

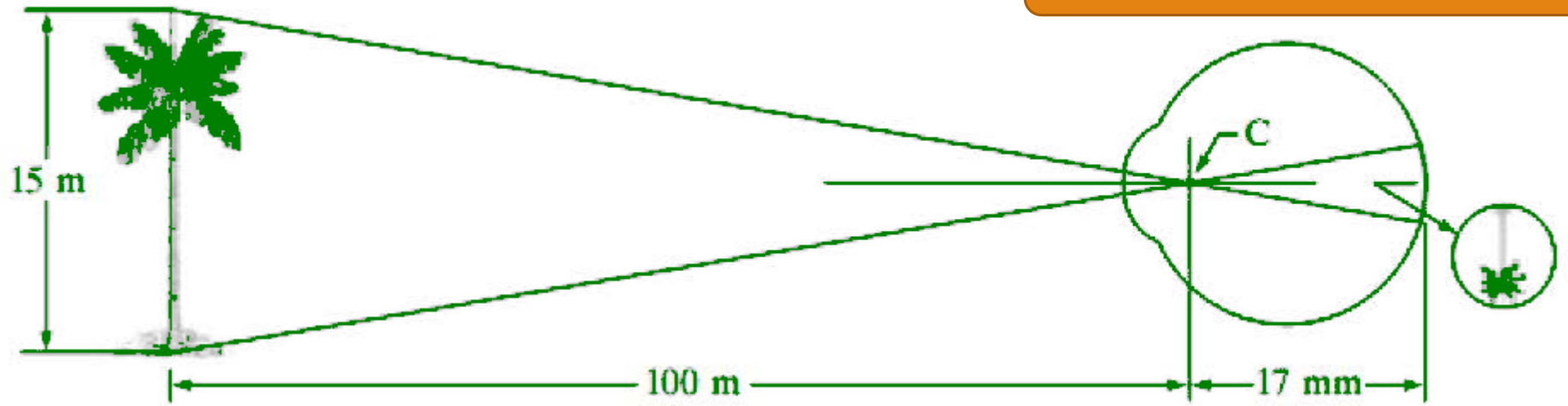
Components of Image Formation

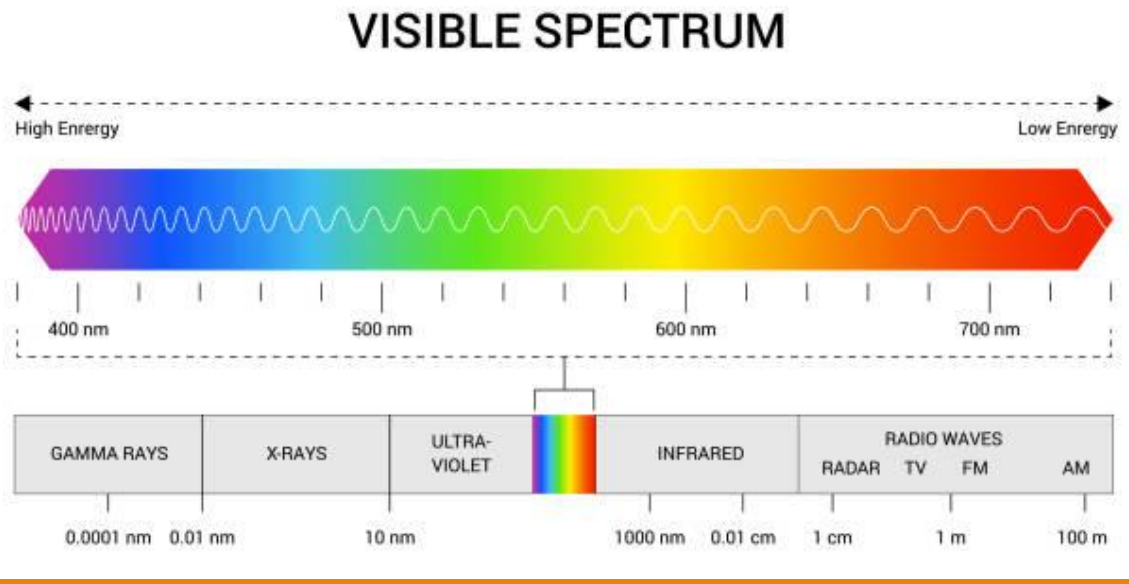




- Illumination
- Reflectance of surface
- Image Receiver : Sensor, Retina

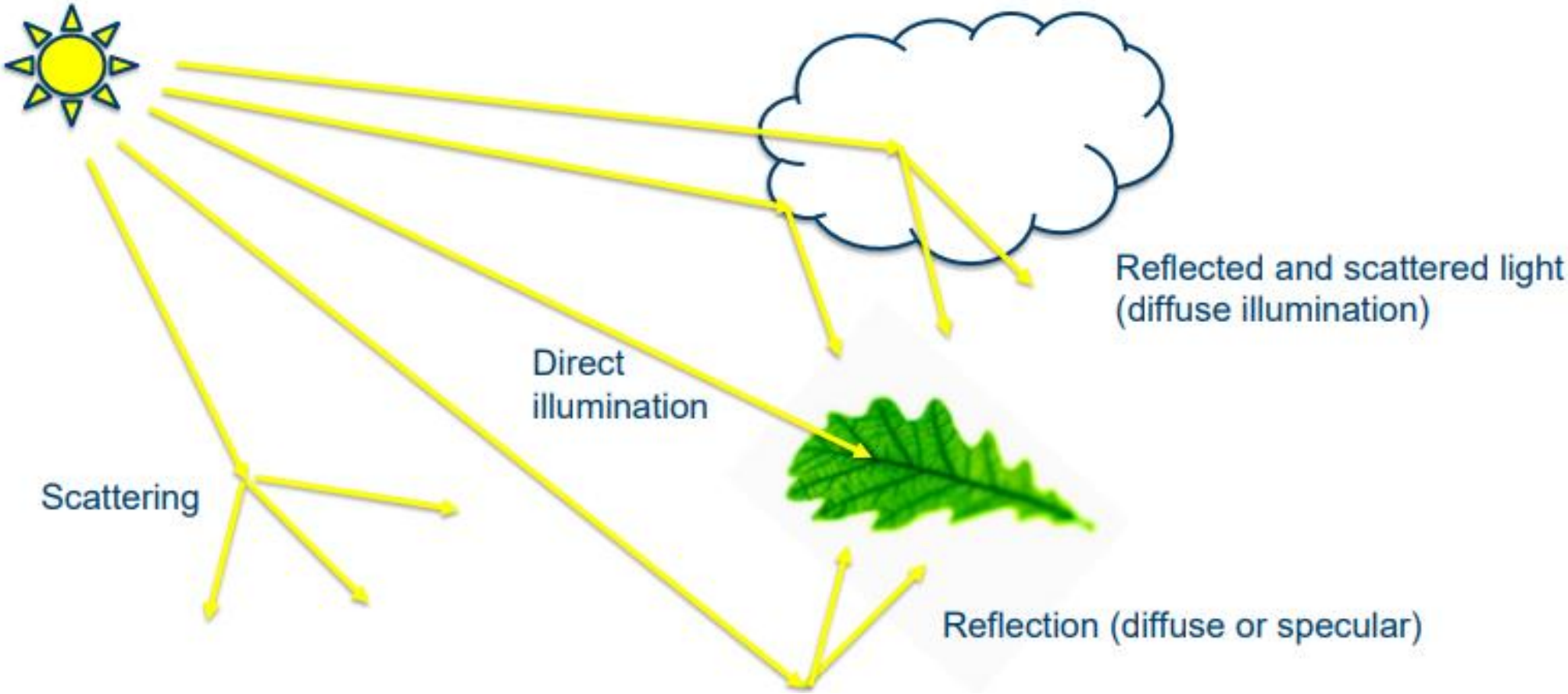
Human Sensitivity





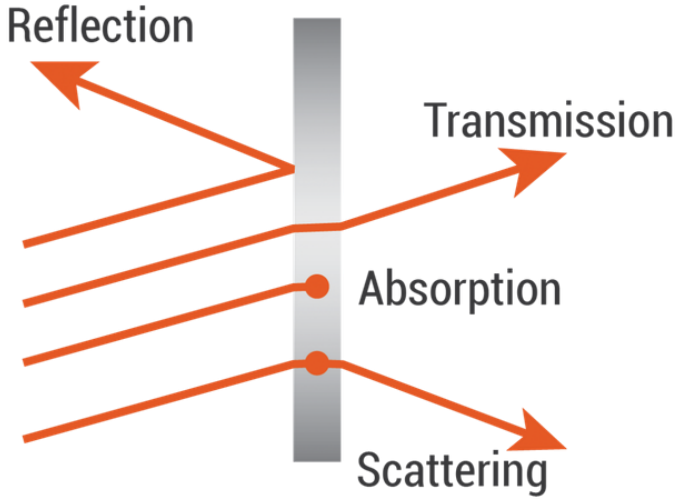
- Light produces the psychological sensation when it impinges on our eyes and excites our visual sense.
- The peak spectral sensitivity of a human observer happens at 555 *nm wavelength.*
- Visible light waves measure anywhere from around 380 nm to about 740 nm

Illumination

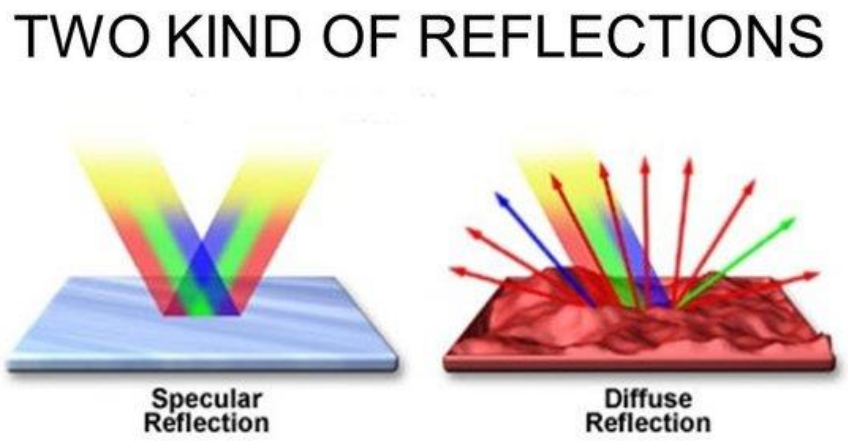


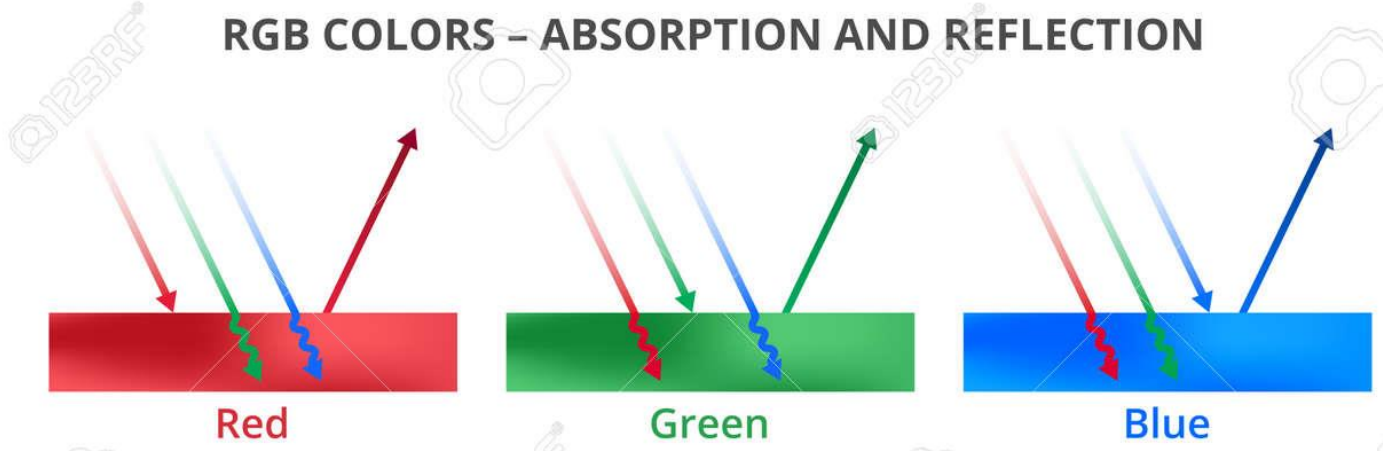
Direct Illumination and Indirect Illumination

Reflectance of surface

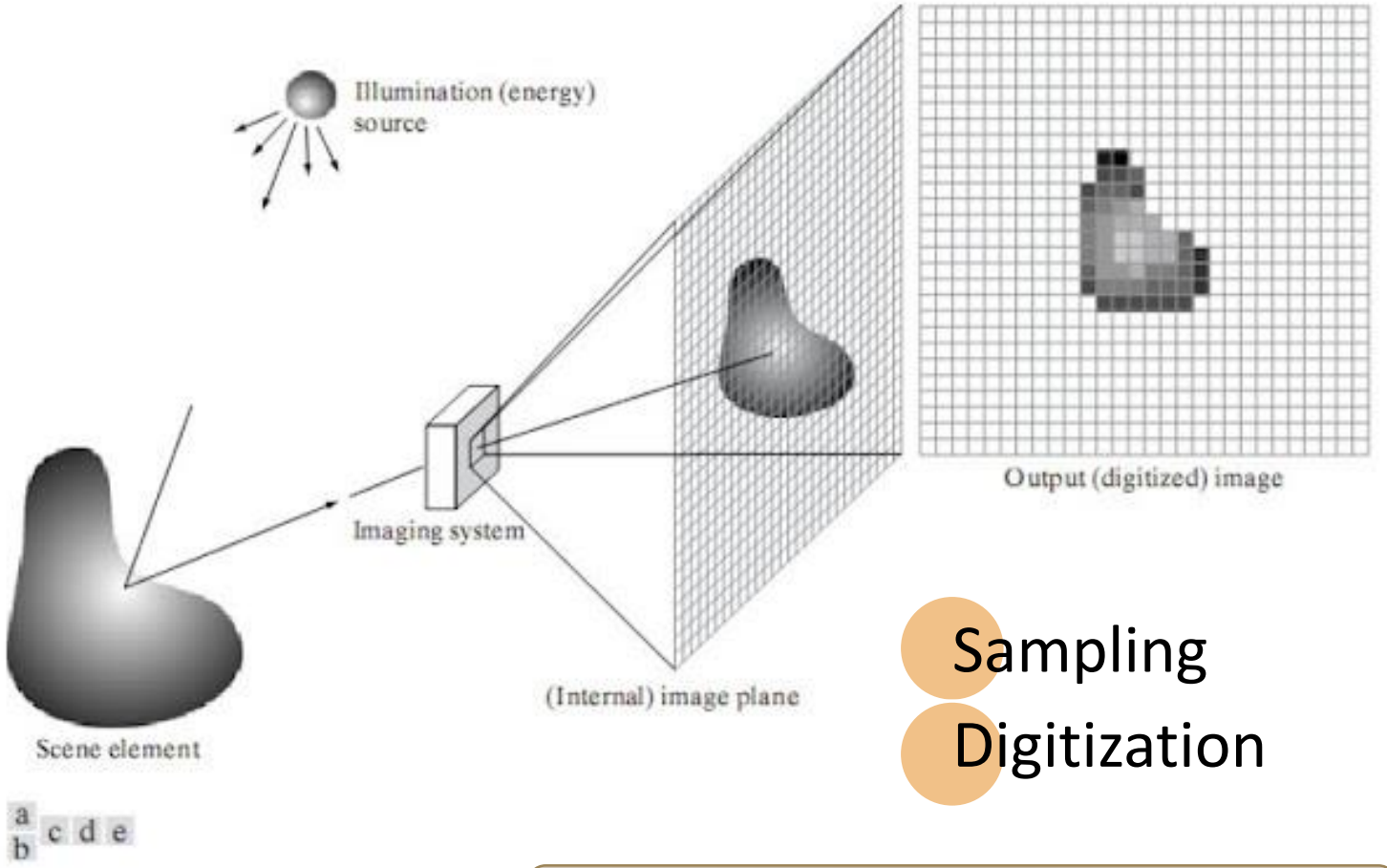


Some surfaces may be perfectly absorbing (e.g., black absorbing surfaces), which absorb the entire incident luminous flux and do not reflect any light.





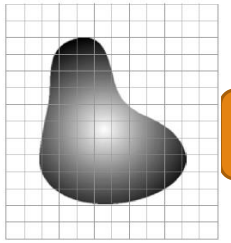
Digital Image Formation



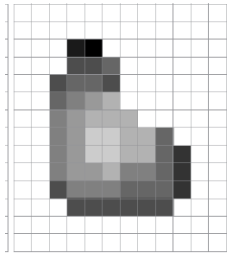
a b c d e

Sampling

Digitization



Analog Image



Digital Image

Sensor

SAMPLING AND QUANTIZATION

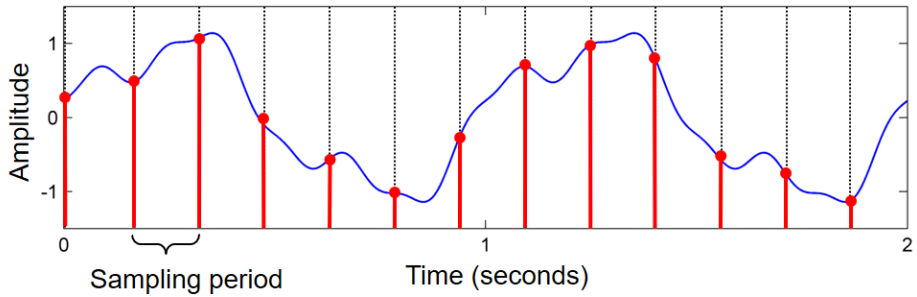
Sampling

Partitioning the image at a finite number of point

Quantization

Representation each sample within the finite work size of he computer

Figure 2.13 from [Müller, FMP, Springer 2015]



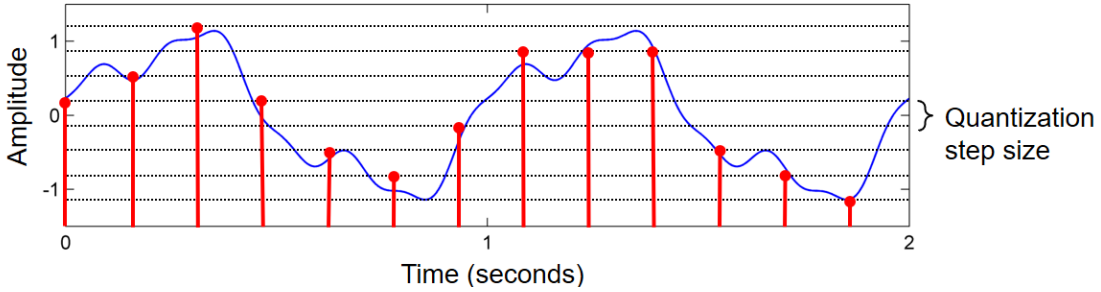


Image Sampling

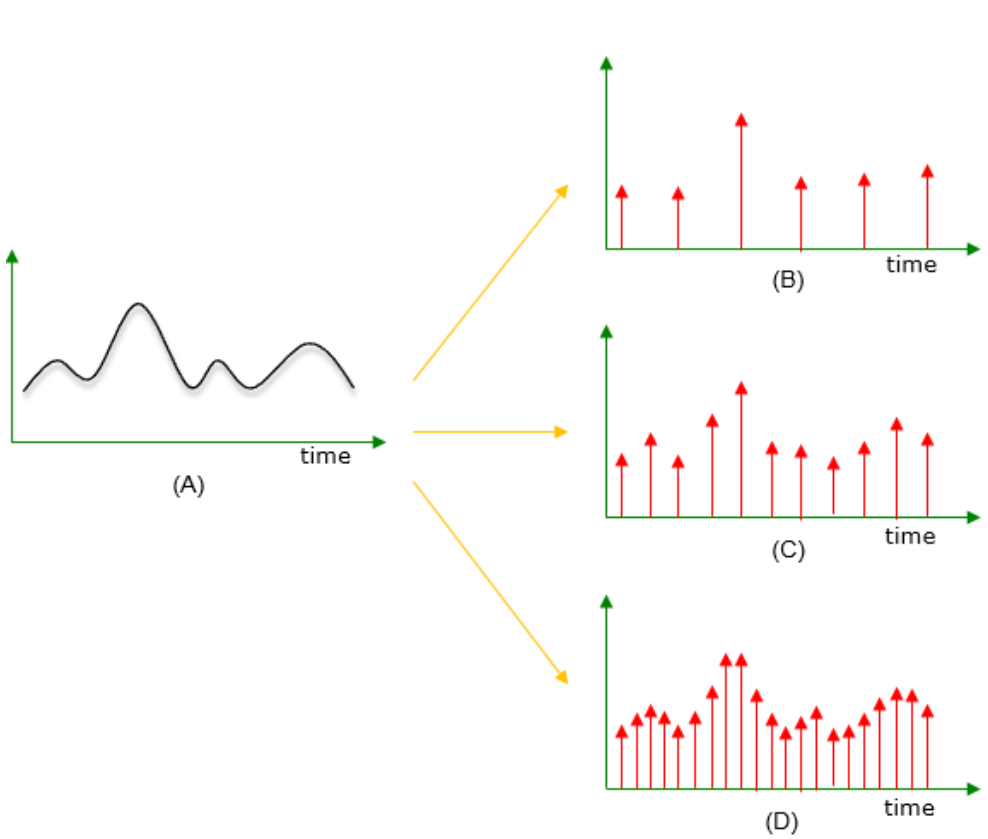
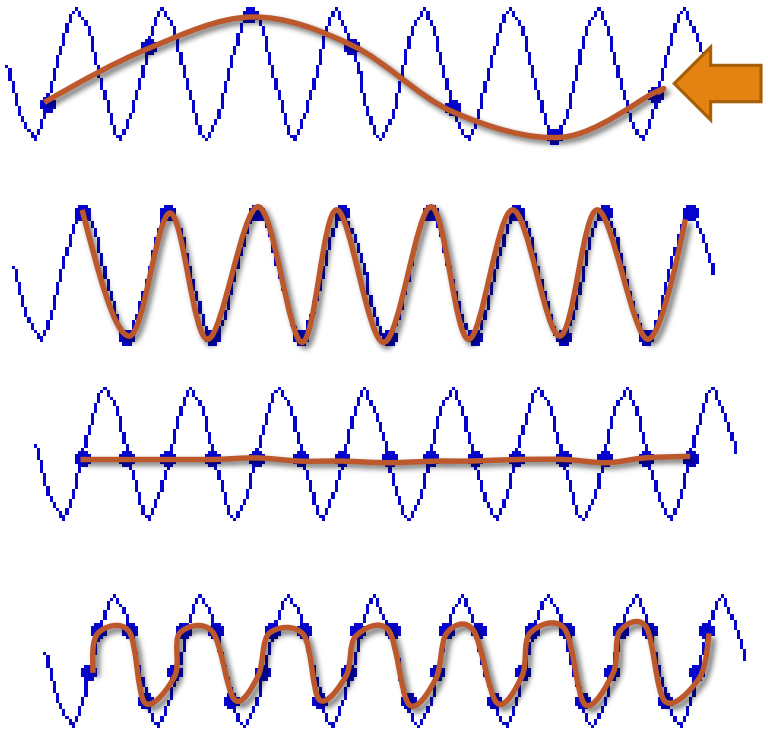
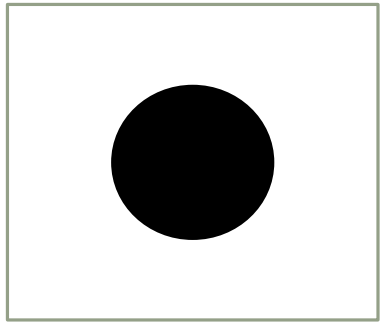


Image Sampling

The sampling period, according to Nyquist criterion, should be smaller than or at the most equal to half of the period of the finest detail present within an image.





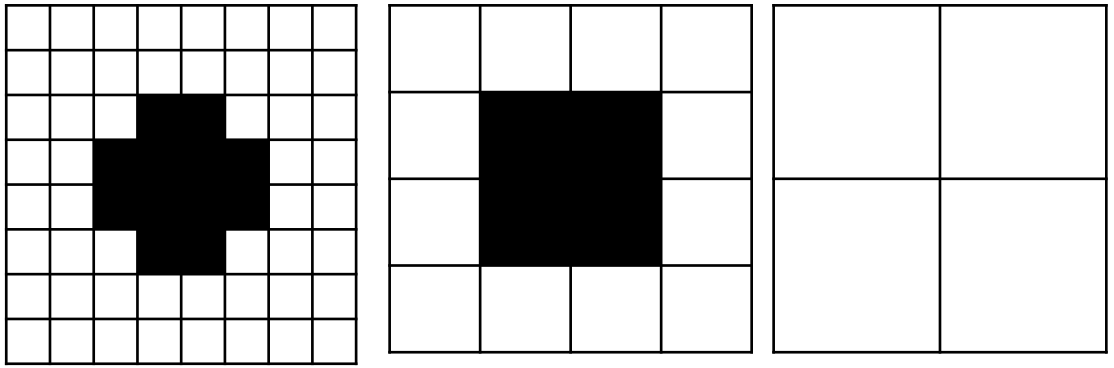
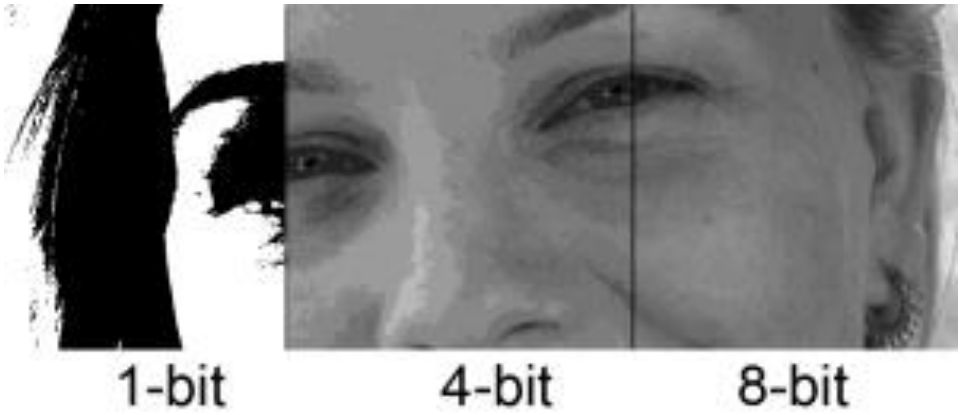
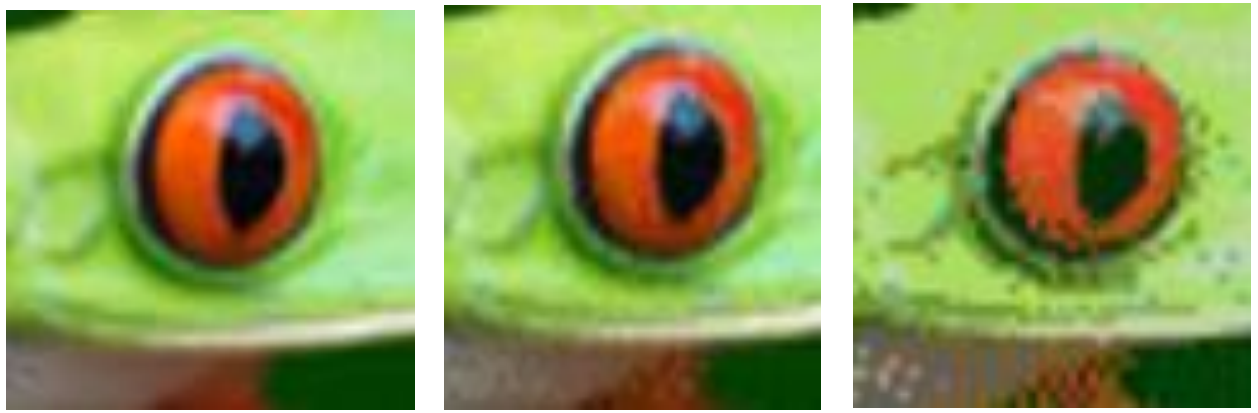
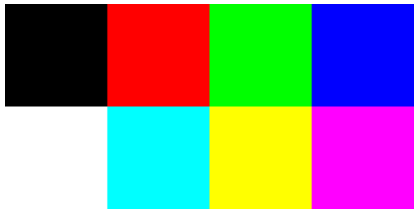


Image Quantization

Conversion of the sampled analog pixel intensities to discrete valued integer numbers

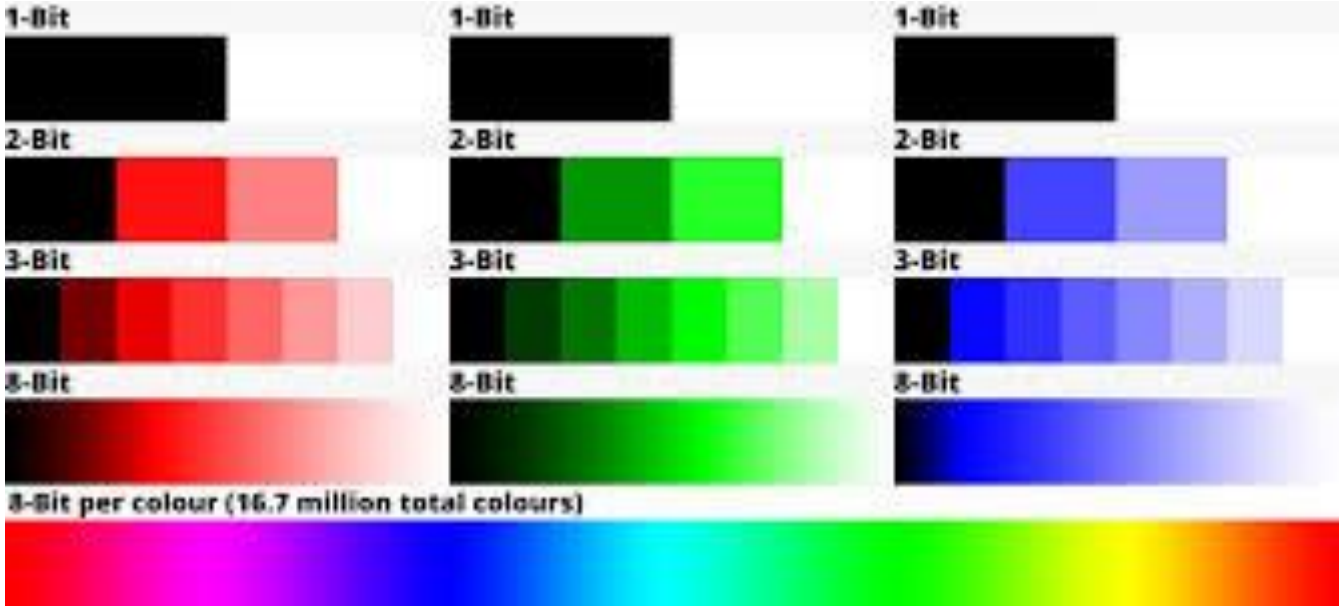




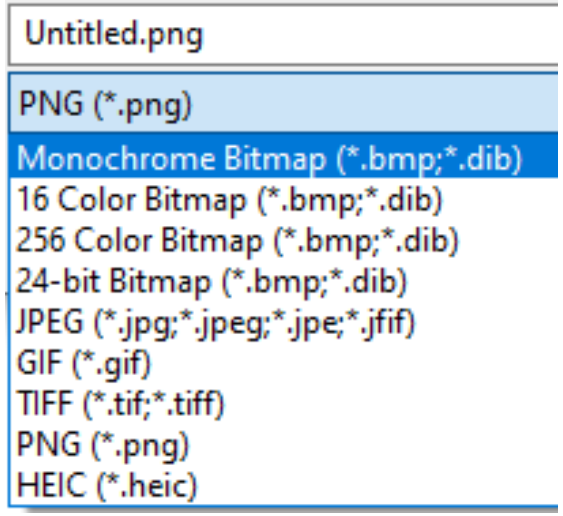


3 bit color

Color Mode	Color Depth	Number of Colors
HiColor	15 Bit	32.768
	16 Bit	65.536
Direct Color	18 Bit	262.144
	21 Bit	2.097.152
True Color	24 Bit	16.777.217
Deep Color	30 bit	1,07x10exp9
	36 Bit	68,7x10exp9
	48 Bit	281x10exp12



Color Depth *(bpp total)*	R,G,B *(bpp)*	No. of Colors	Note
8-bit	(3,3,2)	256	VGA
15/16-bit	(5,5,5) or (5,6,5)	32.7k or 65.5k	High color
18-bit	(6,6,6)	262k	
24-bit	(8,8,8)	16.7M	True Color

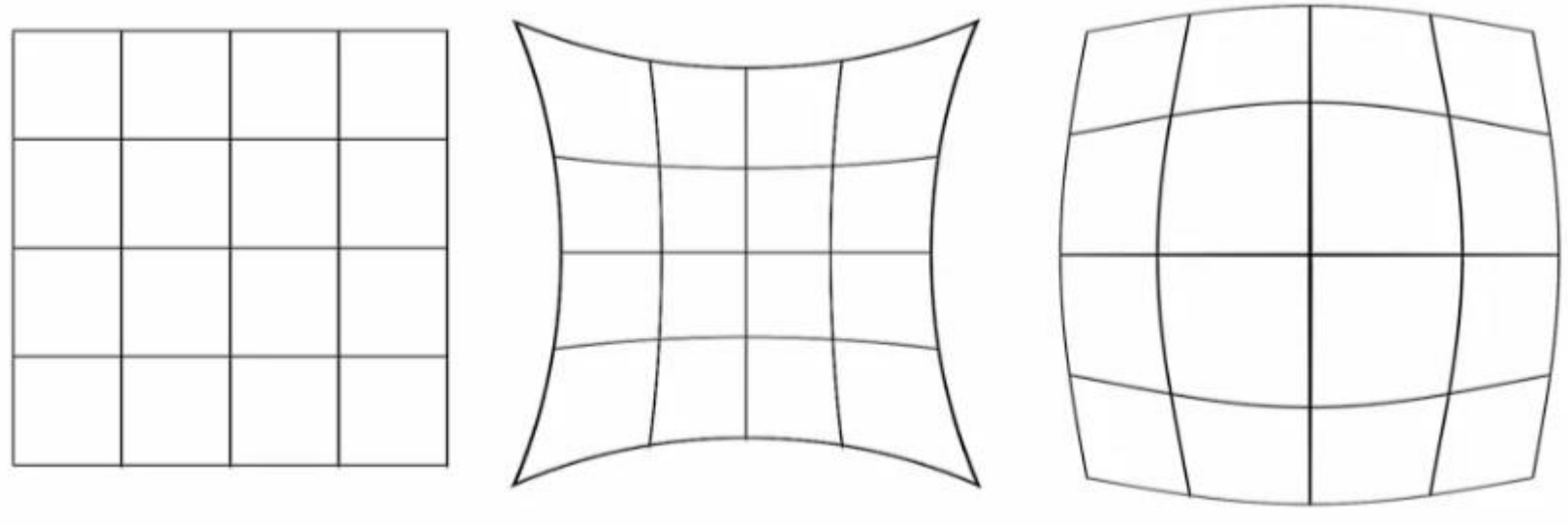


Problem in Digital image

Geometric Distortion

Geometric distortion is an unwanted “warping” of the image that distorts the spatial relationship among objects in the image.

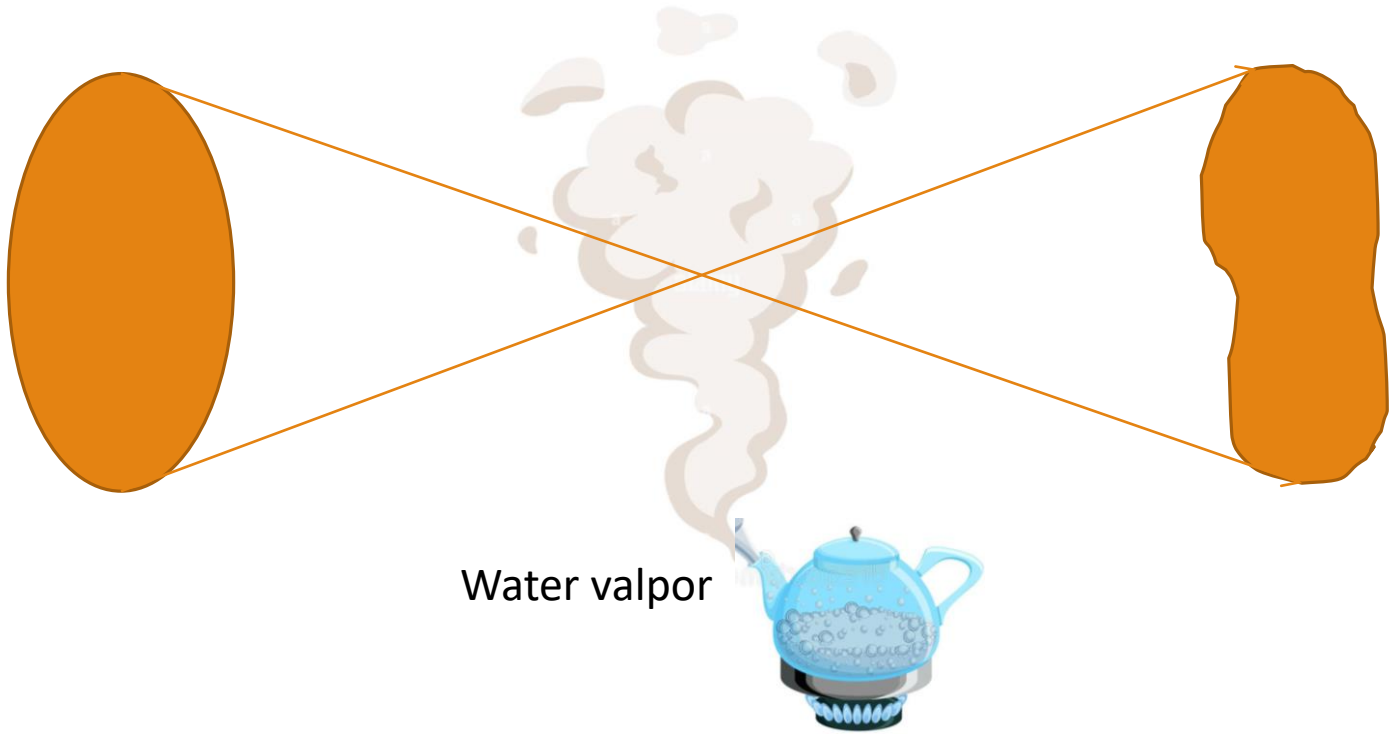
It can change the apparent size and shape of objects and the spacing between them.



Original image *pincushion* distortion *barrel distortion*

Scattering

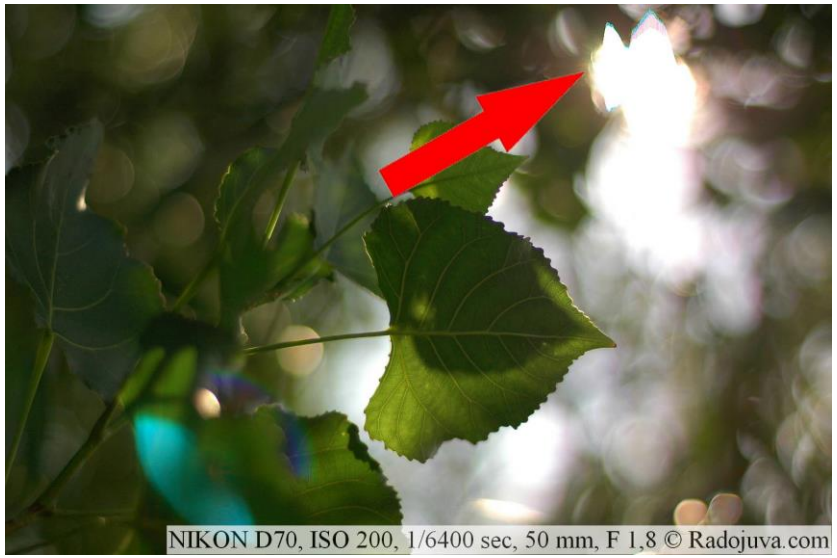
Beam of radiation bent by the medium through which they pass.

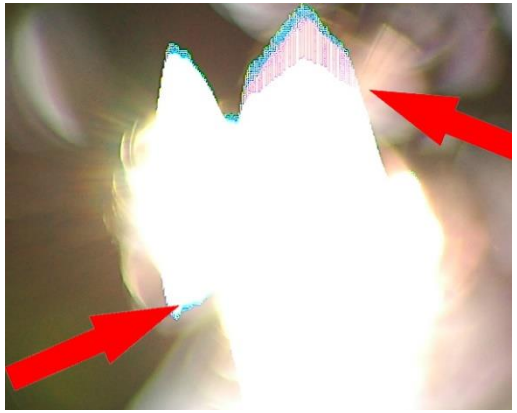


Blooming

Blooming occurs when shooting bright light sources, or when shooting at slow shutter speeds.

In such cases, the cells of the CCD matrix overflow with charges (light up), the charges 'spread' over neighboring cells, illuminating them as well

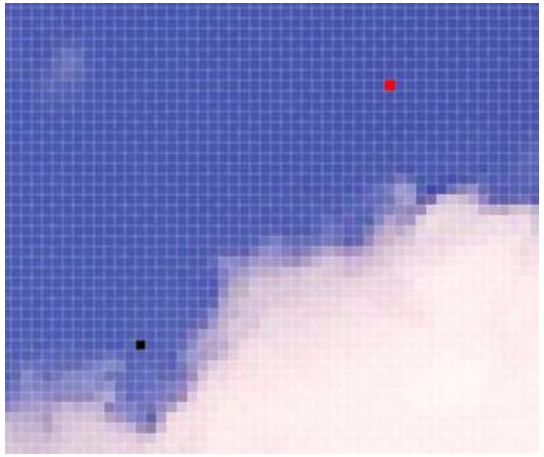




CCD Variation

Difference cells maybe variations response to identical light intensity,

- hot pixel - a pixel "**hot**" when it is bright instead of being dark
- dead pixel - a pixel "**dead**" when they are abnormally dark in a bright scene

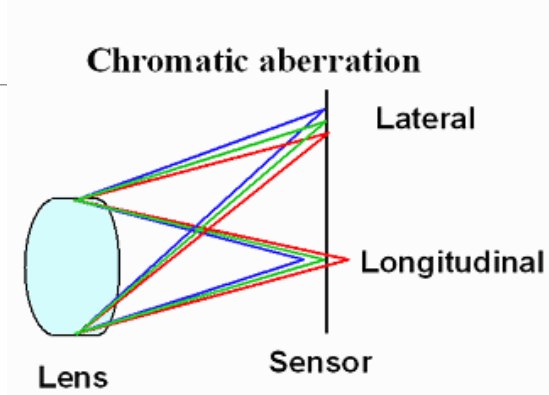


Clipping

A very high intensity may be clipping off to a maximum value

Chromatic distortion

chromatic distortion is a failure of a lens to focus all colors to the same point



Sampling and Quantization effect

THREE-DIMENSIONAL IMAGING

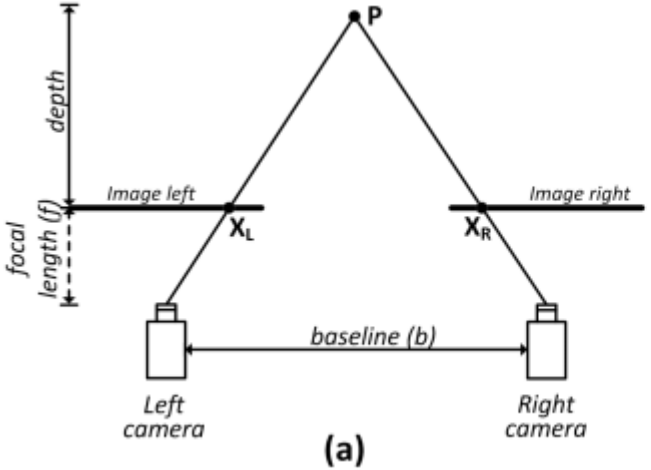
Stereo Images

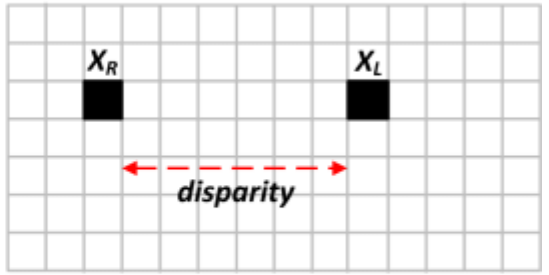
The human eye use two images of the same object captured by both our eyes and combine them to get a three-dimensional perception

we can use two images of the object using two cameras and combine them to get the depth perception as in case of human vision

Left image

Right image





(b)

Coordinate system

Pixel Coordinate System

A digital image is essentially a Matrix, consisting of a certain number of rows and a certain number of columns

The first row is always at the top, and named row number 0. The first column is at the left most, and is call column number 0