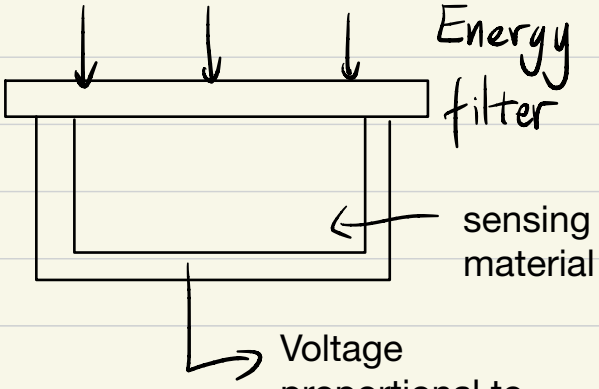
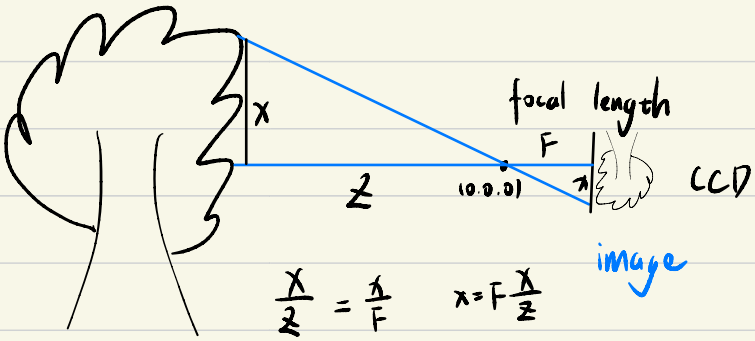
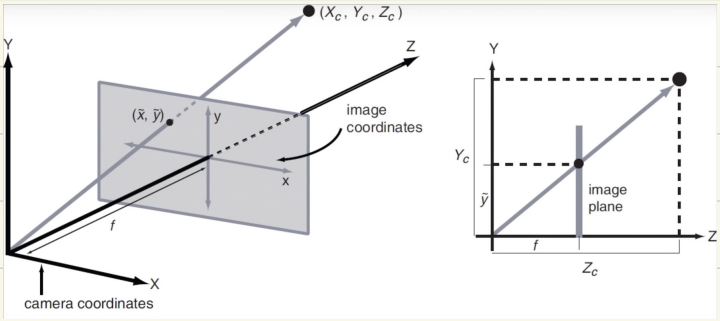
# Image Sensor




Usually, sensors are arranged in an array



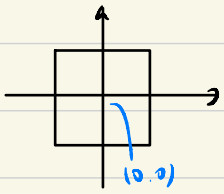




world

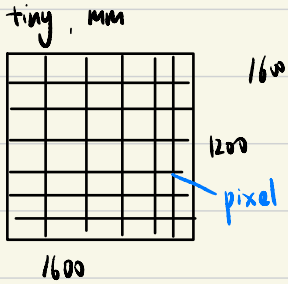
$(X, Y, Z)$ in world coordinate (3D)

Camera pin hole at $(0,0,0)$

projection of (X, Y, Z) onto image plane is (x, y) where $x = F\frac{X}{Z}$, $y = F\frac{Y}{Z}$

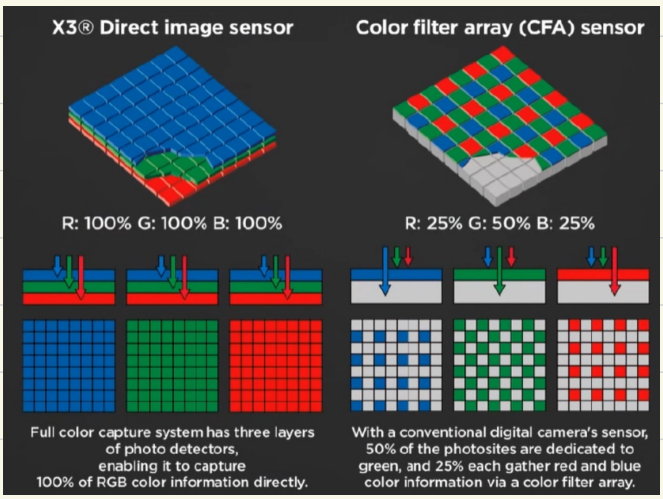


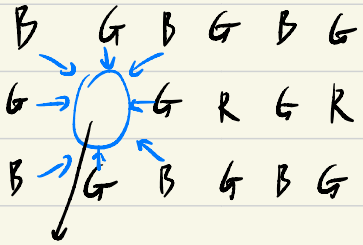

CCD array




$1600 \times 1200 = 1920k$ pixels $\approx 2MP$

pixel color responses are usually arranged in a "Bayer Pattern"

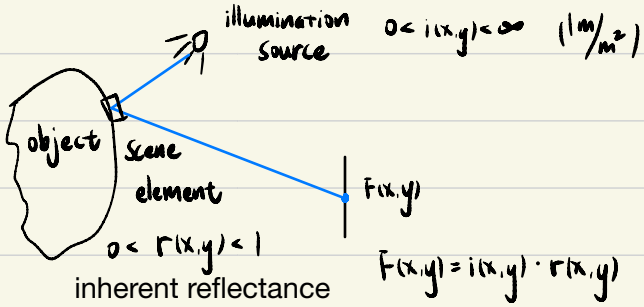



if we want to infer what color it is here

demosaicing

## illumination model



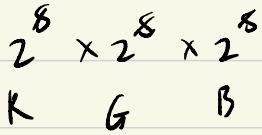

clear sunny day: 90k lm/m$^2$
cloudy day: 10k lm/m$^2$
indoors: 1k lm/m$^2$
full moon: 0.1 lm/m$^2$

$\Leftarrow i(x,y)$

$r(x,y) \Rightarrow$ snow: 0.93
flat white wall: 0.80
stainless steel: 0.65
black velvet: 0.01

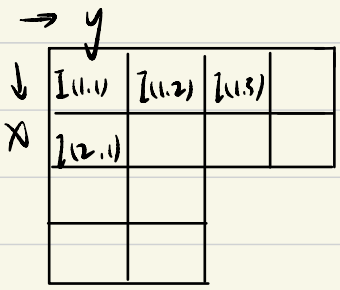
sampling and quantization

we often use 8 bits=256 levels per color channel.



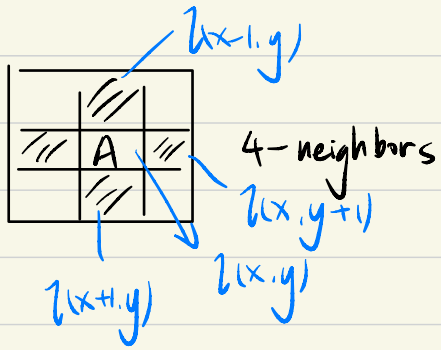

lower sampling(resolution) rate -> blockiness
lower # of levels -> false contouring and low detail

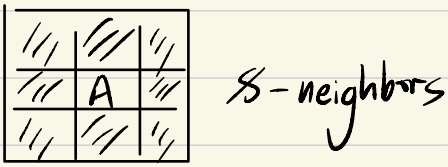
we think of an image as a 2D array of numbers.

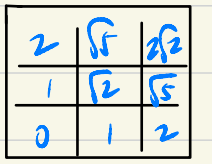



I(Row, col)

imread()
imshow()
imshow( , [ ]) scale: smallest value to black
largest value to white
rgb2gray: convert rgb to gray
A+B, A-B
unit8 vs double




Euclidean dis