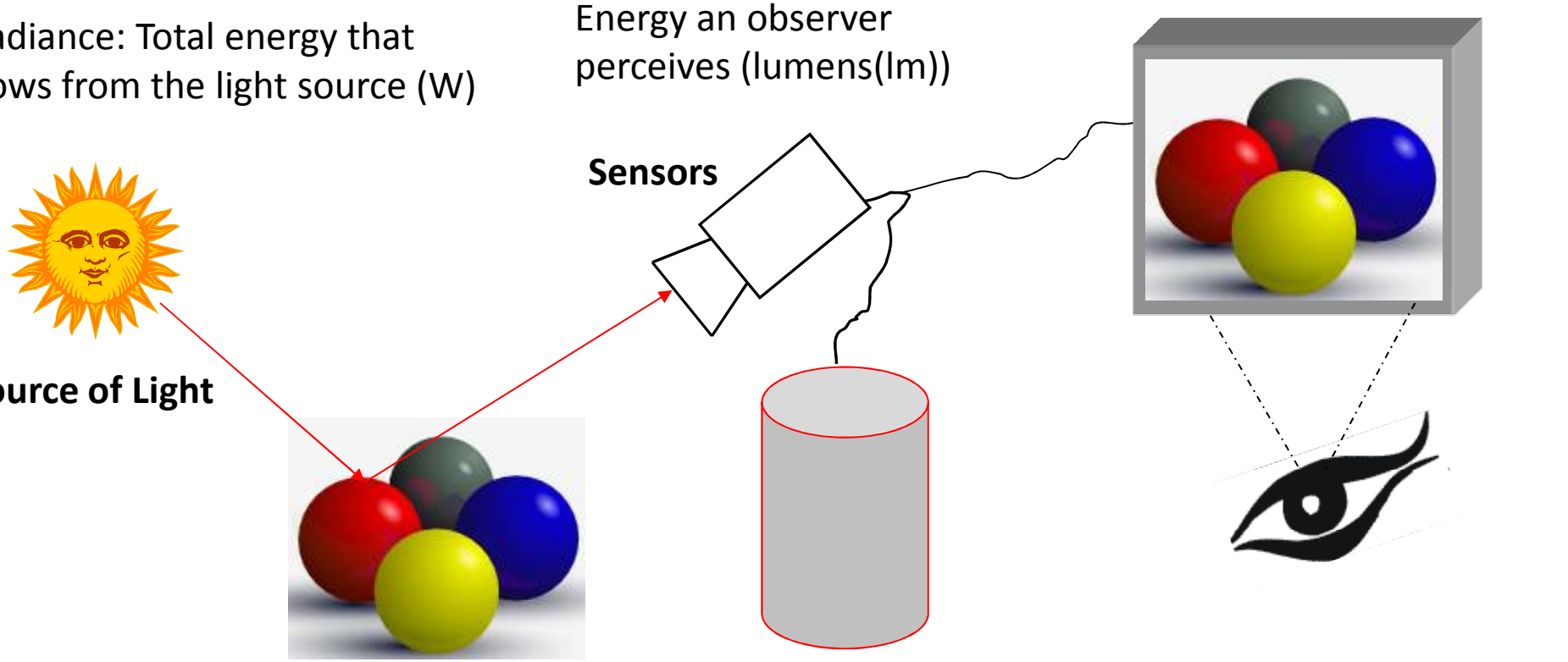
Image Formation

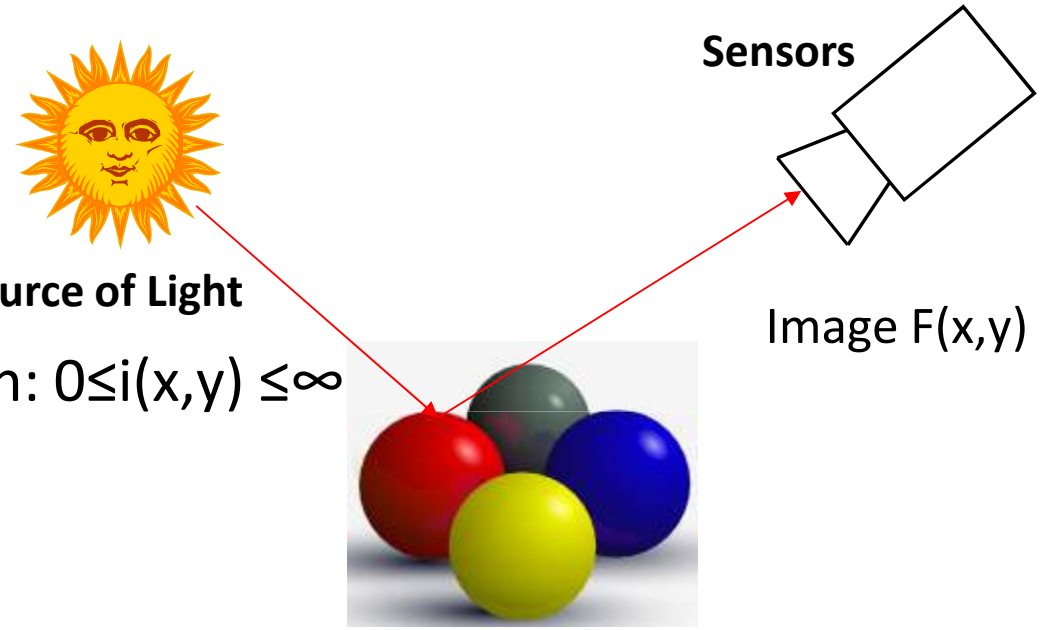
Radiance: Total energy that flows from the light source (W)

Luminance: Amount of Energy an observer perceives (lumens(lm))

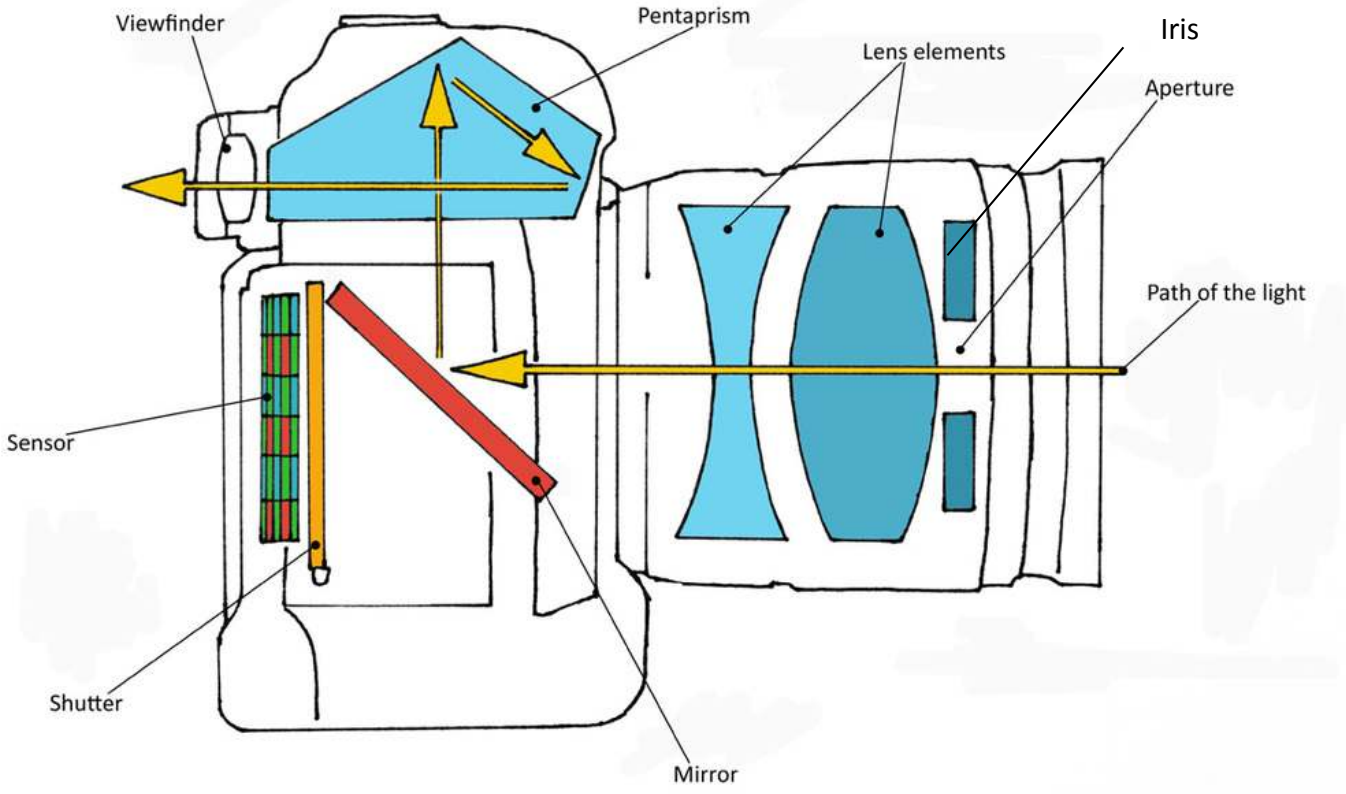
Processing and Visualization



A simple Formation Model

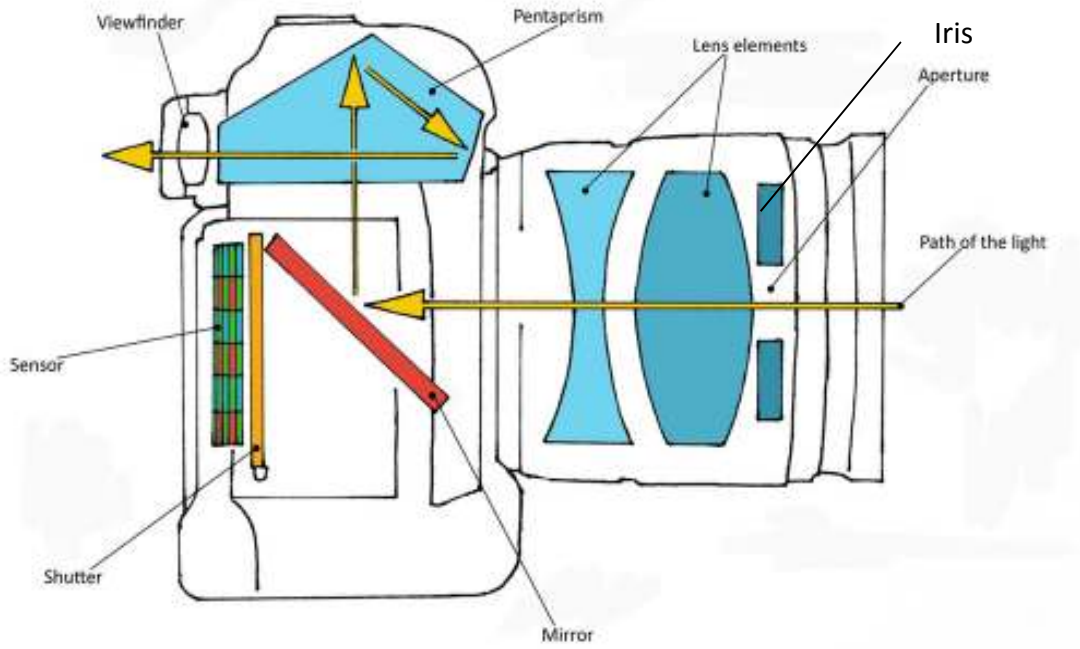


Basics of Digital Cameras



The main components of a digital camera are: Iris, lens, shutter, and sensor.

Basics of Digital Cameras



The iris controls the aperture of the camera, determining the amount of light that reaches the sensor.

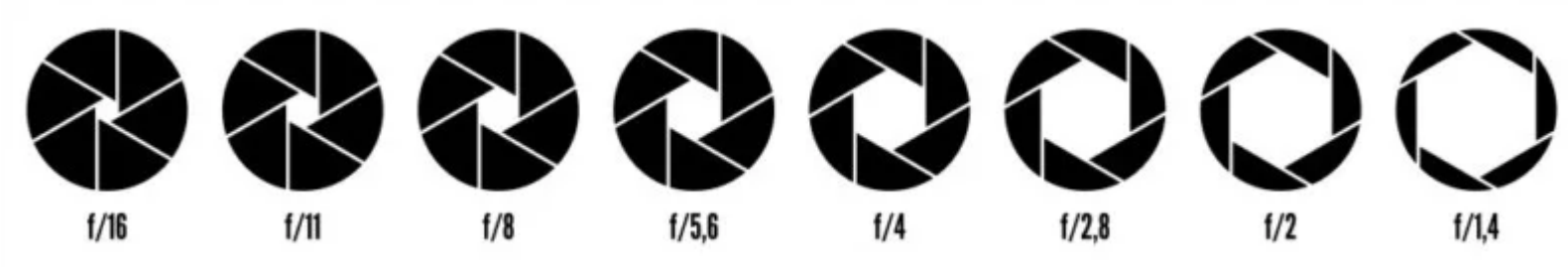
Capturing Different Amounts of Light

Large Aperture

Medium Aperture

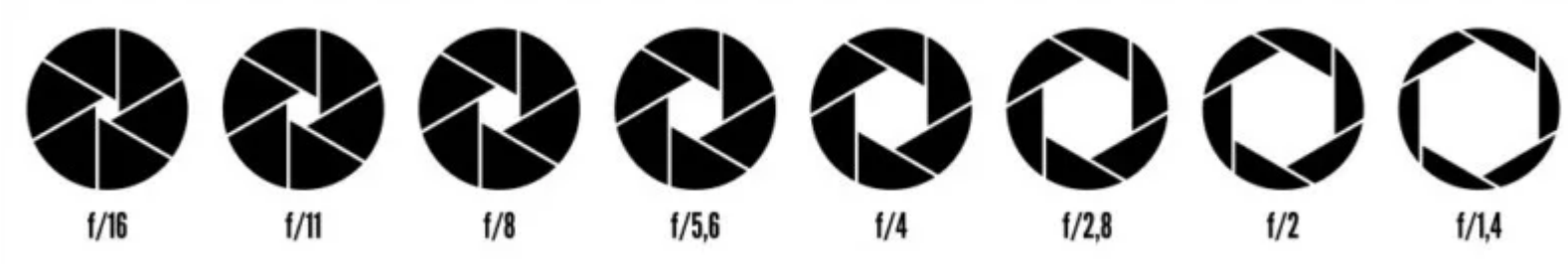
Small Aperture

Basics of Digital Cameras



The opening of the aperture is measured using the f-number (f-stop); the diameter of the aperture is determined by the focal length divided by f-stop number.

Basics of Digital Cameras



Calculate the diameter of the aperture if we are using lens with focal length of 50 mm and aperture of f/2.8.

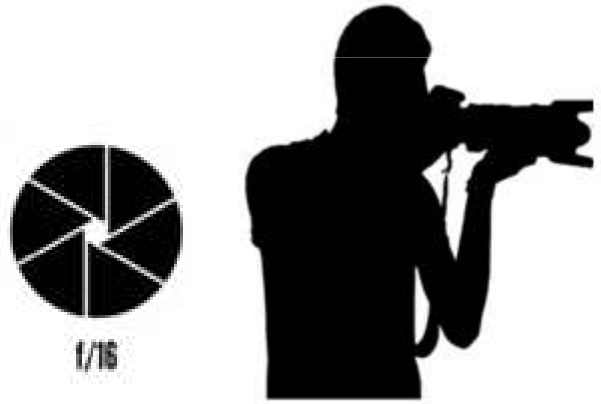
What about an aperture of f/1.4?

$$Area_{f/2.8} = \pi * \left(50/(2.8*2)\right)^2 = 250.44mm^2$$

$$Area_{f/1.4} = \pi * \left(50/(2*1.4)\right)^2 = 1001.54.44mm^2$$

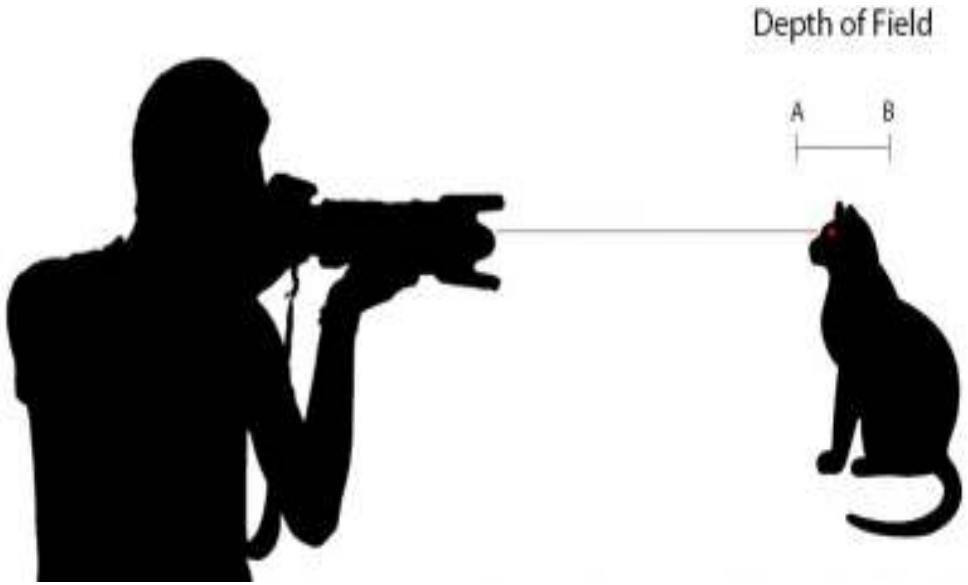
There is a difference of two stops between f/1.4 and f/2.8.

Shallow depth of field (large aperture)

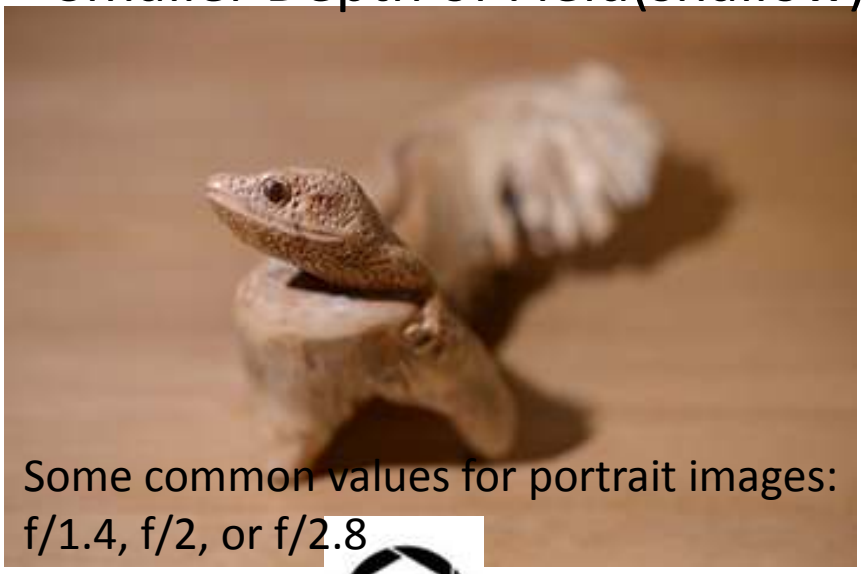


Large depth of field (small aperture)

The opening or closing of the iris (aperture) also controls the depth of field, it refers to the amount of the image that is sharp.



Smaller Depth of Field(shallow)

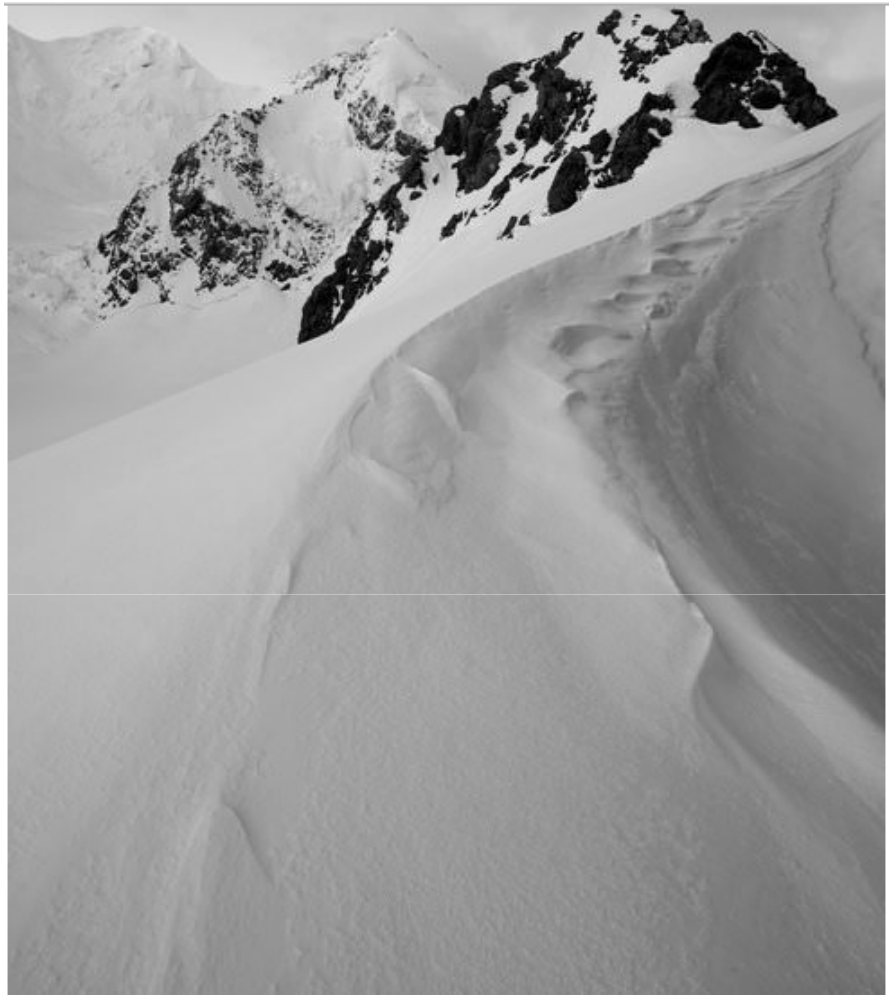


Some common values for portrait images: f/1.4, f/2, or f/2.8

Larger Depth of Field

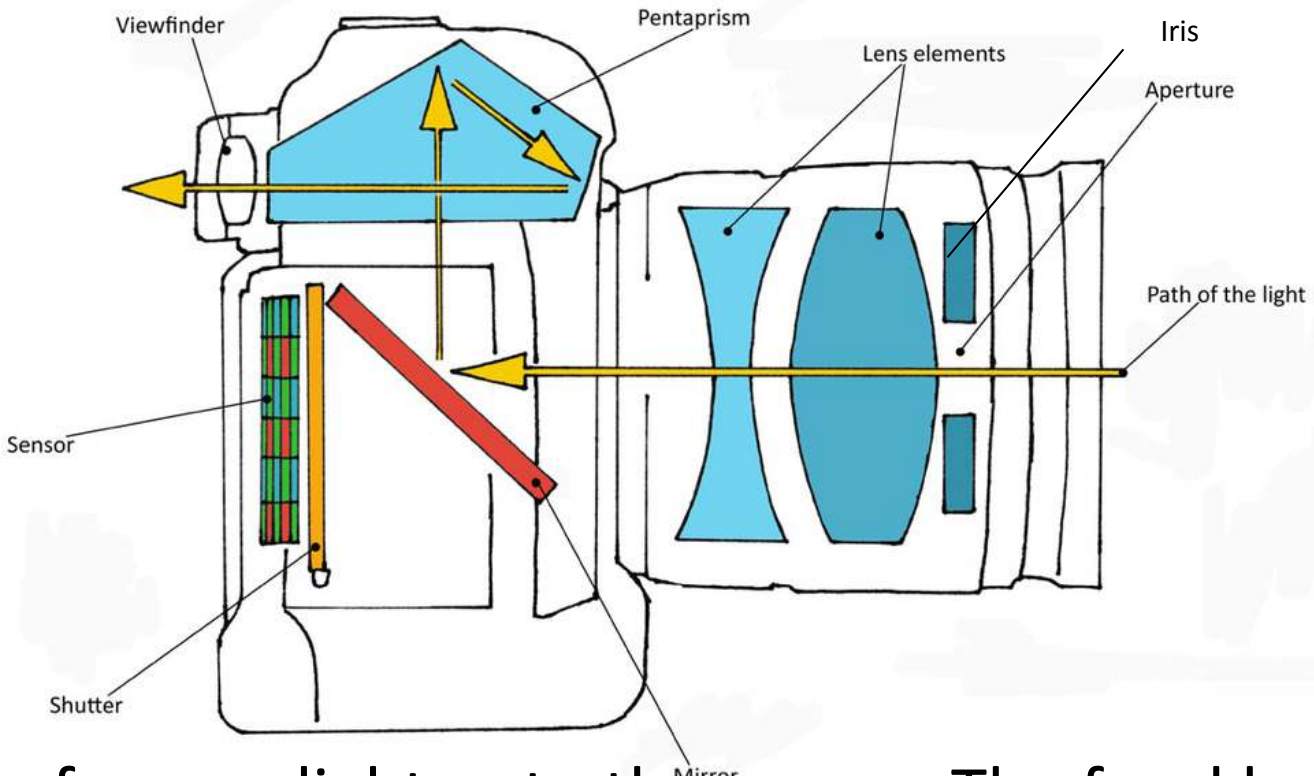
Some common values for landscape images: f/8, f/11, or f/16

Some common values for portrait images: f/1.4, f/2, or f/2.8

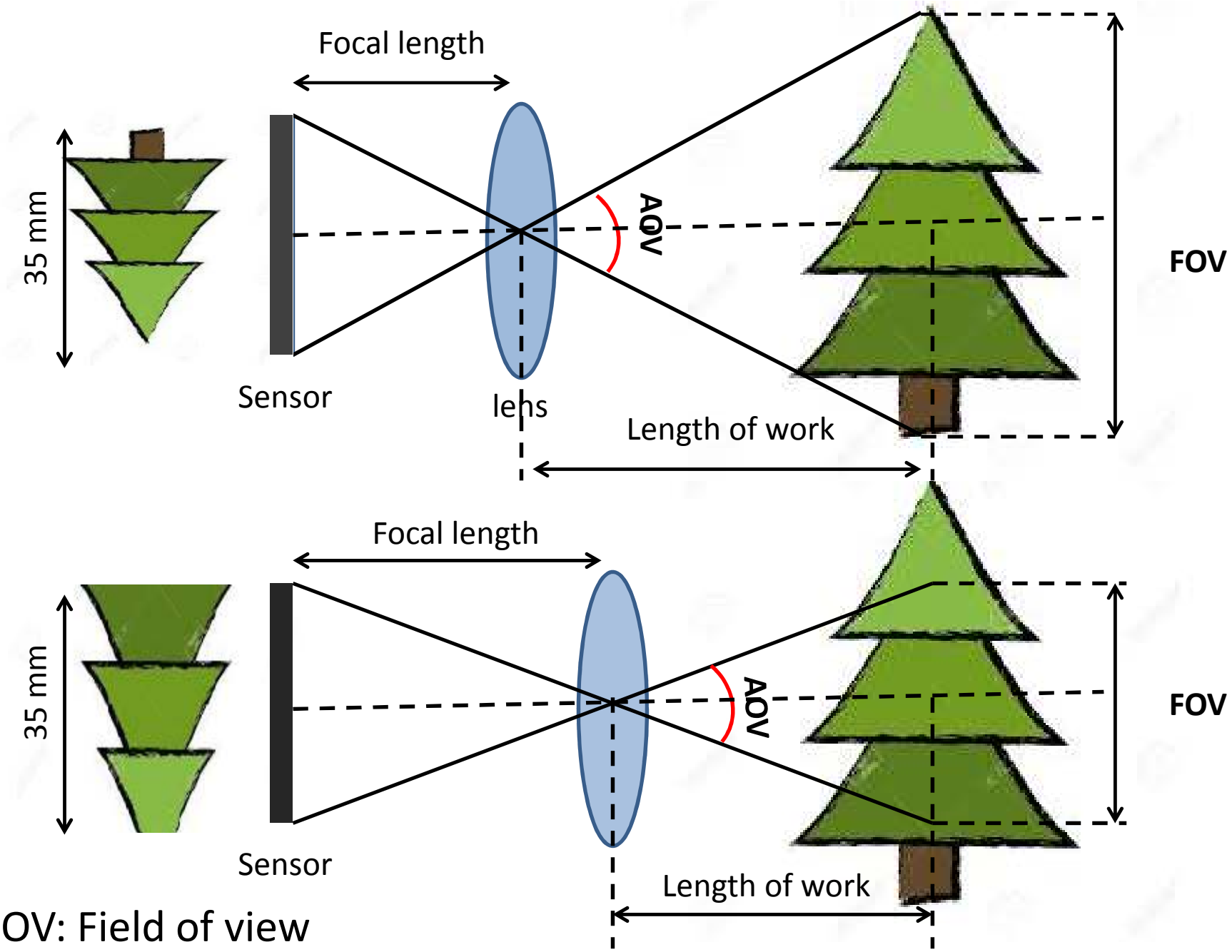


Some common values for landscape images: f/8, f/11, or f/16

Basics of Digital Cameras

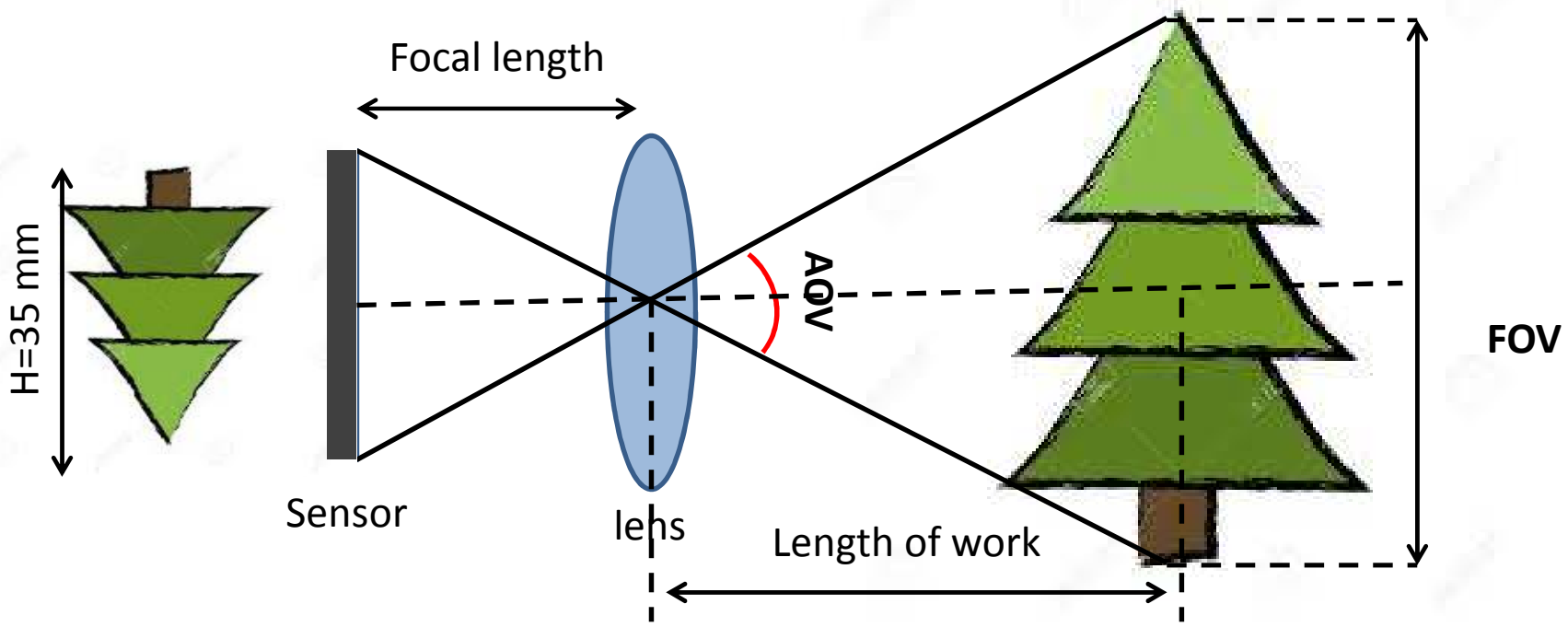


The lens focuses light onto the sensor. The focal length is the distance from the point where all the light rays converge inside the lens (optical center) to the sensor .

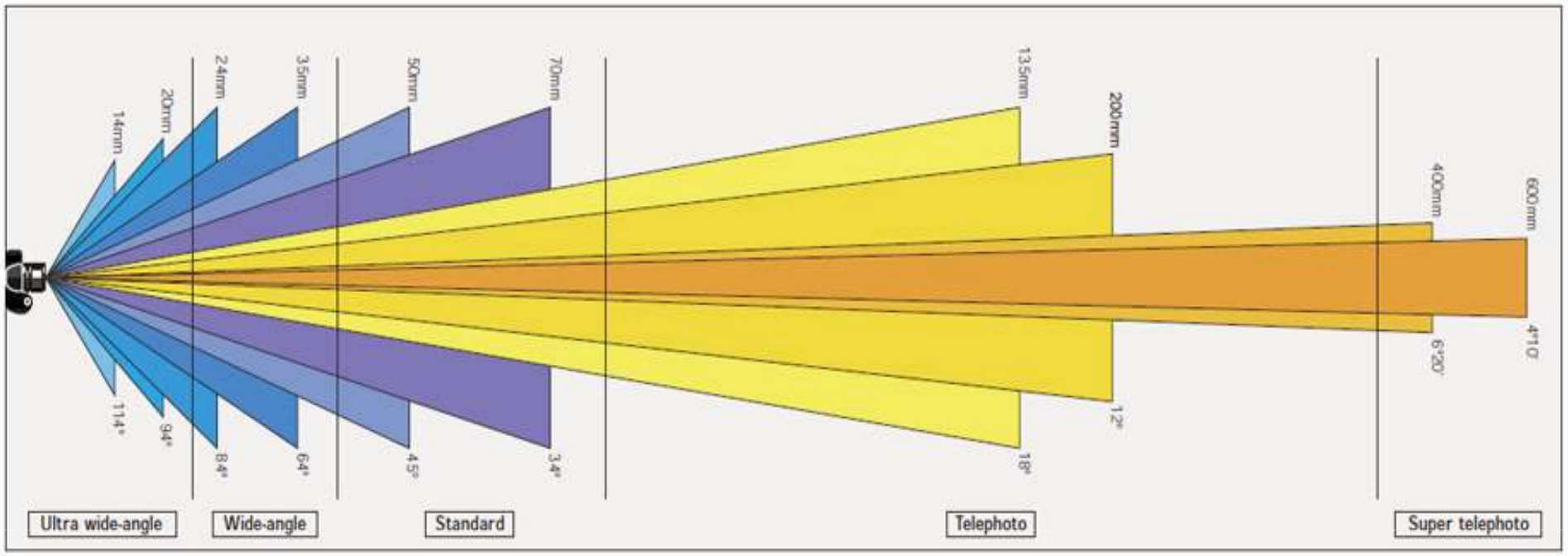


FOV: Field of view

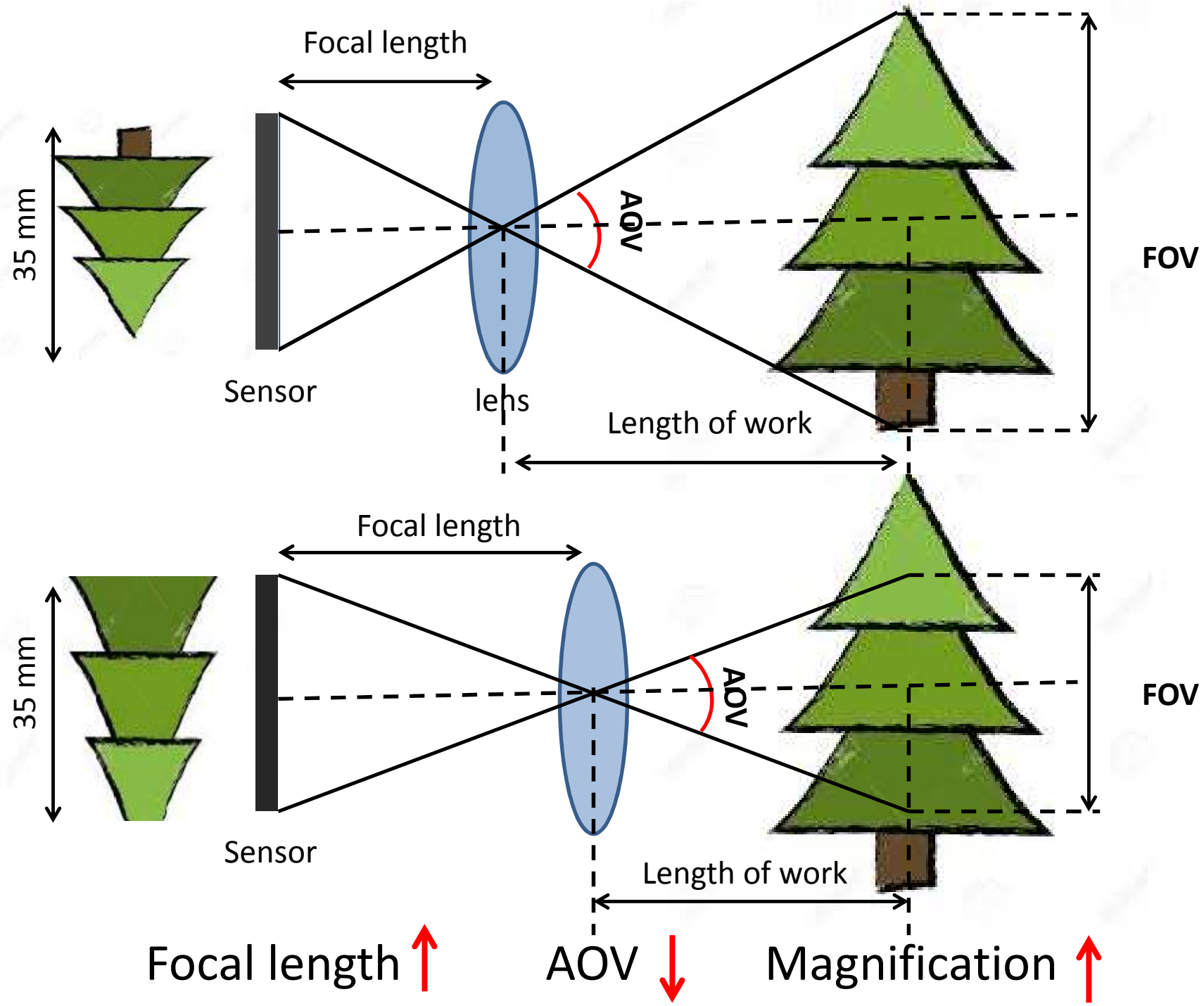
AOV: Angle of view

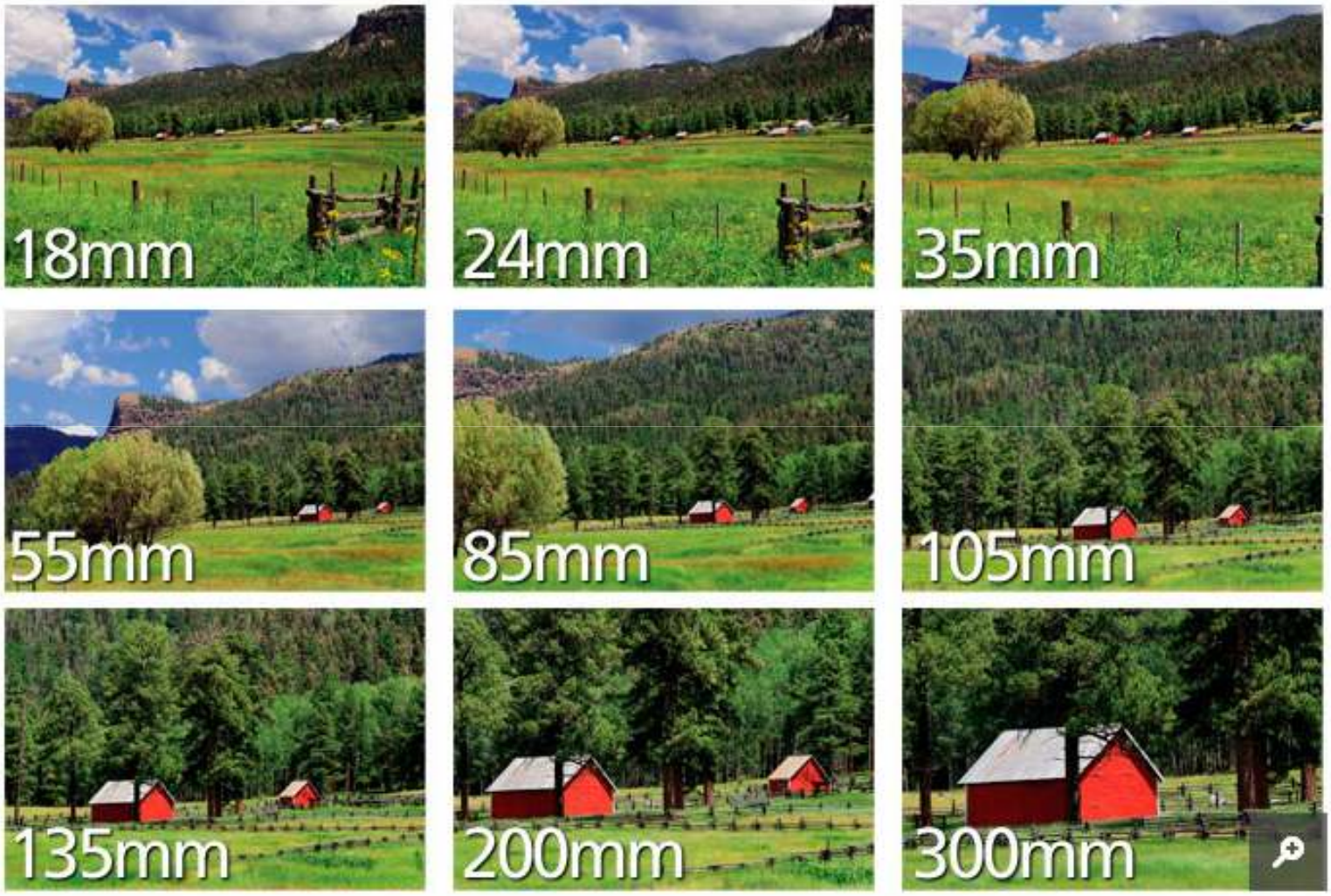


$$\frac{H}{Focal\,Length} = \frac{FOV}{Length\ of\ work}$$

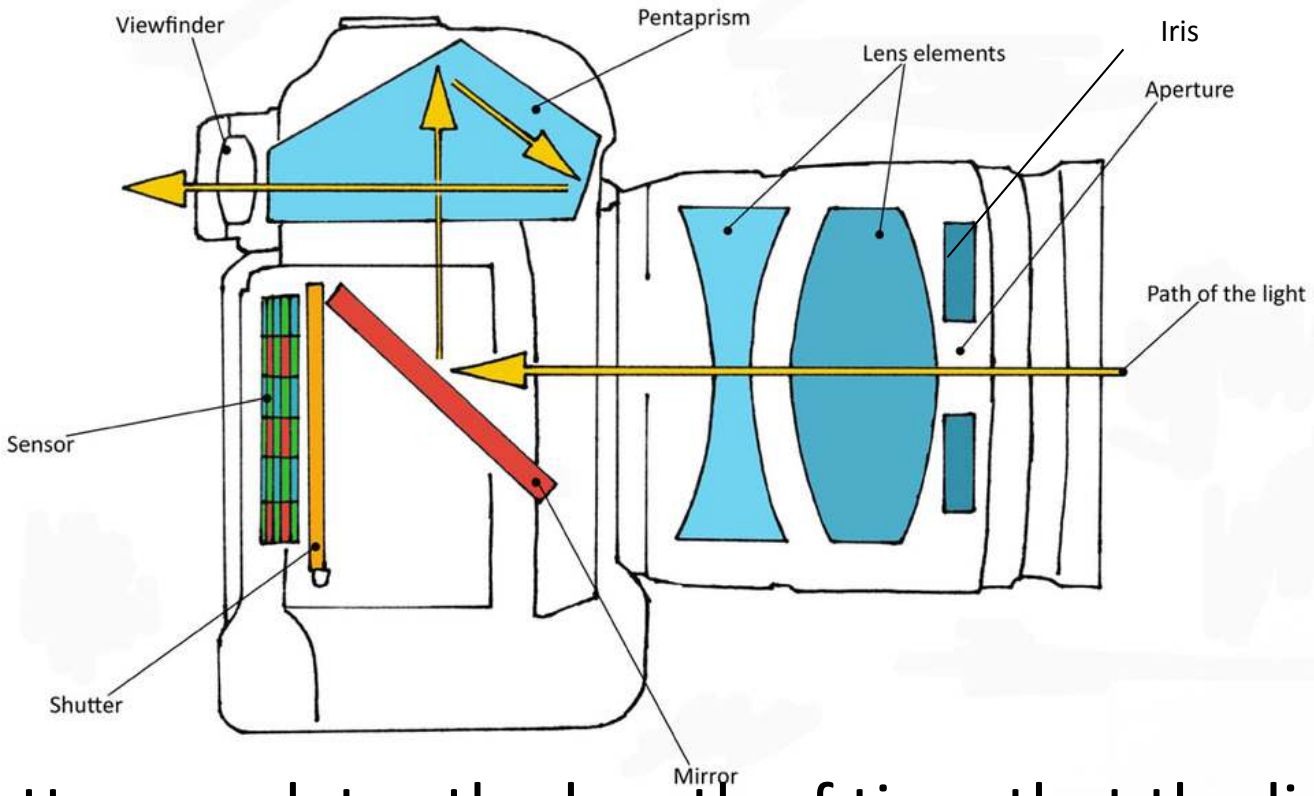


Focal length ↑ AOV ↓ Magnification ↑


Focal length
35 mm
AOV
FOV
Sensor
lens
Length of work
Focal length
35 mm
AOV
FOV
Sensor
Length of work
Focal length
AOV
Magnification


18mm
24mm
35mm
55mm
85mm
105mm
135mm
200mm
300mm
Focal length
AOV
Magnification

Basics of Digital Cameras



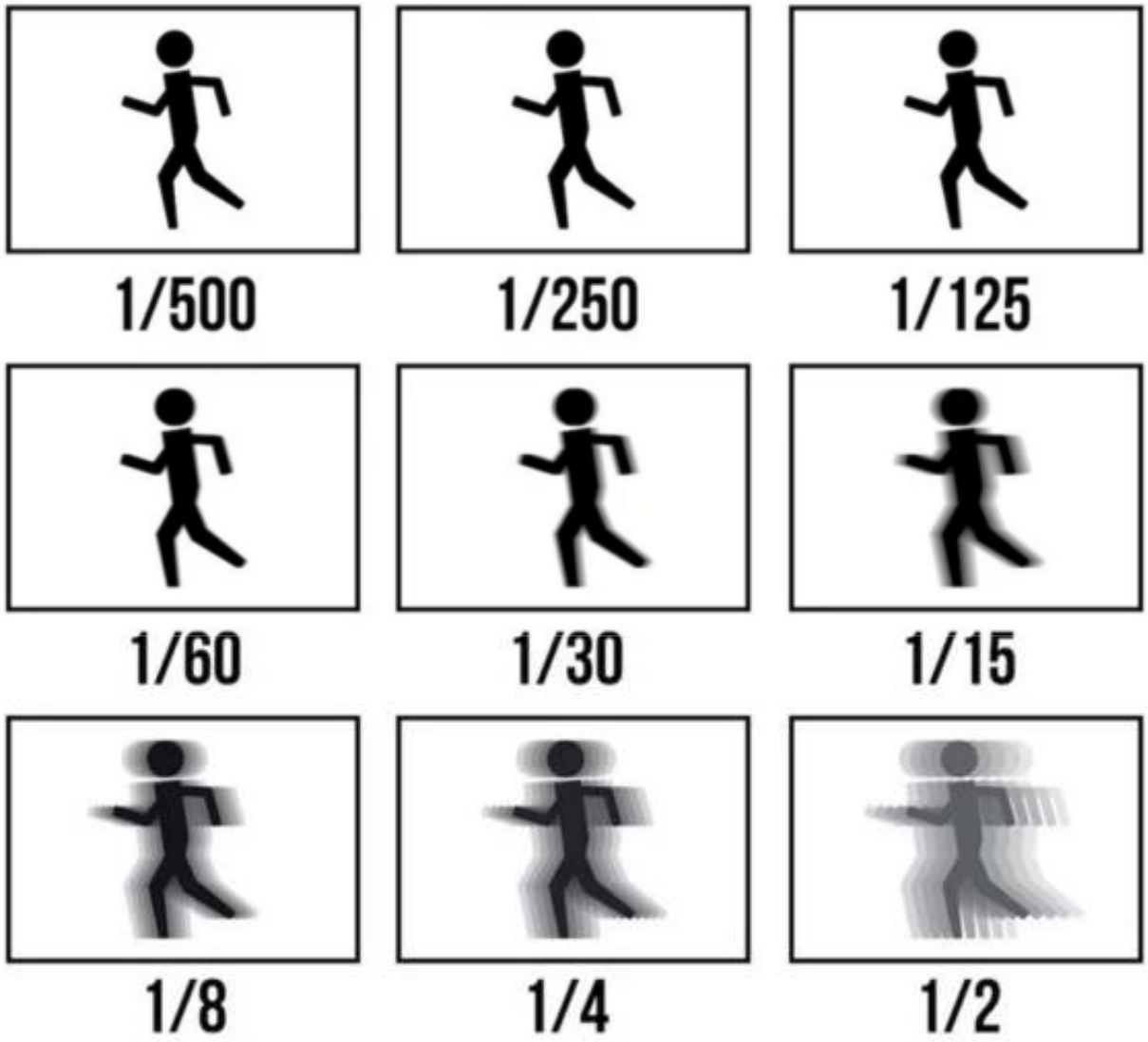
The shutter regulates the length of time that the light is admitted through the lens to the sensor (shutter speed). The shutter speed can be as fast as 1/10,000 of a second or as slow as several minutes.

Capturing Different Amounts of Light

Low
shutter speed

Medium
shutter speed

High shutter
speed



Fast shutter speeds have the effect of freezing motion in the scene. Conversely, slow shutter speeds will blur motion in a scene.

Shutter Speed

1/500 sec

1/8 sec

Shutter Speed

90 sec

Basics of Digital Cameras

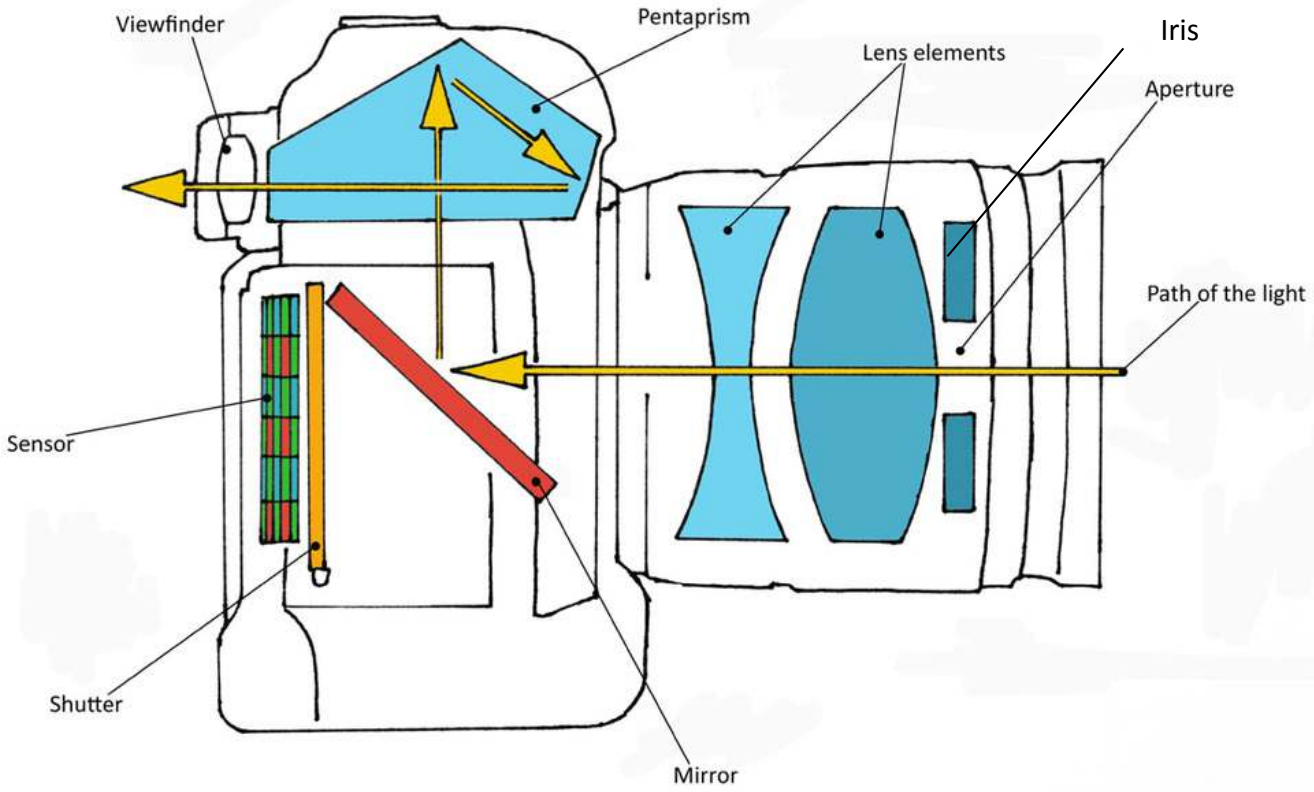
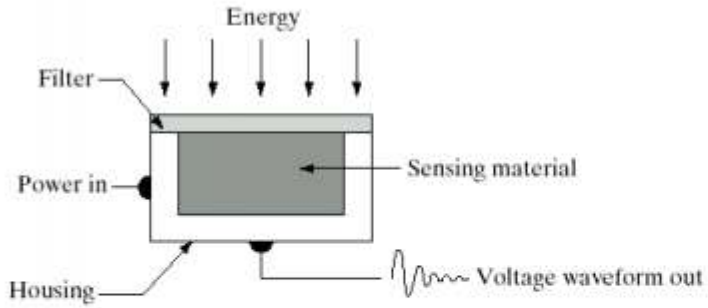


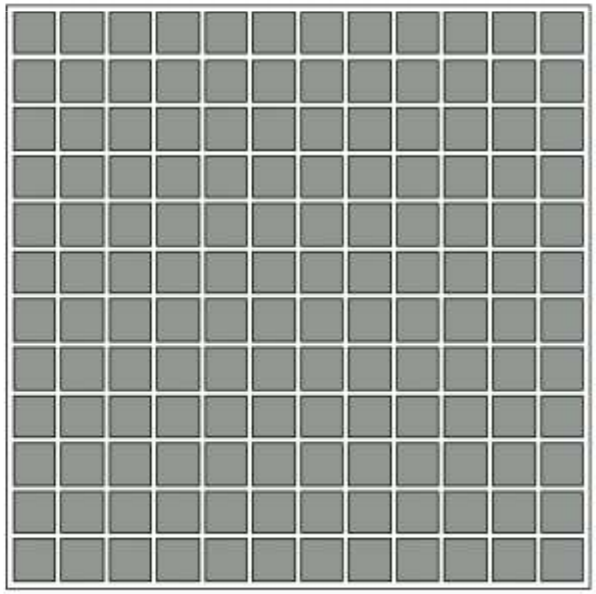
Image Sensing

Incoming energy (e.g. light) lands on a sensor material responsive to that type of energy, generating a voltage. Collection of sensors are arranged to capture images.



Imaging Sensor

Line of Image Sensors



Array of Image Sensors