Image Capture

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Department of Computer Science and Information Engineering,
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Digital Image Processing

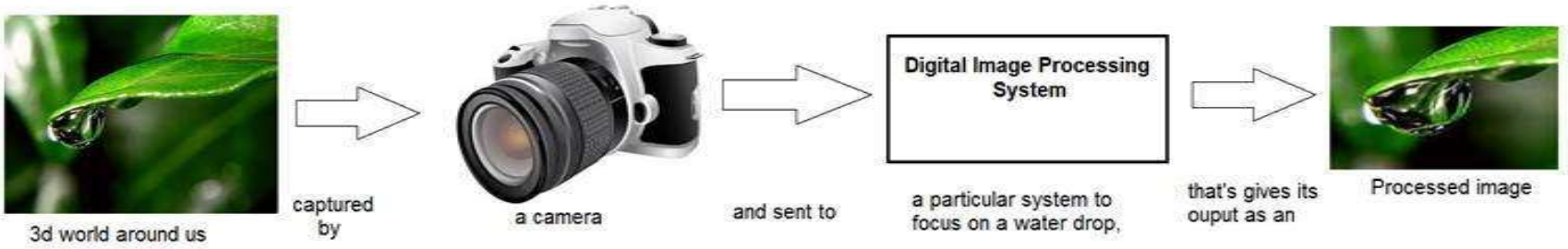
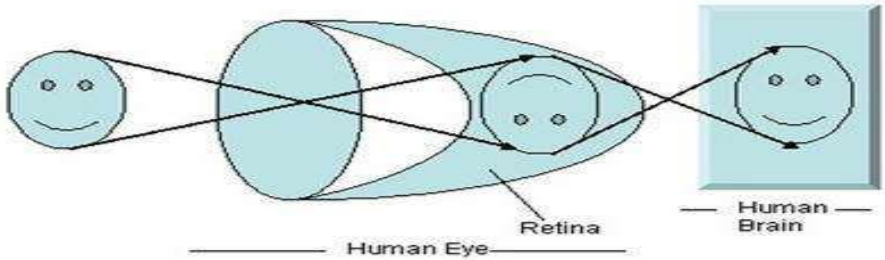
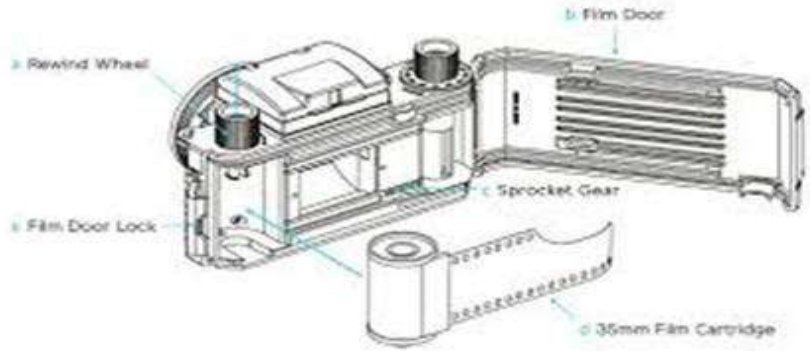


Image Formation on Camera

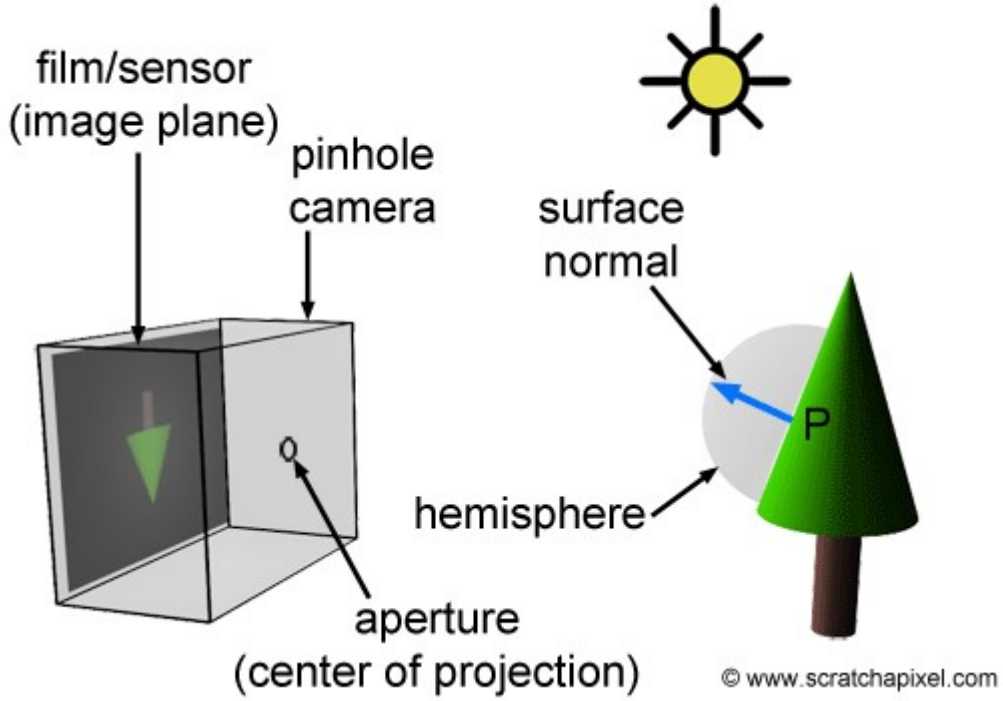
- How human eye works?



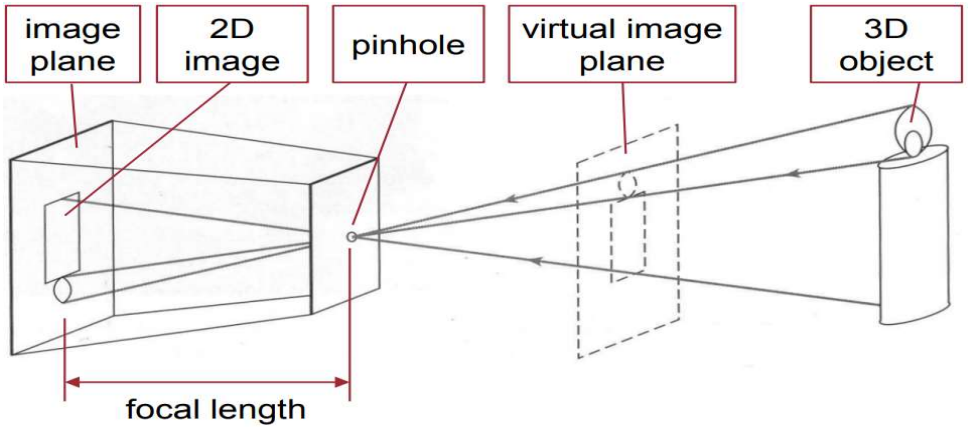
- Image formation on analog cameras

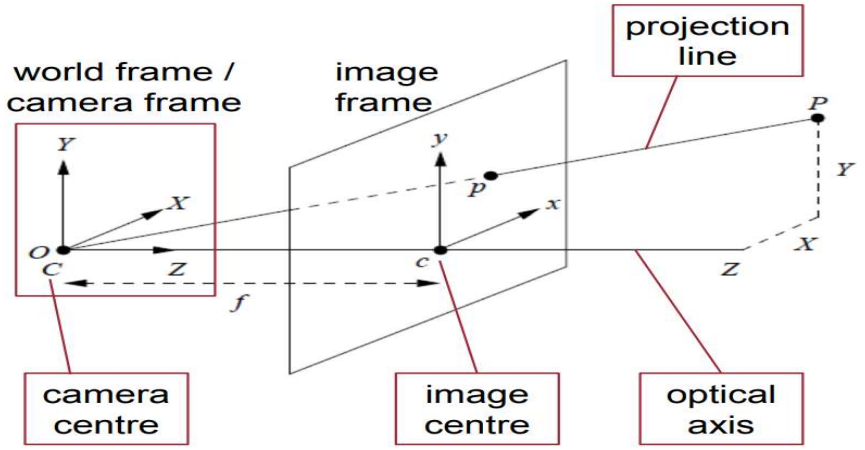


Pinhole Camera Model

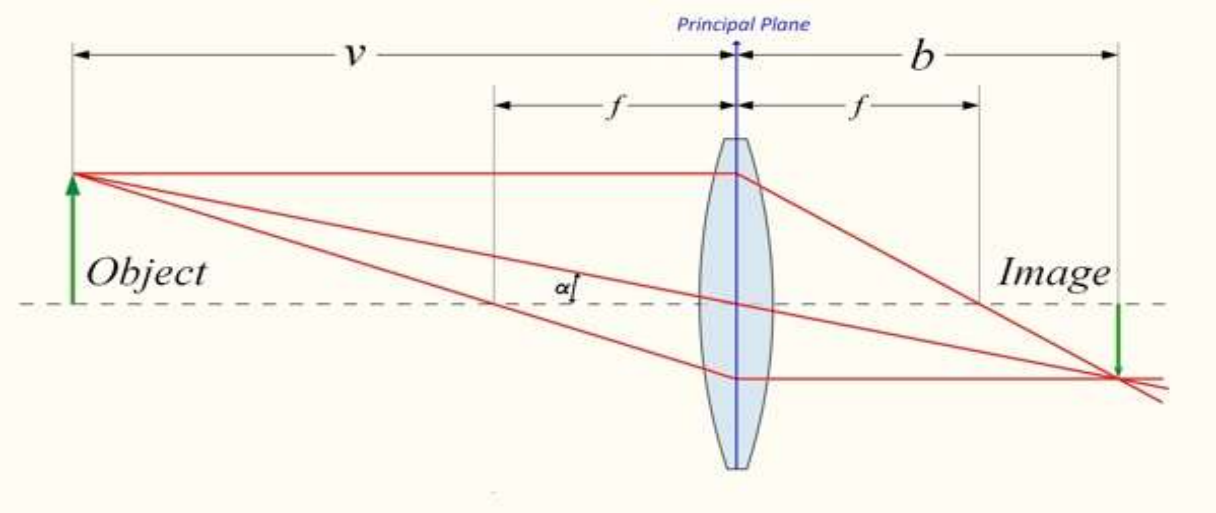


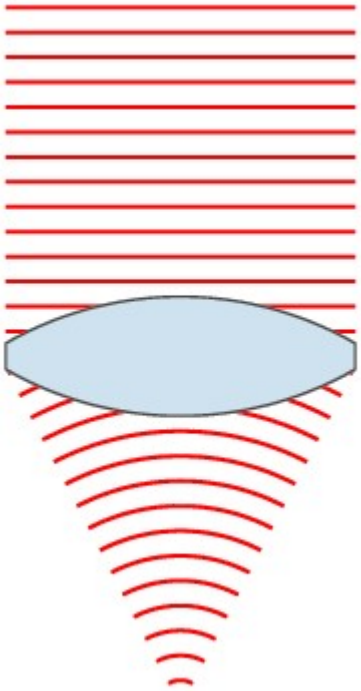
Pinhole Camera Model





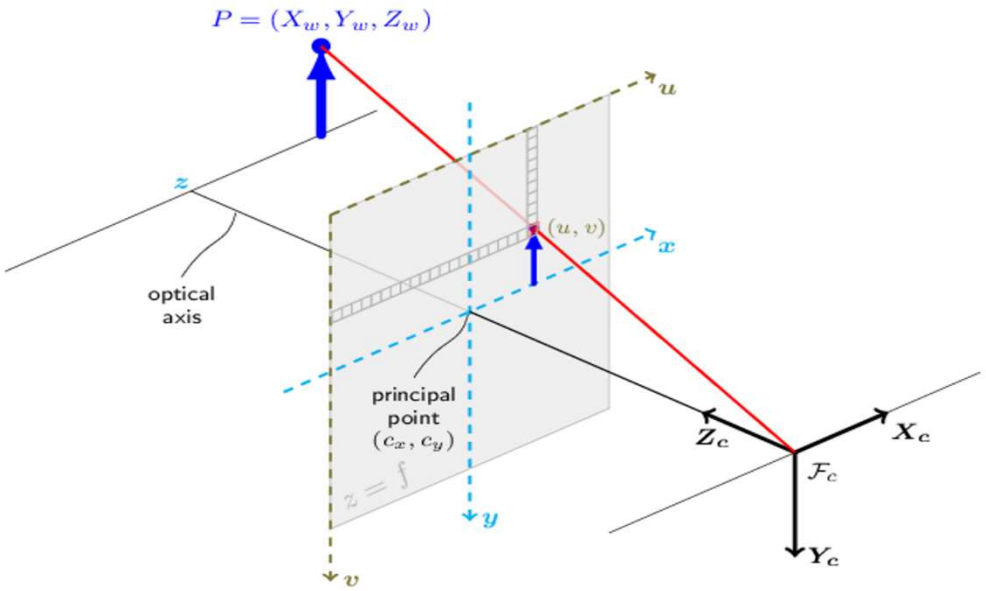
Lens-Camera Model

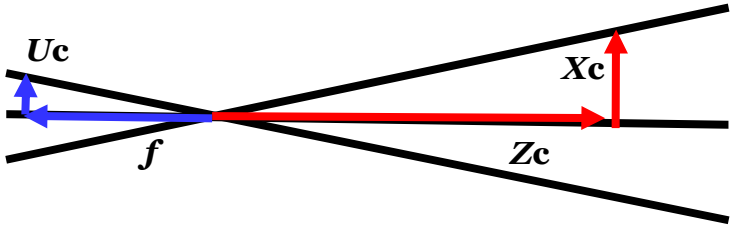




https://en.wikipedia.org/wiki/Lens#Imaging_properties

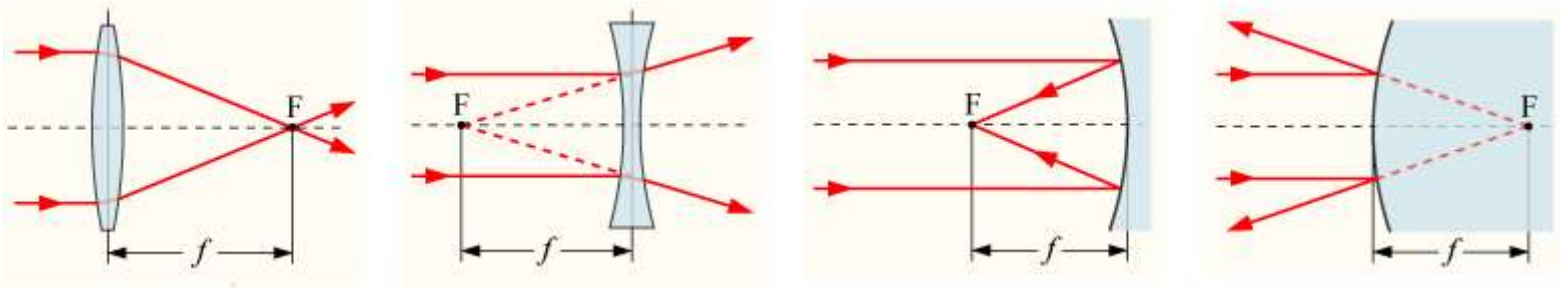
Pinhole Camera Model





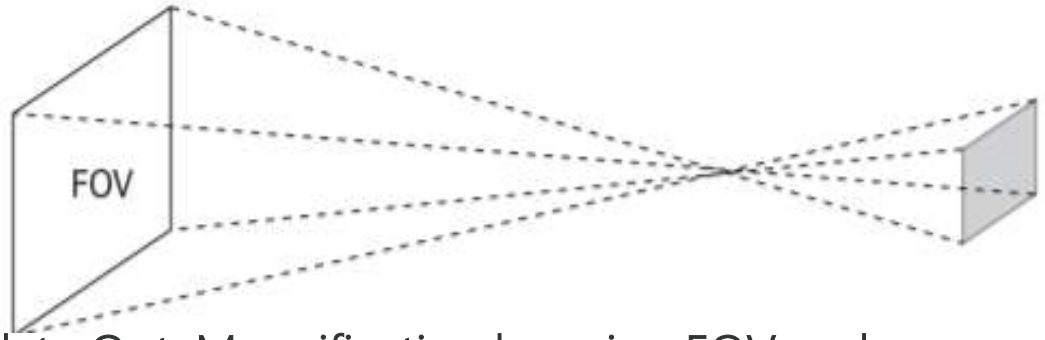
https://allen108108.github.io/blog/2020/02/06/%E9%87%9D%E5%AD%94%E7%9B%B8%E6%A9%9F%E6%A8%A1%E5%9E%8B%20%20Pinhole%20Camera%20Model/

Focal Length

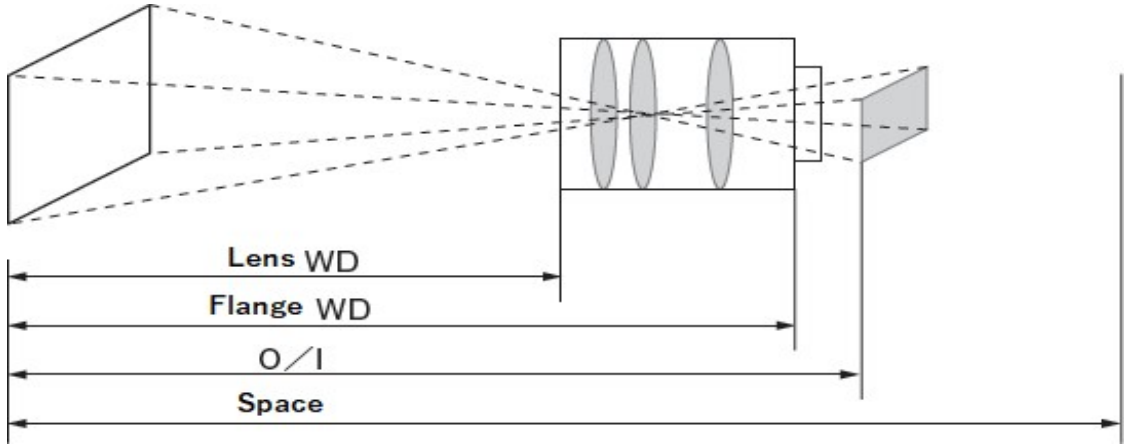


https://chtseng.wordpress.com/2018/09/18/%E5%A6%82%E4%BD%95%E4%BC%B0%E7%AE%97%E5%89%8D%E6%96%B9%E4%BA%BA%E7%89%A9%E7%9A%84%E8%B7%9D%E9%9B%A2/

How to Calculate FOV



Calculate Opt. Magnification by using FOV and sensor size

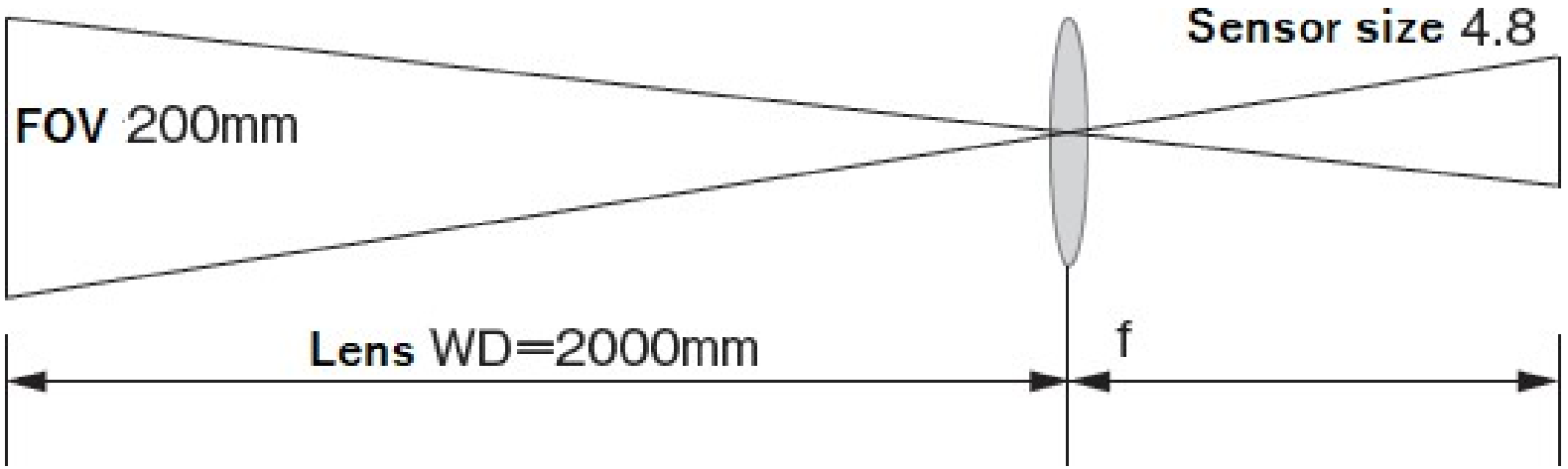


Compromise between many competing factors

Focal Length

- How to calculate Focal Length of a lens

F = Working Distance x CCD Height / Object Height



f = WD * Opt. Mag(Sensor size(V or H) / FOV(V or H))

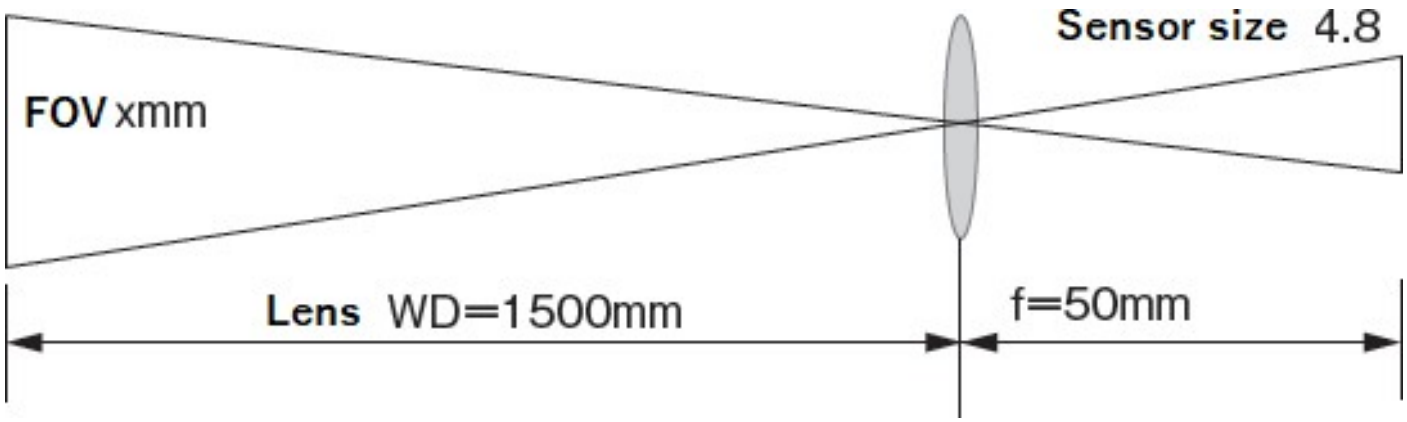
f = 2000mm * Opt.Mag(= Sensor size(4.8mm) / FOV(200mm))

f = 48mm

https://vst.co.jp/en/support/lens-choice/

Field of View

- How to calculate Field of View (FOV)

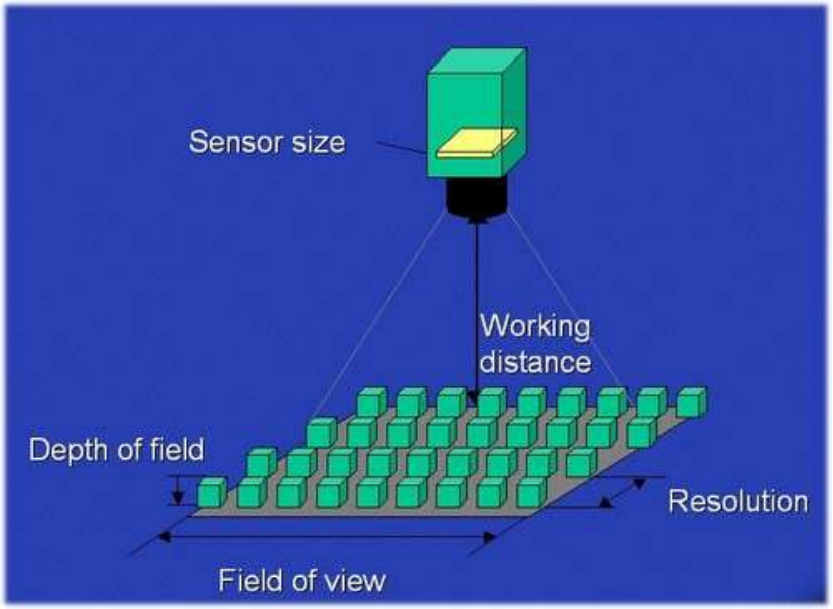


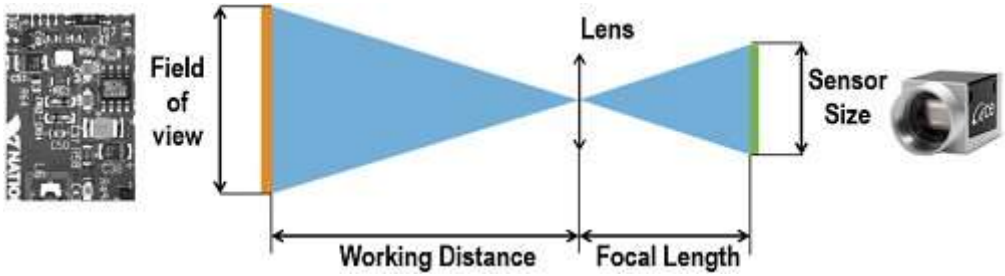
FOV(V or H) = WD * Sensor size(V or H) / f(focal length)

FOV = 1500 * 4.8 / 50 = 144mm

Computer Vision

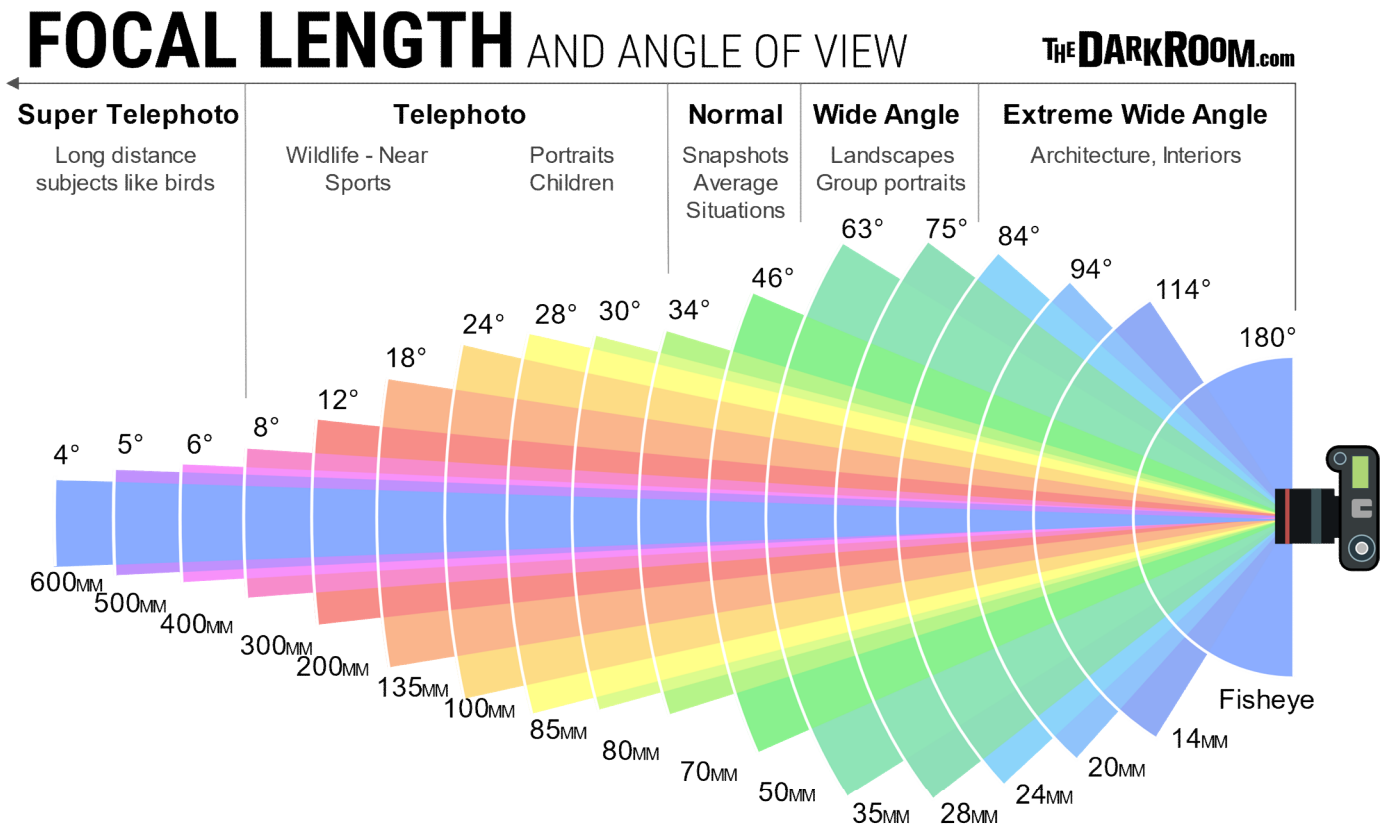
https://www.lightingseika.com.tw/product_description.php?PNo=221



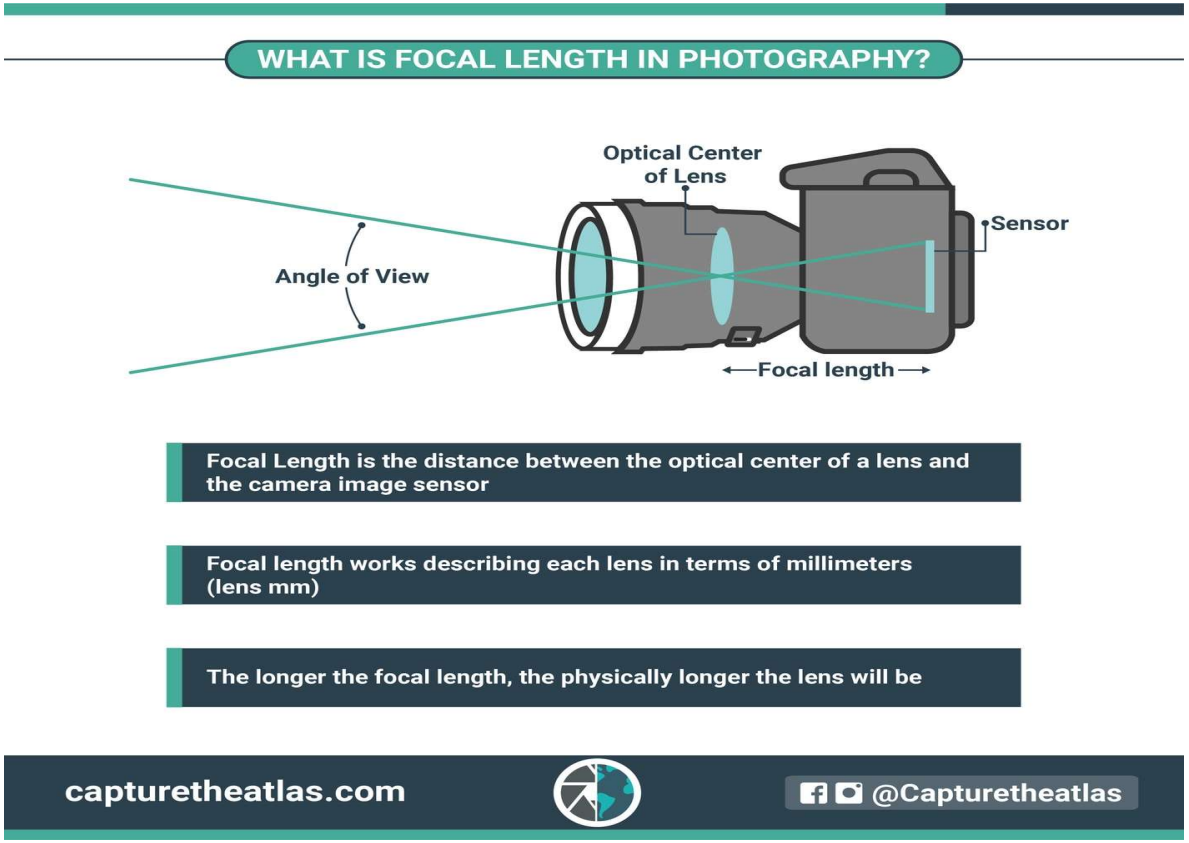


https://www.ni.com/zh-tw/support/documentation/supplemental/18/calculating-camera-sensor-resolution-and-lens-focal-length.html

Focal Length

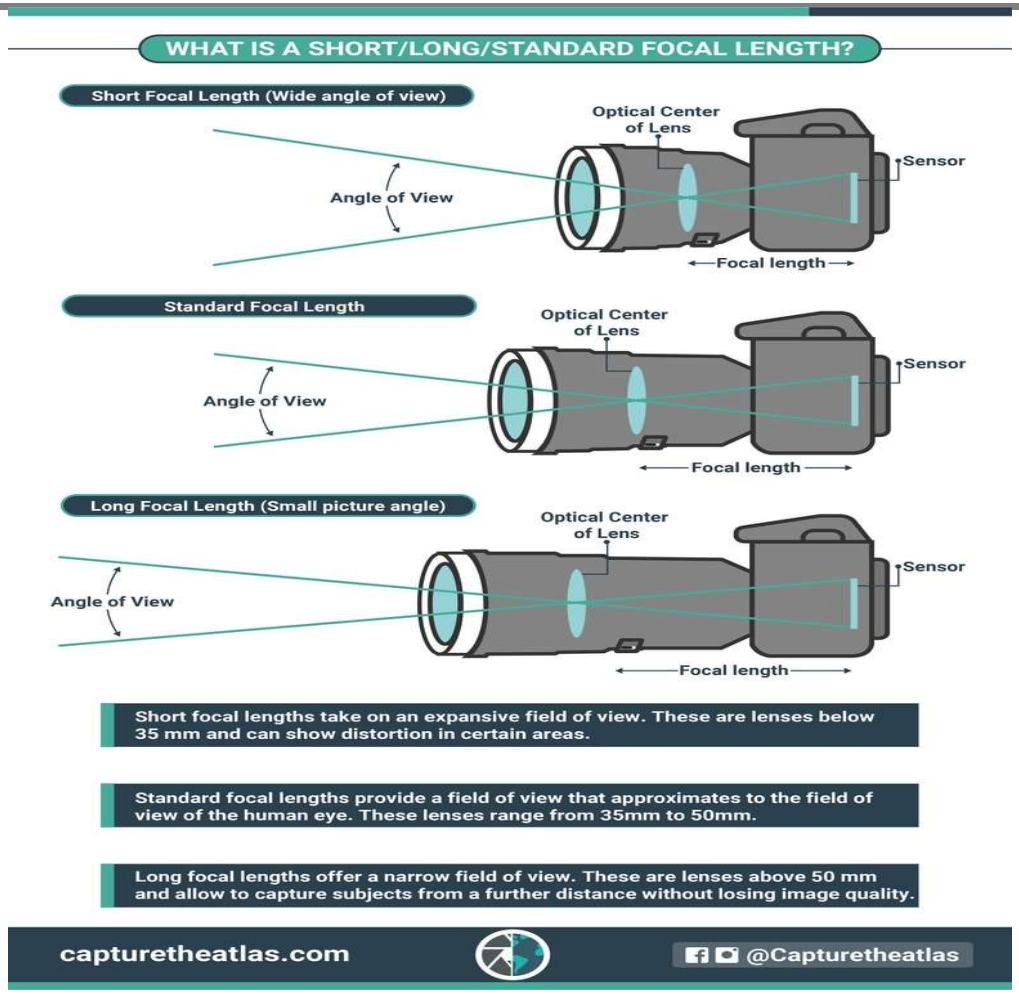


Focal Length



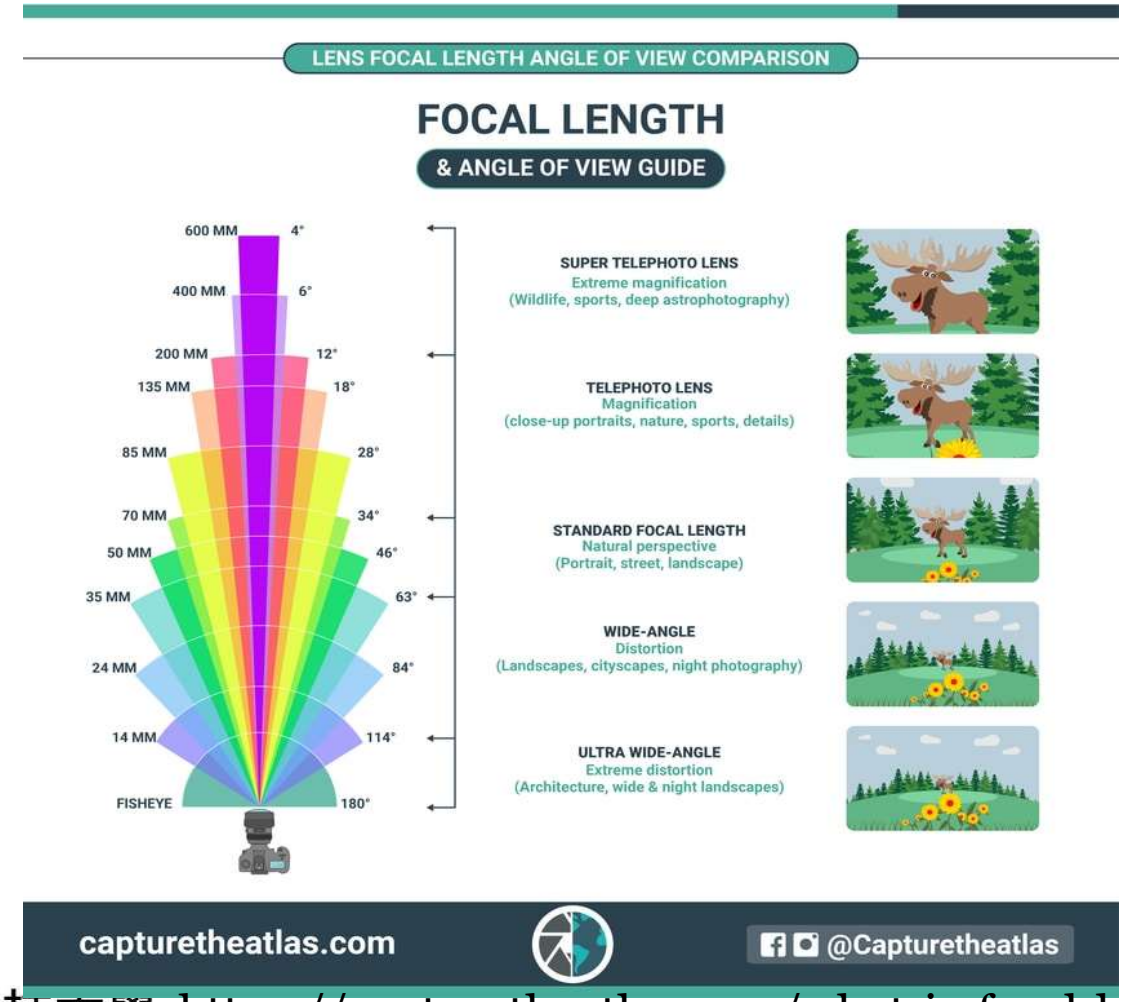
https://capturetheatlas.com/what-is-focal-length/

Focal Length



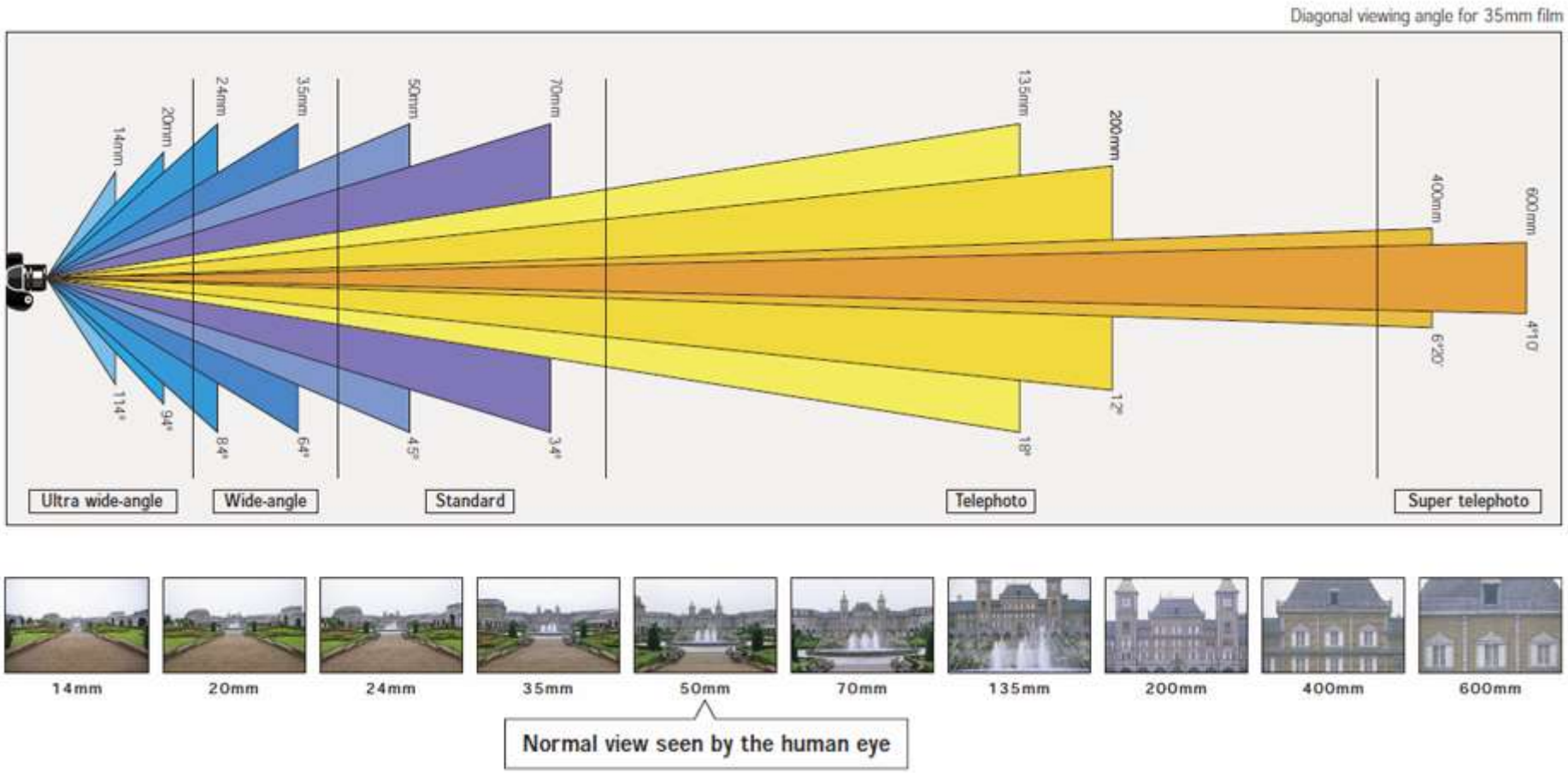
https://capturetheatlas.com/what-is-focal-length/

Focal Length



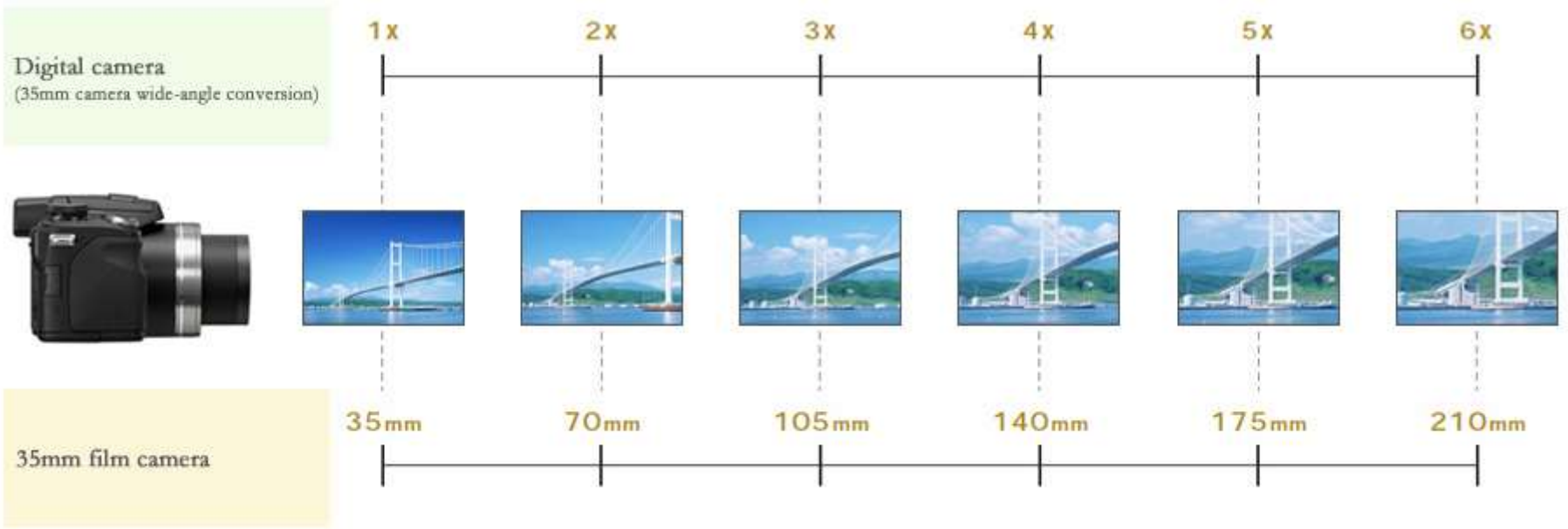
https://capturetheatlas.com/what-is-focal-length/

Focal Length



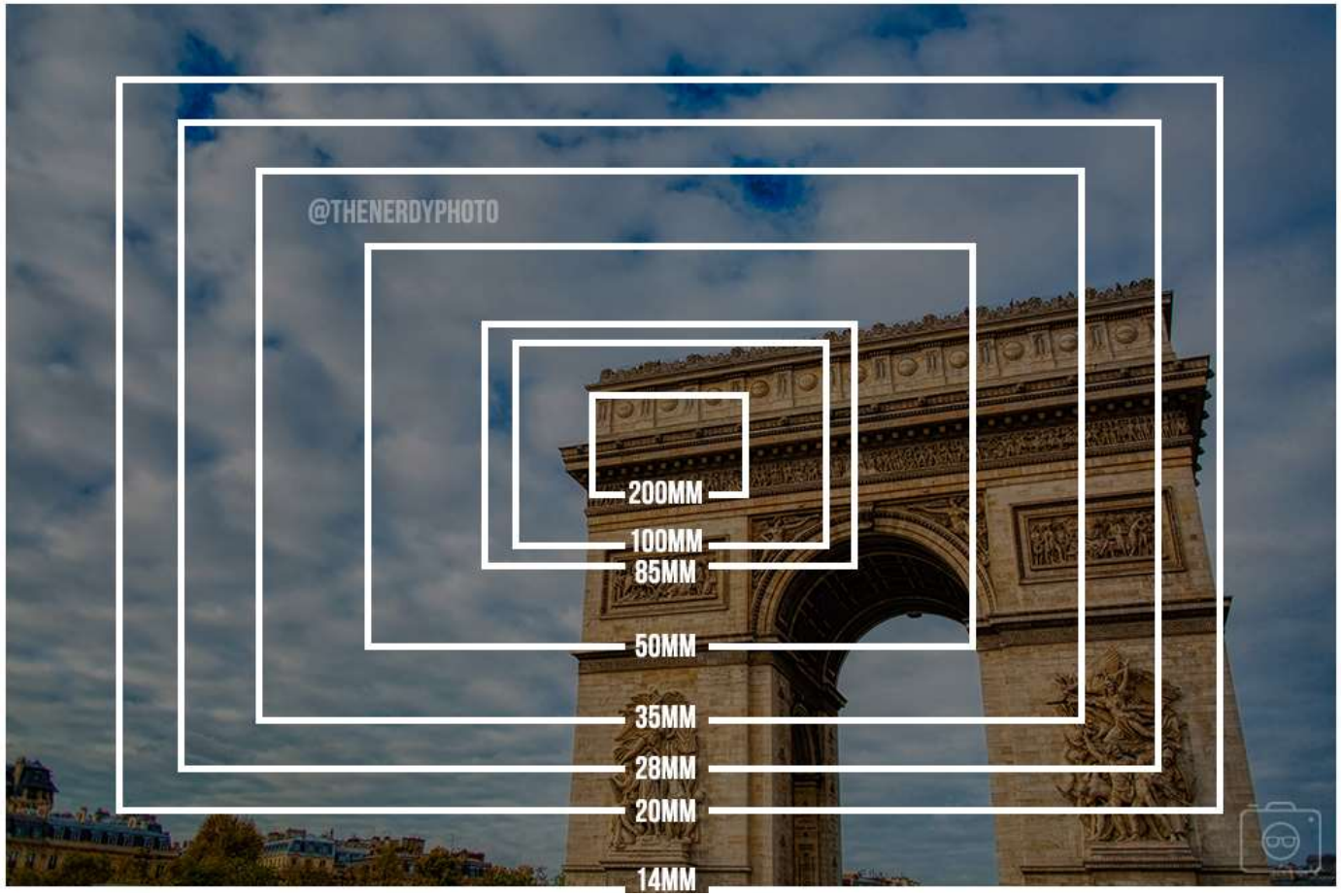
https://av.jpn.support.panasonic.com/support/global/cs/dsc/knowhow/knowhow12.html

Focal Length



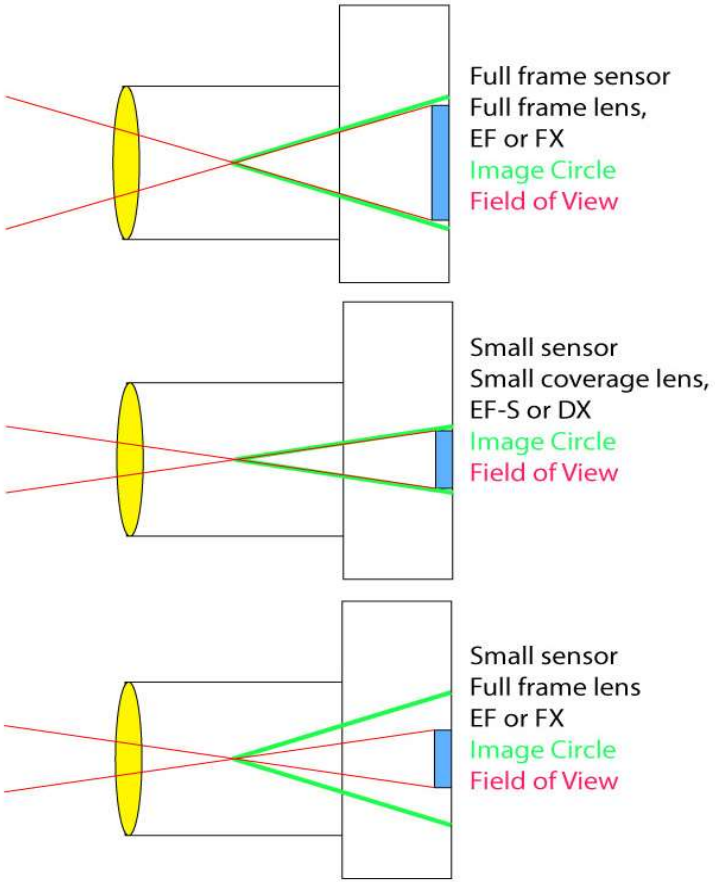
https://av.jpn.support.panasonic.com/support/global/cs/dsc/knowhow/knowhow13.html

Focal Length



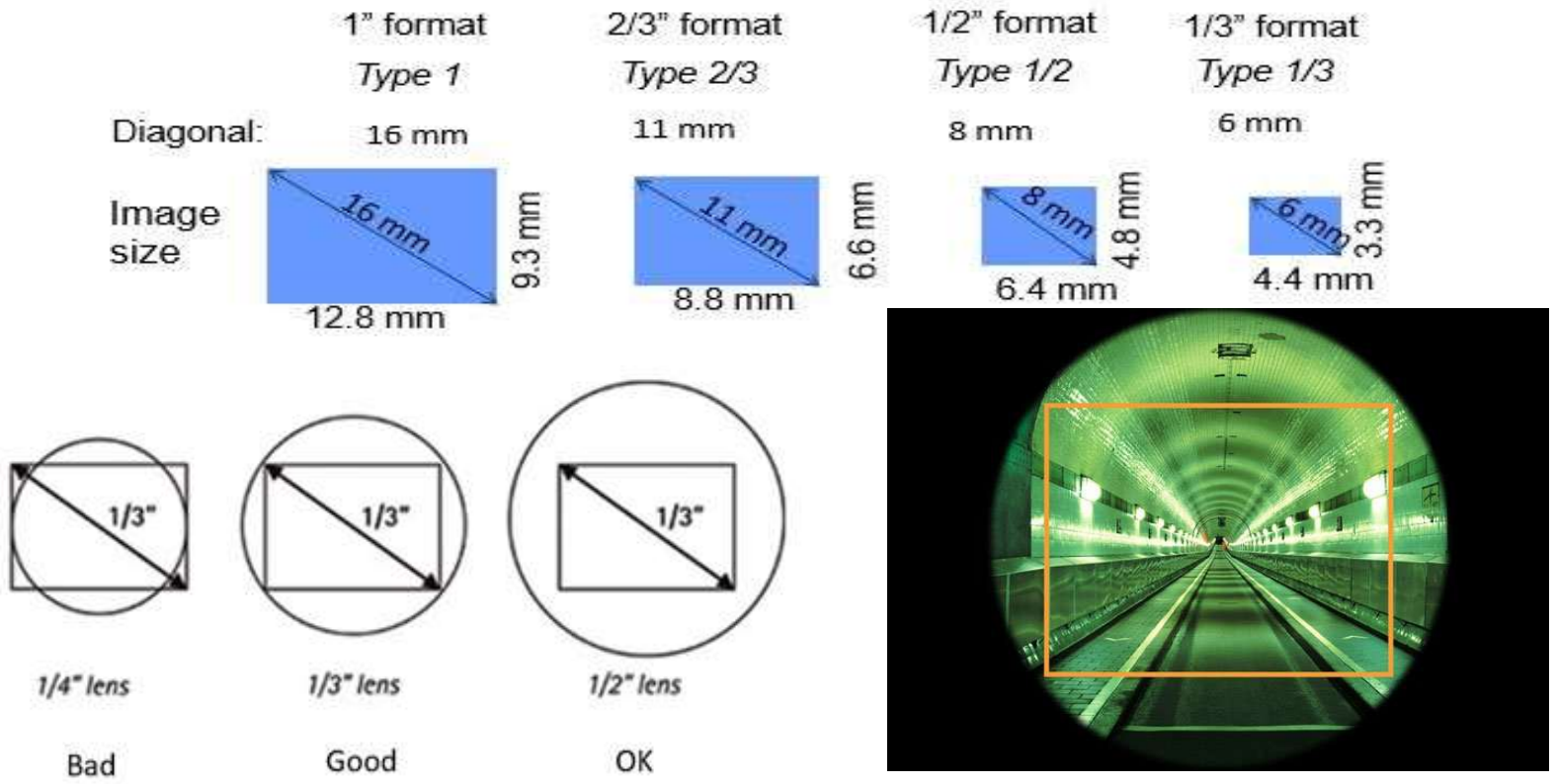
https://nerdyphotographer.com/tips-techniques/lens-focal-length-part-one/

Lens Optical Format



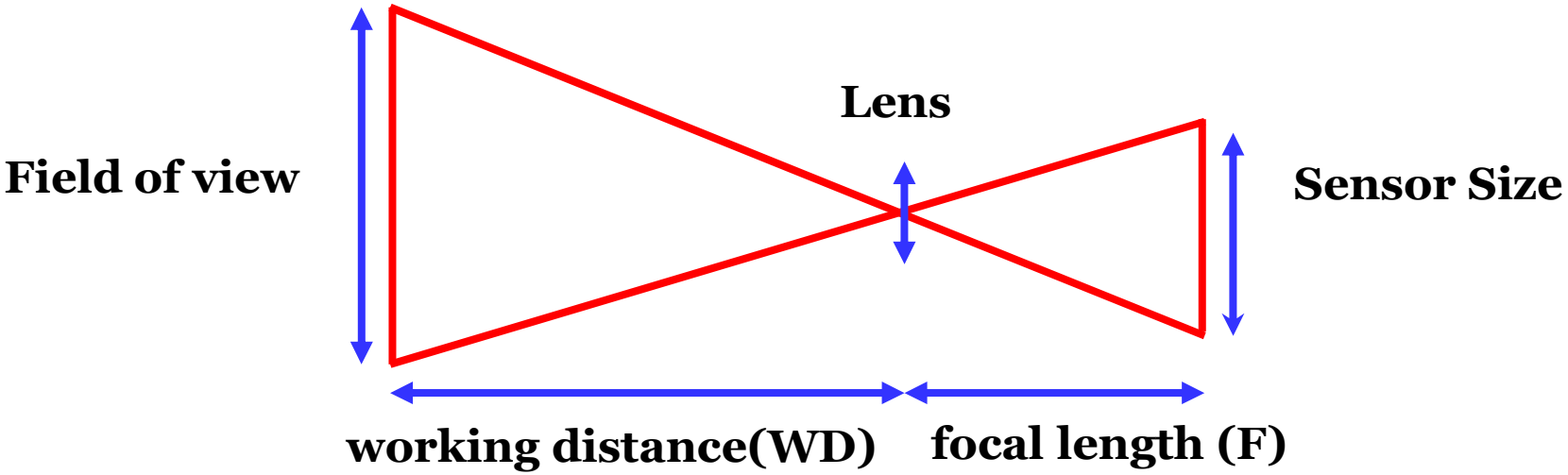
https://www.dimagemaker.com/understanding-canon-ef-s-nikon-dx-and-similar-lenses-for-small-sensor-digital-slr-cameras/

Lens Optical Format



https://www.1stvision.com/machine-vision-solutions/2017/08/how-does-a-lens-optical-format-relate-to-machine-vision-cameras.html

Computer Vision

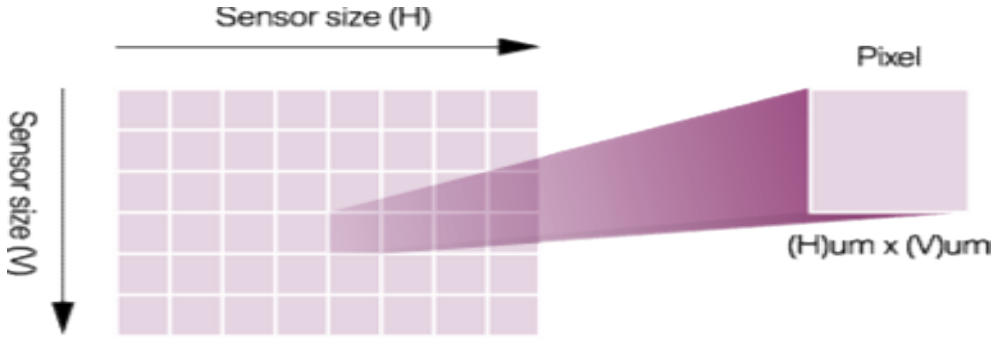


$$\frac{\text{Focal Length(F)}}{\text{Sensor Size}} = \frac{\text{FOV}}{\text{WD}}$$

Sensor Size

Sensor size is the size of the sensor inside a camera
Pixel size is the size of image sensor that compose image sensor
Sensor size = Pixel size (V) or (H) x Effective Pixel amount (V) or (H)
ex:

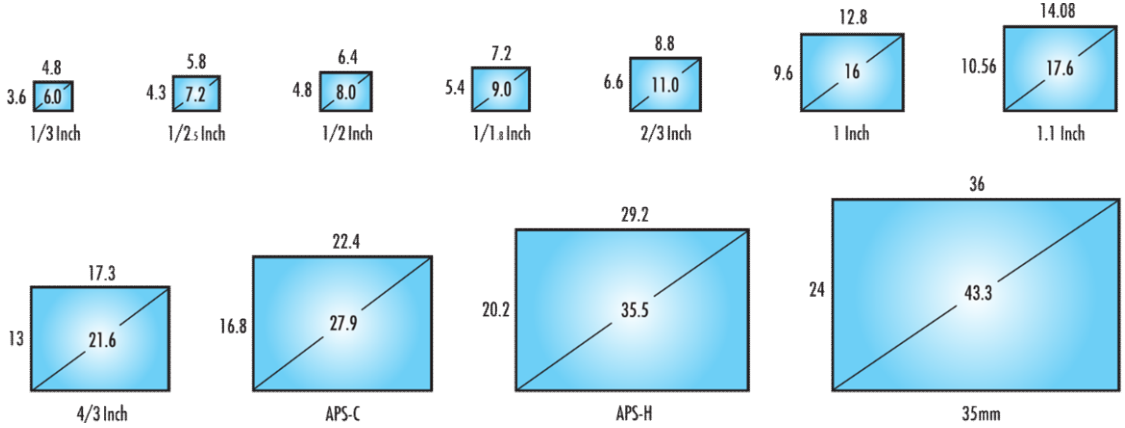
Pixel size: 4.4μm x 4.4μm
Effective Pixel amount : 1600 x 1200
Sensor size (H) = 0.0044 x 1200 = 5.28mm
Sensor size (V) = 0.0044 x 1600 = 7.04mm
Sensor size = 7.04 x 5.28 mm

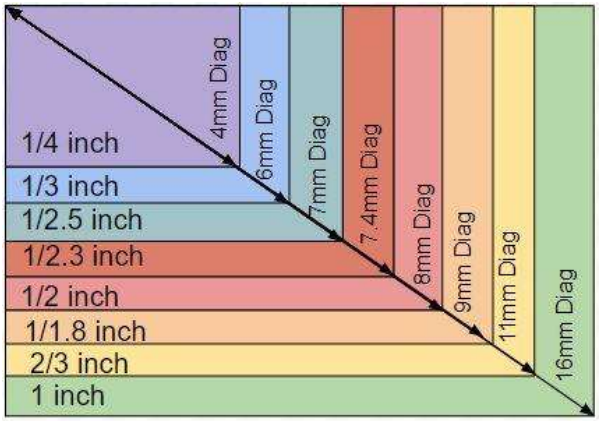


https://vst.co.jp/zh-hant/glossary/sensor-size-pixel-size/

Lens Optical Format

- Standard area-scan sensor sizes
  - ¼", 1/3", ½", 1/1.8", 2/3", 1" and 1.2"





https://www.baslerweb.com/en/vision-campus/vision-systems-and-components/find-the-right-lens/

Sensor Size

- **CMOS Camera (acA2440-20gm - Basler ace)**
  - The Basler acA2440-20gm GigE camera with the Sony IMX264 CMOS sensor delivers 23 frames per second at 5.0 MP Resolution.
  - Sensor Size: 8.4 mm x 7.1 mm
  - Resolution (H x V): 2448 pixle x 2048 pixel
  - Resolution: 5 million pixel camera
  - Pixel Size (H x V): 3.45 µm x 3.45 µm

Sensor Size:

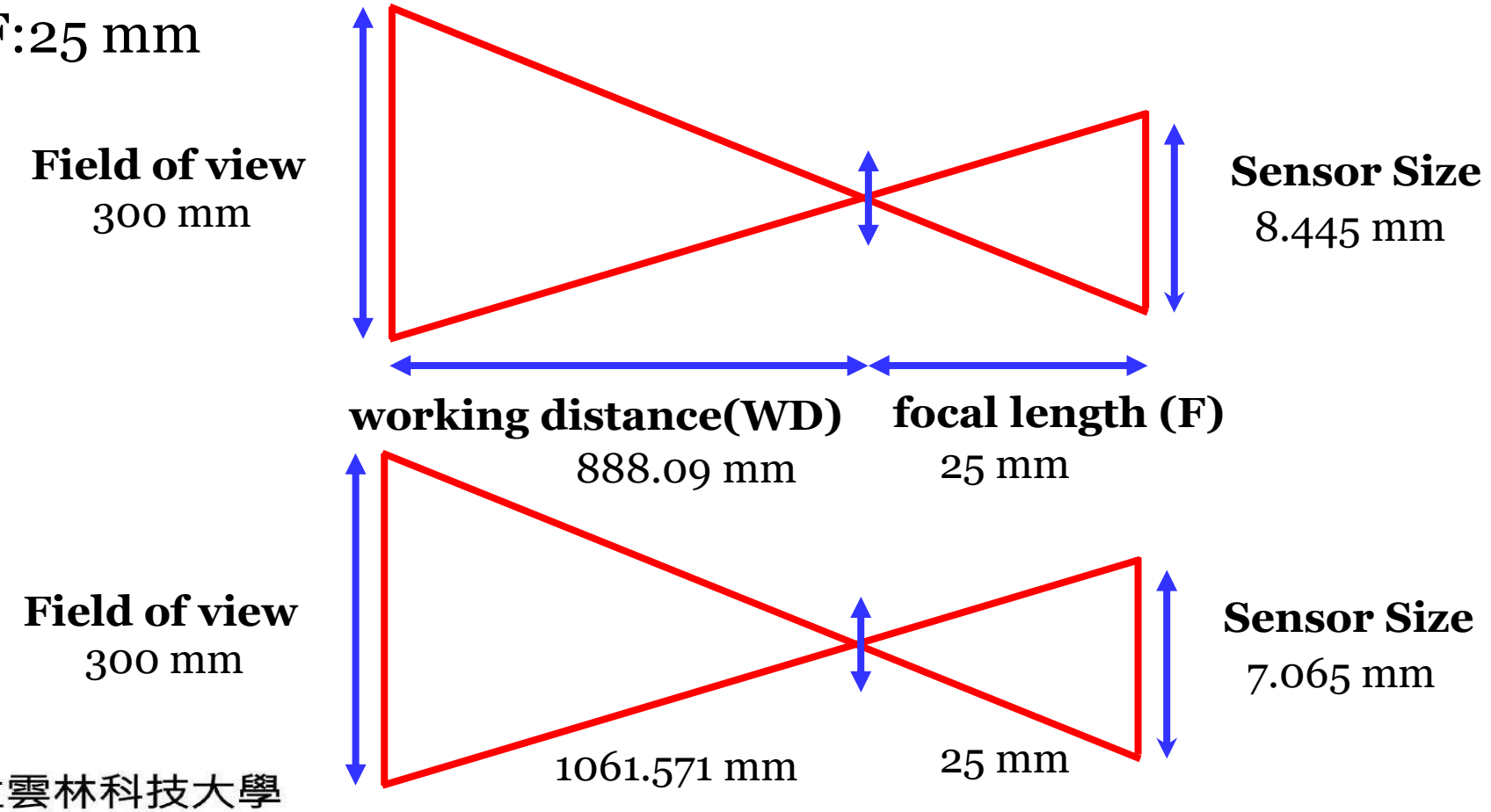
- 2448 x 3.45 µm = 8.445 mm
- 2048 x 3.45 µm = 7.065 mm

- **Lens (ICL-DM2518I-5M)**
  - 25mm 0.083x - 0.05x 300 – 500 1.8

https://www.baslerweb.com/en/products/cameras/area-scan-cameras/ace/aca2440-20gm/
https://www.photon-tech.com.tw/zh/product/show/54

Q & A

- FOV:30cm x 30cm
- F:25 mm



Sensor Size

- **CMOS Camera (BTK-CA060-11GM)**
  - Sensor Size: 7.37 mm x 7.37 mm
  - Resolution (H x V): 3,072 pixel × 2,048 pixel
  - Resolution: 6 million pixel camera
  - Pixel Size (H x V): 2.4μm×2.4μm

- **Lens**
  - 12mm 2/3吋 5M Len

https://www.forwin1.com/include/download.php

Reference

- **Learn DIP**
  - https://www.tutorialspoint.com/dip/index.htm
- **Stanford**
  - https://web.stanford.edu/class/cs231a/course_notes/
- https://www.scratchapixel.com/lessons/3d-basic-rendering/3d-viewing-pinhole-camera
- https://www.itread01.com/content/1543965183.html
- https://www.sipotek.com/hyxw/314.html
- https://allen108108.github.io/blog/2020/02/06/%E9%87%9D%E5%AD%94%E7%9B%B8%E6%A9%9F%E6%A8%A1%E5%9E%8B%20%20Pinhole%20Camera%20Model/

Resolution

攝影機	解析度	掃瞄線(TV LINE)	圖素(PIXELS)	明亮環境	昏暗環境
CCD 彩色攝影機	高解析	470條~580條	38萬~41萬	畫質較細膩	較差
	中解析	330條~420條	25萬~29萬	佳	佳
CCD 黑白攝影機	高解析	480條~600條	38萬~41萬	畫質較細膩	較差
	中解析	350條~420條	25萬~29萬	佳	佳
CMOS (黑白彩色) 攝影機	高解析	350條	35萬	不佳	不佳
	中解析	330條	25萬	不佳	不佳
	低解析	250條	10萬	不佳	不佳

https://documen.site/download/5af60f28f053c_pdf#

C270 Camera

- Logitech C270 camera is not focused at the scanner working distance (about 300 mm), but it is focused at a longer distance. This may cause inaccurate pattern detection and worse calibration values.