Today: Focus, aperture, DOF

Available for checkout:
Cell phone lens kit: macro, telephoto & wide angle
Neb

PHOTOGRAPHY FUNDAMENTALS

1) Framing
2) Camera
3) Lenses
4) Exposure Control
5) Resolution

3) LENSES

TRY THIS NOW
Make images at different lens focal lengths (zooms) and note the image compression effect.

Got your camera today?

FOCUS

'In focus' when all collected light from a point on the object shows up at a single point in the image.

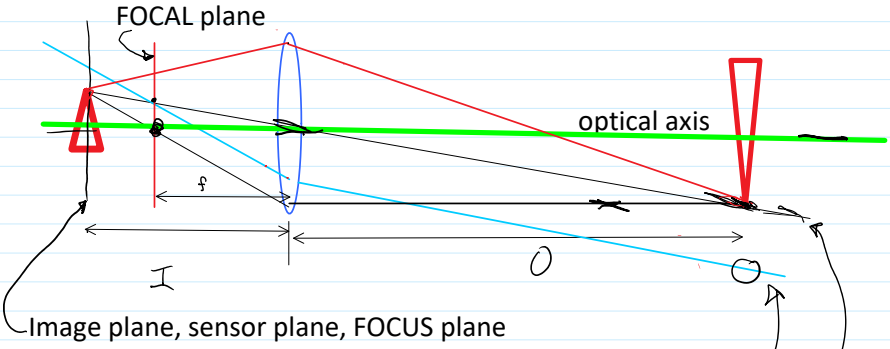
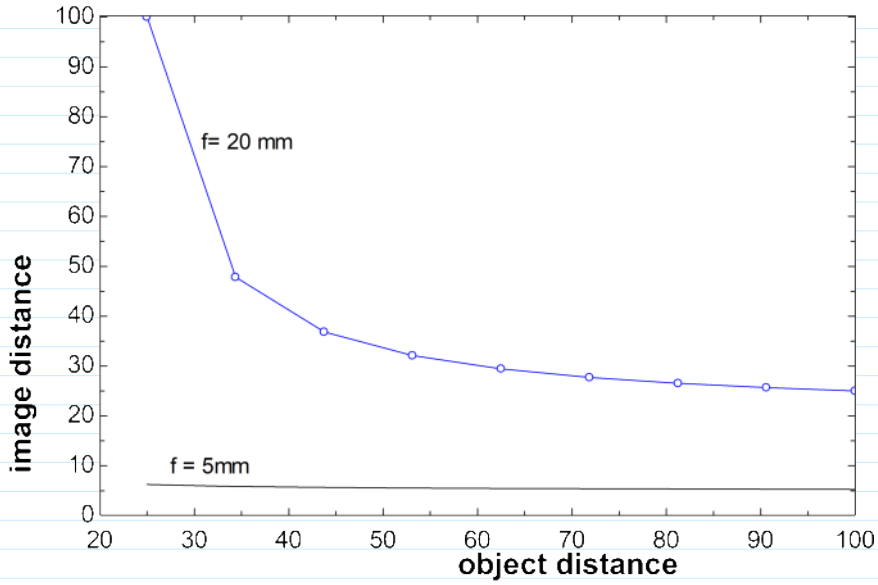


Image plane, sensor plane, FOCUS plane

Lens laws:
1) light through center of lens is undeflected
2) light parallel to axis goes through focal point
3) all light entering lens at a given direction ends up at the same point in the focal plane

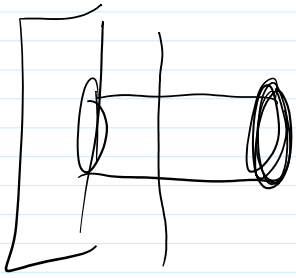
$$\frac{1}{f} = \frac{1}{Ob} + \frac{1}{Im}$$

For a set focal length, as an object moves closer, lens must move away from sensor plane to keep focus plane at sensor. Mechanical limit defines closest possible object distance for focus.



This is why small cameras with small sensors and short focal lengths have better macro capability than larger cameras. Hardly have to move the lens at all.

<file://C:\Users\hertzber\Documents\01CLASSES\FlowVis\Content\objectimagedistances.EES>



Extension tubes (for DSLR) allow lens to move further out and focus closer. $75 set of 3

"Reverse macro" adapters let you turn the lens around, or put a reversed lens at the end of your normal lens. $15.
Caution, interior lens element is now exposed, easily scratched.

'Close up' lenses allow close focus by changing system f . Long f lens, threads on to the outer end of main lens (threads standard, but need to match diameters).
Lower quality, though. Each additional lens element can lose 10% of light, introduce aberrations.
PHD cameras and cell phones often lack threads. You can just hold a close up lens out in front, or
mount to cardboard tube. Check focus often.
Inexpensive, $6 for set of 4. Available for camera phones too.

Spec'd in 'diopters' = 1/f in meters. Typically +1, +2, +4

$$\frac{1}{f_{TOTAL}} = \frac{1}{f_1} + \frac{1}{f_2}$$

PHD cameras often have 'macro mode' =
Flower Button. Does yours?

For DLSRs, prime and zoom 'macro' lenses are available. Expect high price, hope for quality.

Homework Exercise:

1. Can you get the most magnification by zooming out and moving close, or by zooming in and moving back?
2. At which extreme can you focus closest? What is the minimum distance? What is the FOV there?
3. Make an image of a 25¢ coin. At what lens settings do you get the greatest magnification, where the coin is as large as possible in the image and still sharply in focus?

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Example: Iphone 8. Exported medium resolution image. Quarter size (1 inch, 24 mm) is 166/640 px=0.2594 , 26% of the image, at 3" image distance. No optical zoom.

Most have No optical zoom

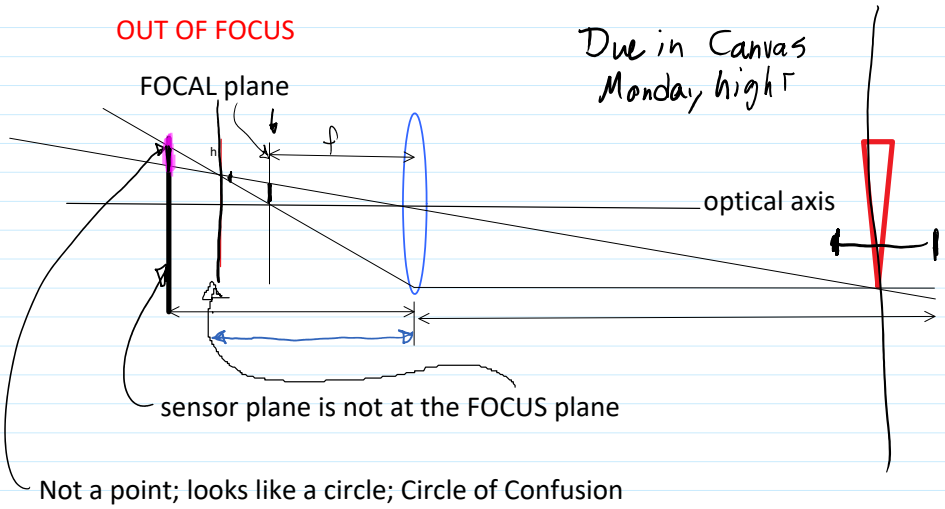
Iphone X does

Homework Results: Can you get the most magnification by zooming out and moving close, or by zooming in and moving back? At which extreme can you focus closest?

zooming out and moving close			by zooming in and moving back?		
Cell	~~PHD~~ small sensor	~~DLSR~~ large sensor	Cell	PHD	DLSR
	4	2		8	12

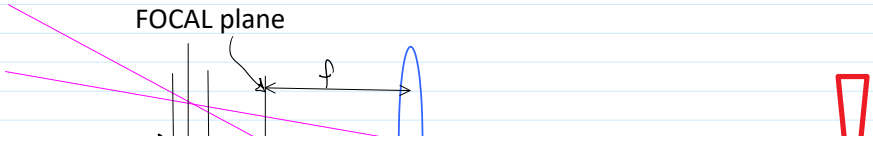
OUT OF FOCUS

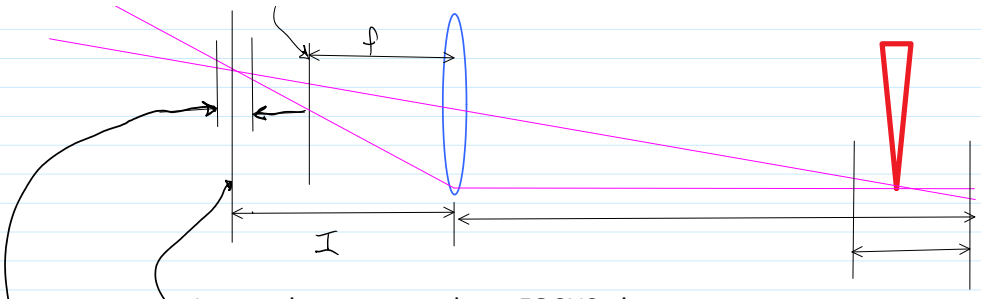
Due in Canvas Monday night



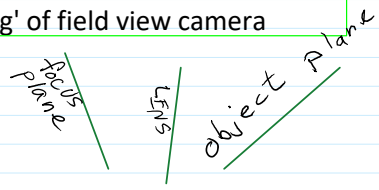
Not a point; looks like a circle; Circle of Confusion

Depth of Field

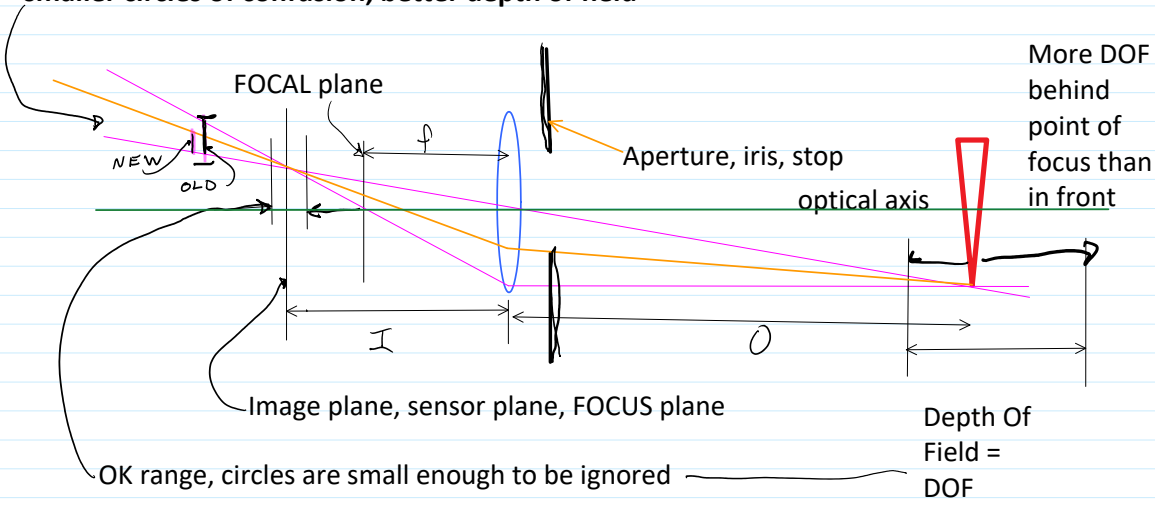


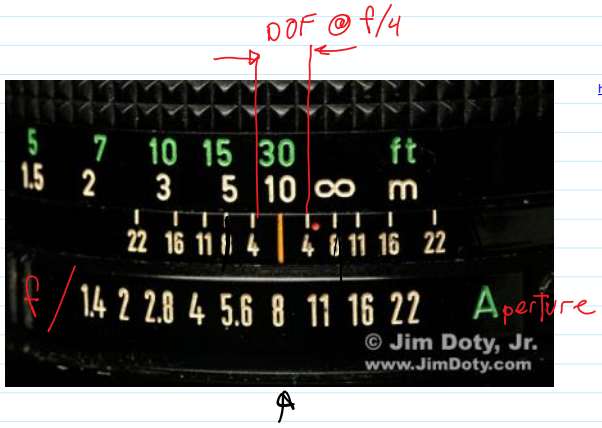


LensBaby: lets you angle the lens axis compared to the camera body axis. Effectively makes the object plane not parallel to the sensor plane. Same as 'swing' of field view camera
http://lensbaby.com/lenses



Improve DOF by reducing aperture diameter: smaller hole, smaller circles of confusion, better depth of field



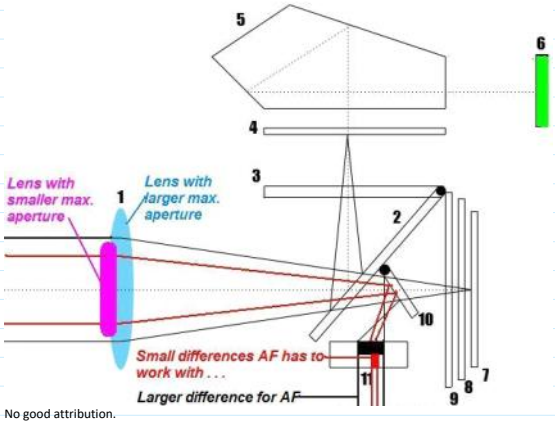


http://jimdoty.com/learn/exp101/exp_big3/exp_big3.html

More DOF behind best focus because of nonlinear lens equation

Detailed article on DOF:
http://www.largeformatphotography.info/articles/DoFinDepth.pdf

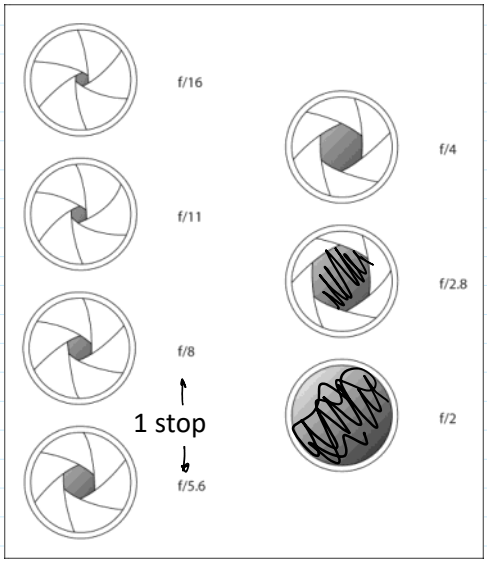
Worse autofocus performance at small apertures. Use a large diameter lens/ large aperture for low light levels.



No good attribution.
https://www.canonrumors.com/forum/index.php?topic=15521.0

BUT, what else happens as aperture gets smaller? What is the problem with tiny apertures?
Think, pair, share

LESS LIGHT



Aperture (iris) mechanism made from overlapping pivoting leaves.

Aperture has impact on exposure too, how much light total hits the sensor.
Units: 1 stop = 1 EV Exposure Value = factor of 2 in area, light.
Camera adjustments in 1/3 stops

Stop used to be a metal plate with hole punched in it. It stopped light.

2.8, 3.5, 4, 5.6, 8, 11, 16, 22, 32, 45, 64

$f/ = \frac{f}{D}$ or f#

http://media.wiley.com/assets/1007/41/0-7645-9802-3_0213.jpg

http://www.lavideofilmmaker.com/cinematography/f-stops-focal-length-lens-aperture.html

Ansel Adams founded f/64 club. Tiniest hole, maximum DOF.
Modern lenses often best sharpness at f/5.6 or design point. We will come back to this when discussing resolution.

Homework Exercise: Make the same image with three f/stops:
max, min and low medium. (Keep ISO the same, and use tripod
or keep shutter time short.) Inspect the three images closely.
What happened?

4. EXPOSURE

For a given light intensity, exposure = (aperture area) X (time shutter is open)

Shutter speeds: 30 = 1/30th of a second etc.
5 = 1/5th of a second
30" = 30 seconds
T = time, click to open shutter and again to close
B = bulb, shutter stays open as long as button is pressed (or bulb is squeezed)

Check your camera shutter speed options. What is the range?
Tv or S = Time priority; you set the shutter speed and ISO, camera AE will choose the aperture.
Av = aperture priority. You choose the aperture, camera will choose shutter speed.

Equivalent exposures: f/5.6, 1/100 sec
f/8, 1/50 sec
f/11, 1/25 sec