

11. Exposure

Wednesday, October 2, 2024 5:36 PM

Today:
Admin
Exposure
Aperture
Shutters
Sensitivity: ISO

'Every day
I see or hear
something
that more or less
kills me
with delight,
that leaves me
like a needle
in the haystack
of light.'
From 'Mindful' (2004) by American poet Mary Oliver.

Admin

The Lia-Kate-Sarah team cleaned up the fish tank flume, and filled it with rheoscopic fluid. Available in ITLL for other teams. Big ITLL flume is being repaired; not ready yet.

Michael Reardon joining Team 4. Good schedule match. Austin and Pablo.

CLICKERS TODAY, YES!

4. EXPOSURE

For a given light intensity, exposure = Total photons hitting the sensor: (aperture area) X (time shutter is open)

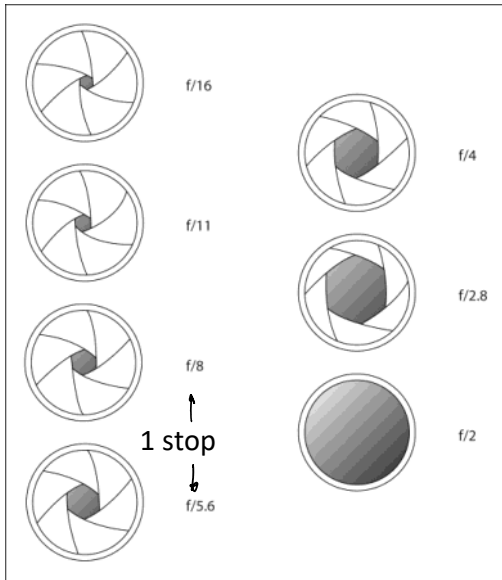
Aperture

$$f/ = \frac{f}{D} = \frac{\text{focal length}}{\text{aperture diameter}}$$

Aperture has impact on exposure too, how much light total hits the sensor.

- Exposure units: 1 stop = 1 EV Exposure Value = factor of 2 in area, or total light, or sensor sensitivity.
- Camera adjustments in 1/3 or 1/2 stop steps

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



Aperture (iris) mechanism made from overlapping pivoting leaves.

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



F-stop series, 1 stop increments: 1.4, 2, 2.8, 4, 5.6, 8, 11, 16, 22, 32, 45, 64
WRITE THIS DOWN, we'll use in in a few minutes

Shutters

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)

In groups:
Check your camera shutter speed options. What is the range?
Shutter Speed

make a loong time exposure

Proper exposure = middle value on an average pixel

Same image brightness
 f/5.6, 1/100 sec, ISO 200
 f/8, 1/100 sec, ISO 400
 f/4, 1/400 sec, ISO 400

OK, many combinations lead to the same overall brightness. How to choose?

In groups, what are the side effects of each choice?

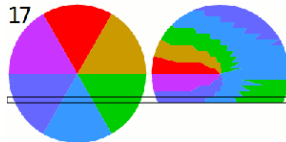
Side Effects	If you want your photo		Side Effects
	Darker	Brighter	
DOF ↑ sharpness may ↓	Aperture 		DOF ↓
?	Shutter Speed 		Motion blur
Might miss details quantization	ISO Sensitivity 		Noise

Types of Shutters

	Mechanical	Electronic
Global	×	×
Rolling	×	×

Four types exist.

Rolling shutter



https://commons.wikimedia.org/wiki/File:Rolling_shutter_effect_animation.gif

Electronic shutters do this all the time.
 Mechanical shutters do this at speeds above the sync speed, > 1/60th sec typically
 Flash illumination only works for speeds < sync.

Rolling electronic shutters have lower hardware and data processing requirements than global.

~95% of digital cameras have rolling electronic shutters. Maybe 5% have global shutters; whole sensor is turned on and off at once, then read off line by line. Slower than rolling shutter. Industrial/pro use only. But this could change in the next few years!

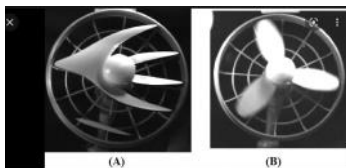


Fig 3.18 Global shutter (B) versus rolling shutter (A) and motion blur distortion [84]

From <https://www.researchgate.net/publication/242404501>
[Foveated Sampling Architectures for CMOS Image Sensors/figures?lo=1](https://www.researchgate.net/publication/242404501/figure/fig1)

Mechanical shutter operation:

https://www.youtube.com/watch?v=YNhakG6_RBk

2:08 - 2:52

https://commons.wikimedia.org/wiki/File:SLR_-_DSLR_optical_diagram_07.gif



Sync Speed = highest speed when entire sensor is exposed and turned on

Strobe or Flash with thus expose whole image.

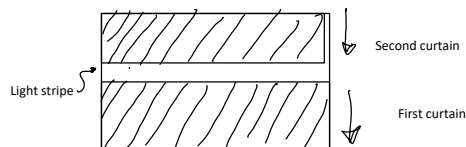
If shutter speed is higher than synch, only part of the image will catch the flash.

Mechanical shutters are global for speeds < synch speed

Rolling for speeds > synch

Second curtain starts moving before first curtain finishes

Light stripe gets smaller as speeds get higher



Mechanical vs Electronic (rolling) Shutters

Advantages to Using A Mechanical Shutter

- Sync better with flash – mechanical shutters tend to allow you to operate the flash at higher speeds than an electronic shutter
- ~~They cope better than electronic shutters with flickering light sources~~
- Reduce Rolling Shutter distortions – Rolling shutters (a type of electronic shutter) can often result in lateral distortion of images especially when the camera is panned quickly, or a subject is on motion.
- ~~They cope better than electronic shutters with flickering light sources~~

Disadvantages of Using A Mechanical Shutter

- Reduced Top Shutter Speed – The mechanical nature of these kinds of shutters means that the maximum speed is usually less than electronic shutters
- They have a life span – as mechanical shutters feature moving parts these are obviously prone to wear and tear and may stop working over time. Most cameras that come with a mechanical shutter system will have a "shutter count" or number of times the shutter can be used before it might start to fail.
- Camera shake – The movement of the shutter doors and mirrorbox can cause minor camera shake although inbuilt image stabilisation can help reduce this.
- Response Time – Again due to the mechanical nature of the shutters there can be a minor delay between pressing the shutter button and the camera taking the photo.

Advantages to Using Electronic Shutters

- They are silent – without the moving parts of a mechanical shutter the camera is silent which is great for wildlife photographers and other situations when you need to not make any noise.
- Faster shutter speeds – electronic shutters eliminate the mechanical shutter delay meaning that a shutter speed of 1/32000th second is not that unusual.
- Higher continuous shooting rates – as the camera doesn't need to wait for the mirror and shutters to physically reset it can be ready to take the next photo quicker.
- No more blackout – as these cameras use an electronic viewfinder you can continue to see through the viewfinder through the shot which is great for long exposures, panning and continuous shooting.

Disadvantages of Using Electronic Shutters

- Potential for Banding and Jelly-like distortion in rolling shutters – this is especially prevalent in fast moving subjects and during panning.
- Flickering light banding – electronic shutters don't always cope with flickering light sources and often banding can be seen which is difficult to remove.
- Slow flash sync speeds – while you can still sync flashes with cameras using electronic shutters the top sync speed is generally much lower.
- No trusted use – in some cameras using an electronic shutter can stop you from using some features of the camera.

<https://photodoto.com/here-is-why-mirrorless-cameras-have-shutters/>

Physically protect the sensor from intense light

Exposure

Put it together: exposure = Total photons hitting the sensor: (aperture area) X (time shutter is open)

Equivalent exposures:

f/5.6, 1/100 sec

f/8, 1/50 sec

Think pair share, what's next in this sequence?

f/11 1/25

The effect of those photons depends on the sensor (CCD, CMOS etc) that converts photons into numbers (three, for RGB) for each pixel

ISO = sensor sensitivity, gain

1 EV = 1 stop = factor of 2 in ISO

100 200 400 800

Check your camera ISO settings. How easy to change?

1. Have ISO button
2. Thumbwheel
3. In a menu
4. mysterious

2024	2023	2022
35	65	39%
47	25	39%
18	5	17%
0	5	4%

What is the highest ISO your camera has?

120,000
6400 |||
3200 |||
512,000

Used to be hard to change sensitivity, ISO: change film or go into menus.

Now is becoming easier; single button or thumbwheel select.

Sensors respond ~ linearly up to a certain ISO. Above that, numbers aren't given, instead rated as H, H2 etc.

The ISO sensitivity of a digital sensor works in a slightly different way to film. A film rated at 200 ISO is physically different to a film rated at 800 ISO, whereas a digital sensor is the same regardless of the ISO setting used in the camera. All digital sensors have a base ISO setting but to achieve higher ISO settings the sensitivity of the sensor is increased.

The sensitivity of a camera sensor is increased in steps which correspond to ISO settings i.e. ISO 100, ISO 200, ISO 400, ISO 800 etc. The difference between ISO 100 and ISO 200 is that ISO 200 is twice as sensitive as ISO 100 (or 1 stop difference). This is also the same between ISO 200 and ISO 400 (1 stop difference).

When increasing a digital camera's ISO sensitivity by a large amount the sensor may perform slightly differently to the ISO standard for that ISO speed. Due to this we rename these settings as Hi 1, Hi 2 or Hi 3 instead of actually naming the sensors ISO setting. Whilst the camera is often performing at levels far past available film speeds, the performance of the sensor, in relation to how much light is needed to expose correctly, may differ by a very small amount to the level expected at that ISO setting.

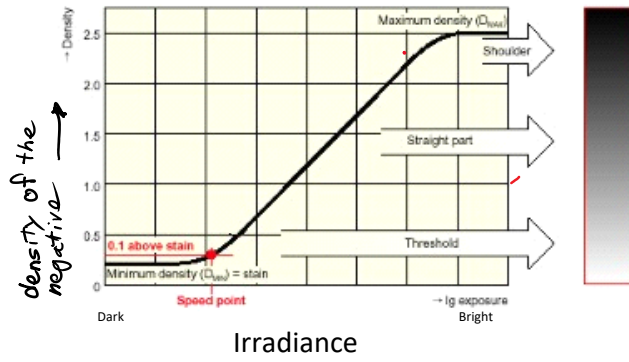
From <https://www.nikonimgsupport.com/na/NSG_article?articleNo=000027508&configured=1&lang=en_SG>

Sensitivity measure used to be called ASA for film.

From [American Standards Association](#) (now named [ANSI](#))

ISO = International Organization for Standardization

Fixing the speed (B/W)



http://www.sapiens.itgo.com/documents/foto/photographic_terms8.htm

Now, digital photography:

Have you been taught to count in binary or base 8 or 16?

Where?	2024	2023	2022
College math class	13	10	10%
College computer science class	33	20	30%
Other college class	13	25	30%
K-12 school	40	30	20
Never	0	15	10

Digital colors are usually expressed in hexadecimal, base 16:

Decimal 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Hex 0 1 2 3 4 5 6 7 8 9 A B C D E F

Bit = 0 or 1

Byte = 8 bits.

One digit in hexadecimal is $2^4=16$ = a nibble

Byte = $2^8 = 256$, FF in hexadecimal

Hex decimal

0F = 16 - 1=15

10 = 16

1F = 16+15 = 31

23 = $2*16 + 3 = 35$

FF = $16*16 - 1=255$ = highest we can count using 2 'digits'. 0 to 255 = range of 256 levels.

RGB

What color does a pixel value of FF FF FF correspond to?

1. Black
2. White
3. Neutral gray
4. Pure red
5. No idea

	2024	2023	2022
20%	43	14	
53	52	67	
0	0	5	
7	0	0	
20	4	14	

