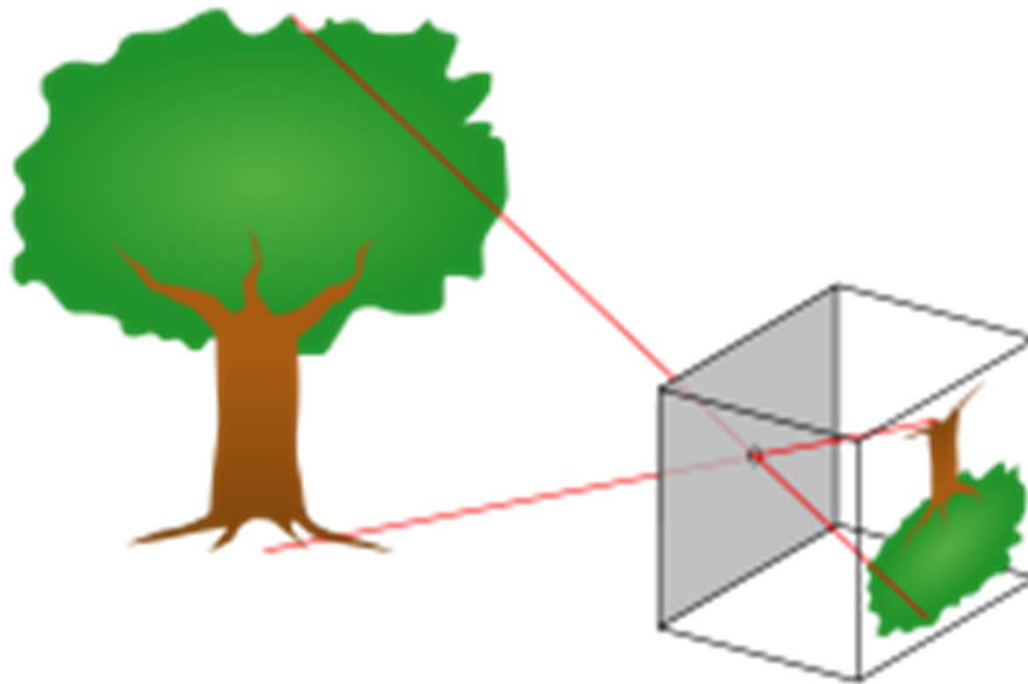


DSLR Cameras and Lenses

Paul Fodor

Camera

- Principle of a pinhole camera:
 - Light rays from an object pass through a small hole to form an image on the sensor:

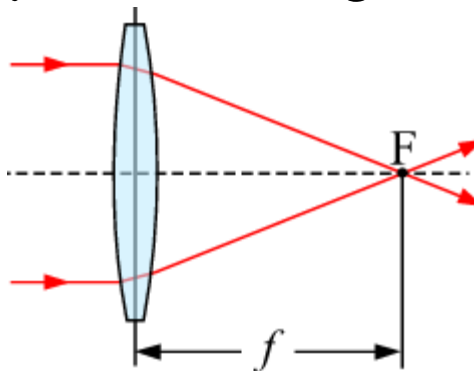


Aperture and Focal Length

- Aperture is the hole through which light travels
 - it regulates the amount of light that passes to form the image



- Focal length (specified in millimetres (mm)) is a measure of how strongly the system converges (focuses) light



- It also determines the distance to the objective that is photographed

Focal length

- Determines the distance to the objective that is photographed



28 mm lens



50 mm lens



70 mm lens



210 mm lens

- $F\text{-number} = f/D$ where f is the focal length and D is the diameter of the aperture
 - It is a measure of the camera light



each aperture has half the light gathering area of the previous one

- Modern lens ads specify the maximum aperture (i.e. the f-stop) of the lenses

Depth of field

- The depth of field (DOF) is the distance between the nearest and farthest objects in a scene that appear acceptably sharp in an image
 - In some cases, a small DOF may be desirable, emphasizing the subject while de-emphasizing the foreground and background:



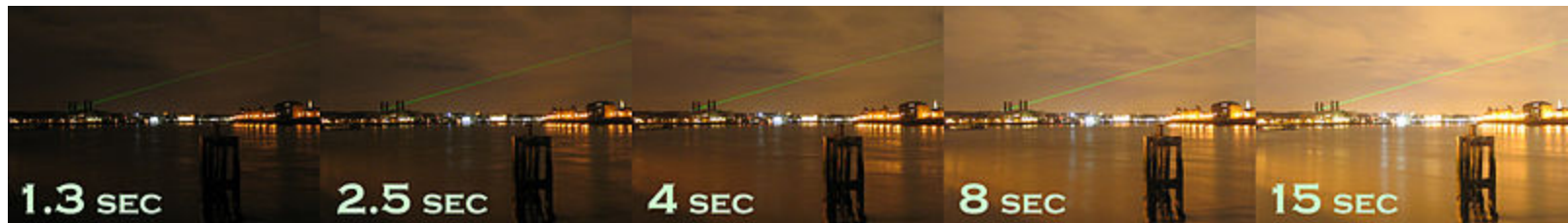
- In other cases, it may be more effective to have the entire image sharp, and a large DOF is appropriate.



(c) 2011 P.Fodor (CS Stony Brook)

Shutter speed

- The *shutter speed* is used to regulate the time during which light may pass through the aperture
 - Standard shutter speeds: 1/500s, 1/250s, 1/125s, 1/60s, 1/30s, 1/15s, 1/8s, 1/4s, 1/2s, 1s, 2s, ...
- A combination of the shutter speed and the aperture gives the *exposure*: the total amount of light allowed to fall on the photographic medium (photographic film or image sensor) during the process of taking a photograph



- The depth of field is also a result of the shutter speed and the aperture

Film Speed (ISO)

- The *film speed* (ISO) is the measure of a photographic film's sensitivity to light
 - ISO standard examples:

ISO100



ISO200



ISO800



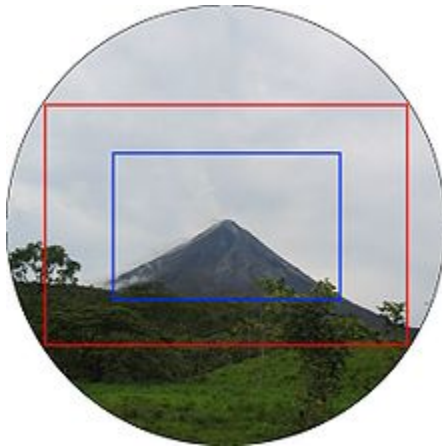
ISO1600



- In digital camera systems, an arbitrary ISO can be achieved by setting the signal gain of the sensor

Image Formats

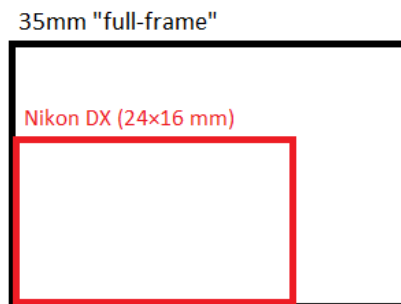
- The *image formats* are the standard sizes of images for photography:
 - The 135 film, 35mm, 24×36 mm (ISO 1007 or *full frame*) is the most popular photographic film format
 - The *crop factor* is the ratio of the dimensions of a camera's imaging area compared to a reference format:



The red box displays what a 24×36 mm sensor would see.

The blue box displays what a 15×23 mm sensor would see.

Most digital single-lens reflex (DSLR) cameras on the market have reduced APS-C-sized image sensors:



e.g., Nikon DX is the sensor size for all the Nikon DSLR cameras except the full-frame D3, D3s, D3x and D700 – it is about $2/3$ of a 35mm film format

Digital Single-Lens Reflex camera

- Digital Single-Lens Reflex (DSLR) cameras are digital cameras that use a mechanical mirror system and pentaprism to direct light from the lens to an optical viewfinder on the back of the camera.
 - accurate preview of framing close to the moment of exposure
 - The major difference between a DSLR and an ordinary digital point-and-shoot camera is the reflex design scheme: the image captured on the camera's sensor is **also** the image that is seen through the view finder: light travels through a single lens and a mirror is used to reflect a portion of that light through the view finder (i.e., Single Lens Reflex).
- 2007 market: Canon 41%, Nikon 40%, Sony 6%, Olympus 6%
- 2010 market: Canon 44.5%, Nikon 29.8%, Sony 11.9%

Nikon DSLR cameras

		1999			2000			2001			2002			2003			2004			2005			2006			2007			2008			2009			2010			2011			2012					
		2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4						
Professional	Flagship	D1			D1X									D2X						D2Xs									D3X																	
					D1H									D2H			D2Hs						D3						D3S						D4											
	Compact																												D700												D800/D800E					
														D100									D200						D300						D300S											
Consumer	Advanced																D70			D70s			D80						D90			D7000														
	Mid-range																			D50						D40X			D60			D5000						D5100								
	Entry-level																									D40									D3000			D3100								
Early models		Nikon Still Video Camera (Prototype, 1986) • Nikon QV-1000C (1988) • Nikon NASA F4 (1991) Nikon E2/E2S (1995) • Nikon E2N/E2NS (1996) • Nikon E3/E3S (1998)																																												
		Full-frame (FX format) camera. — Without an AF motor (needs lenses with integrated motor for autofocus). — HD video capable (Video AF)																																												

Nikon DSLR cameras



- Nikon D7000 (entry level advanced)(2010)
 - DX sensor
 - 16.2 megapixels
 - 39 focus points
 - Video: full HD 1080p (at 24 frame/s) movie mode with auto-focus while filming, mono sound, and stereo external mic support.
 - Alternative: 30 frame/s, 25 frame/s, 24 frame/s when recording at 720p
 - \$1,400 on Amazon with 18-105mm f/3.5-5.6 AF-S DX VR ED Nikkor Lens included

Nikon DSLR cameras



- Nikon D800 (professional compact)(2012)
 - FX sensor – “full frame”
 - 36.3 megapixels
 - 51 focus points (15 cross-type, 11 points sensitive at maximum apertures F8)
 - Video:
 - 1080p Full HD movie mode at 24/25/30 fps
 - 720p at 24/25/30/50/60 fps
 - \$2,999 on Amazon

Nikon DSLR cameras



- Nikon D4 (Nikon flagship camera)(2012)
 - FX sensor – “full frame”
 - 16.2 megapixels
 - 51 focus points
 - Video: full HD 1080p (at 24 frame/s) movie mode with auto-focus while filming and stereo mic.
 - Alternative: 30/60 frame/s and 25/50 frame/s when recording at 720p
 - \$5,999 on Amazon

Nikon focus modes

- Nikon has multiple focus (AF) modes:
 - **AF-C** (short for Auto Focus Continuous, sometimes called continuous servo) is used when photographing moving objects.
 - When you focus AF-C on a moving subject, the focus will stay on the animal so long as your shutter button is held half way down (the camera will keep re-focusing as the animal moves and you keep your shutter button held half way down).
 - **AF-S** (short for auto focus single) is good for photographing subjects that don't move (flowers or portraits).
 - When you press the shutter button halfway, it locks the focus on the non moving object that you want to photograph. You can then move the camera and take the photograph.
 - **AF-A** (auto default) guesses if the subject is stationary or moving, and accordingly sets the focus to either **AF-C** or **AF-S**

Nikon Image Formats

- Nikon DX format is 2 / 3 of “full frame” format
 - When DX format lenses are used on 135 format (35mm film or FX format) cameras, vignetting often occurs, as the image circle does not cover the entire area of the 135 format.
 - DX cameras take every lens (by using only the inner part of the lens).
- Nikon FX format is the name for “full frame” image sensors
 - FX cameras cannot use DX lenses in “full frame” mode because the smaller image circle will give black corners at some or all settings.
 - **However, digital FX cameras usually crop their sensors automatically for the DX lenses and use only the smaller DX inner portion of their sensors!!!**

Nikon F-mount

- The Nikon F-mount (1959-) is a type of interchangeable lens mount developed by Nikon for its 35 mm SLR cameras
- *Autofocus* Nikkor lenses:
 - **AF** (1986): focus driven by a motor inside the camera body - all AF lenses have a CPU to compute the motor movement formula
 - **AF-S** (AutoFocus-Silent) (1996-): focus quietly and quickly
 - **PC** (Perspective Control lenses): support shifting the lens in relation to the film or sensor plane-used for macrophotography
 - **PC-E** (the "E" designates an electromagnetic diaphragm) (2008-) offer automatic aperture control
 - **IF** (Internal Focus): accomplishes focus through the movement of internal lens groups, eliminating extension and rotation of the front lens element, allowing focus to be driven quickly by a small motor

Nikon lenses (cont.)

- **AF-I** (AF-Internal Motor) (1992-): the internal motor focusing the lens is controlled electronically (not by a mechanical AF connection between camera and lens)
- **ED**: uses "Extra-low Dispersion" glass to reduce chromatic aberration
- **N**: indicates a new type of lens coating called the "Nano Crystal Coat" used for some telephoto lens
- **VR** (Vibration Reduction): uses a moving optical group to reduce the photographic effects of camera shake.
 - Some VR lenses also support a panning mode, detecting horizontal movement of the lens and minimizing only vertical vibration.
- **G** (gilded): have their aperture rings removed to save cost (won't work on manual focus cameras)

Nikkor Lenses

- Lens types and Nikkor examples:
 - Manual Focus Primes: fixed lenses (15 mm $f/3.5$, 50 mm $f/1.4$)
 - Autofocus Primes: autofocus fixed lenses (50 mm $f/1.4D$ AF)
 - D means Double-Gauss lens (reduce optical aberrations over a large focal plane)
 - Micro Lenses: for macro photography (85mm $f/2.8D$ PC-E Micro)
 - Manual Focus Zooms: 25–50 mm $f/4.0$, 70–210mm $f/4.5-5.6$
 - Autofocus Zooms: 17–35 mm $f/2.8$ ED-IF AF-S,
80-200mm $f/2.8D$ ED AF-S
 - Vibration reduction (VR) lenses in FX (full-frame) format:
600 mm $f/4G$ ED-IF AF-S VR N
 - Lenses for Nikon DX format: 35 mm $f/1.8G$ AF-S DX
 - Vibration reduction (VR) lenses in DX format: 18–200 mm $f/3.5-5.6G$ ED-IF AF-S VR DX

Bokeh

- Bokeh is how lenses render out-of-focus areas.
- Ideally these areas are soft and smooth.
 - People genuinely concerned about bokeh shoot f/2.8 or faster lenses.
 - Newspaper photographers own some kind of 80-200 f/2.8 lens



- Pro fashion photographers own 300mm f/2.8 or 400mm f/2.8 lenses.



Nikon's Best Lenses

- 14-24mm f/2.8 AF-S (2007-today): ultra-wideangle lens.
\$1,999 on Amazon



Nikon's Best Lenses

- 24mm f/1.4 AF-S G (2010-today): good for low light.
\$2,049 on Amazon.com



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Nikon's Best Lenses

- 50mm f/1.8D AF (1978 - today): cheap, among Nikon's fastest lenses, covers film and the full FX frame. \$124



Nikon's Best Lenses

- 135mm f/2 DC AF (1990 - today): among Nikon's sharpest lenses ever. \$1,394 on Amazon



Nikon's Best Lenses

- 70-300mm f/4.5-5.6G ED IF AF-S VR Nikkor Zoom Lens (2001- today): telephoto zoom. \$589 on Amazon



Canon DSLR cameras

	Sensor	2000			2001			2002			2003			2004			2005			2006			2007			2008			2009			2010			2011			2012	
		2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	
Professional	Full Frame											1Ds			1Ds Mark II						1Ds Mark III														1D X				
	APS-H						1D			1D Mark II			1D Mark II N			1D Mark III						1D Mark IV																	
Advanced	Full Frame															5D						5D Mark II								5D Mark III									
	APS-C																													7D									
Midrange		D30			D60			10D			20D			30D			40D			50D			60D																
Entry-Level												300D Digital Rebel Kiss Digital			350D Digital Rebel XT Kiss Digital N			400D Digital Rebel XTi Kiss Digital X			450D Rebel XSi Kiss X2			500D Rebel T1i Kiss X3			550D Rebel T2i Kiss X4			600D Rebel T3i Kiss X5									
																								1000D Rebel XS Kiss F						1100D Rebel T3 Kiss X50									

Green background indicates HD video-capable camera

Canon DSLR cameras



- Canon EOS 600D (EOS Rebel T3i in the United States) 2011
 - Canon EF-S and EF lens mount
 - 18.0 megapixels
 - 9 focus points
 - Video: Full HD 1080p video recording at 24/25/30 frame/s
 - Alternative: HD 720p and 640×480 video recording at 50/60 frame/s
 - \$709 on Amazon

Canon DSLR cameras



- Canon 5D Mark III 2012
 - Canon EF lens mount
 - 22.3 megapixels
 - 61 Point AF + 41 Crosstype AF compared to 9 Point AF + 6 Assist Points
 - No Video
 - \$3,499 on Amazon

Canon DSLR cameras



- Canon EOS-1D X (2012)
 - Canon EF lens mount
 - 18.1 megapixels
 - 61 autofocus points: 21 f/5.6 cross-type, 20 f/4 cross-type, 5 f/2.8 cross-type and diagonal-sensitive
 - Video: Full HD (1920×1080) at frame rates of 24, 25 or 30 fps,
 - Alternative: 720p (1280x720) at 50 or 60 fps, and SDTV (640×480) at 25 or 30 fps
 - \$6,800 on Amazon

Canon Lenses

- The **EF** (“Electro-Focus”) (1987) lens mount is the standard lens mount on the Canon EOS family
- **EF-S** lens mount is a derivative of the EF mount that is strictly for digital EOS cameras with APS-C sensors released after 2003



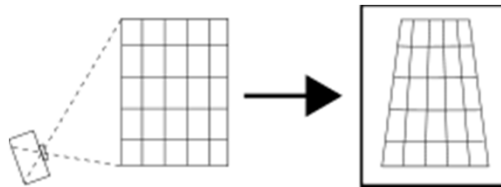
- EF lenses can be mounted on EF-S bodies.
- EF-S lenses **cannot** be mounted on EF bodies.
- Canon **FD** lens mount (1971-1987) is the old Canon mount

Canon Lenses

- **UM** (Ultrasonic motor): electric motor powered by the ultrasonic vibration
- **IS** (Image stabilization): techniques used to reduce blurring
- **L** "Luxury" lens is the Canon's top-of-the-line lens line
- Examples:
 - Ultra-wide-angle: 8-15mm f/4L USM fisheye
 - Standard: 24-70mm EF f/2.8L USM (\$1,289 on Amazon)
 - Telephoto: 28-300mm f/3.5-5.6L IS USM
 - Prime (fixed) Wide-angle: 14mm f/2.8L II USM
 - Prime standard & medium telephoto: 50mm f/1.2L II USM (\$1,527 on Amazon)
 - Prime telephoto: 300mm f/2.8L IS II USM
 - Prime Super telephoto: 800mm f/5.6L IS USM

Canon Lenses (cont.)

- Examples (cont.):
 - Prime macros: 100mm f/2.8L Macro IS USM
 - Prime tilt-shift (perspective control lens - allows the photographer to control the appearance of perspective in the image): 17 mm f/4.0L Tilt-Shift



Sony DSLR Cameras and Lenses

- Sony Alpha (Sony α) is a digital SLR camera system (2006)
 - Sony bought Minolta camera operations in 2006
 - Sony owns 11.08% in Tamron lens manufacturer
 - **DT** (Digital Technology) are lenses for APS-C size sensors.
 - **G** (Gold) series: professional grade telephoto lenses.
 - **ZA** (Zeiss Alpha)
 - **SSM** (SuperSonic Motor): ultrasonic motor used on Zeiss and G lenses.
 - **SAM** (Smooth Autofocus Motor): cheaper alternative to the SSM
- Sony E-mount (2010-) is a lens mount designed by Sony for their New E-mount Experience (NEX) series of cameras.

Sony DSLR cameras

	Sensor	2004		2005				2006				2007				2008				2009				2010				2011				2012
		3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1				
Flagship	Full frame																	α900														
High-end																			α850													
Midrange	APS-C	DG-7D								α700														α77								
																							α65									
																						α55										
					DG-5D			α100															α580									
																								α560								
																							α450									
Entry-level																								α33		α35						
																								α390								
Early models	Still Video Back SB-90 for Minolta 9000 / Still Video Back SB-70 for Minolta 7000 (1986) Minolta MS-C1100 (1992) · Minolta RD-175 (1995)																															

Single-lens translucent (SLT) camera — [HD video capable](#) ([Video AF](#))

Sony DSLR cameras



- Sony Alpha 55 with GPS (2010)
 - Single-Lens Translucent (SLT) camera
 - between digital single-lens reflex cameras (DSLR) cameras and mirrorless interchangeable-lens cameras (MILC)
 - contains a mirror like in DSLRs, but it does not move: it is semi-transparent, allowing the majority of the light to pass through to the sensor whilst reflecting a portion of it onto a phase-detection autofocus sensor
 - 16.2 megapixels
 - 15-point (12 line, 3 cross)
 - Video: 1080i, but only 9min with Image Stabilization turned on or 29min with Image Stabilization turned off
 - \$799 on Amazon

Panasonic Lumix DMC-L10 (2007)



- 10.1-megapixel
- Interchangeable Four Thirds mount system
- No video

Olympus E-5 (2010)



- Uses the Four Thirds company interchangeable lens system (Olympus and Kodak)
- 12.3 megapixels
- 11 biaxial cross auto-focus points
- Video: 720p HD

Pentax K-5 (2010)



- 16.3-megapixel
- Interchangeable Pentax K_{AF3} and K_{AF2} mount
- Video: 1080p video