M&Ms: Freshmen Experience
Toys for Tots in the 21st Century

Digital Cameras

Introduction

Keywords:

- Focus
- SLR (Single Lens Reflex)
- ISO
- Megapixels
- RAW vs. JPEG
- Buffer Memory / Burst Rate

Digital Cameras

Film-less Cameras

- CCD - Charge Coupled Device
- CMOS – Complimentary Metal Oxide Semiconductor

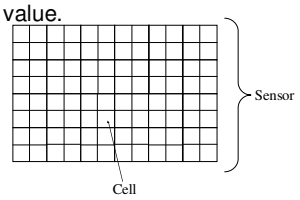
An array of tiny cells converting light into electrons.

Pros and Cons:

- CCD sensors create higher-quality, lower-noise images.
- The light sensitivity of a CMOS chip is lower.
- CCDs consume as much as 100 times more power than an equivalent CMOS sensor.
- CCD sensors have been mass produced for a longer period of time, so they are more mature.

Digital Cameras

Where traditional cameras had film, we now have an array of tiny cells converting accumulated light into a digital value.



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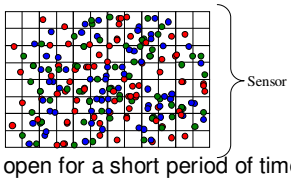

The shutter is open for a short period of time, and each cell gets hit by a number of photons. After the shutter closes, you get the rough count of the photon hits.

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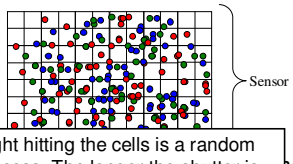

Light hitting the cells is a random process. The longer the shutter is open for, the more "stable" the image.

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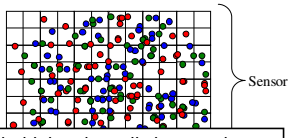

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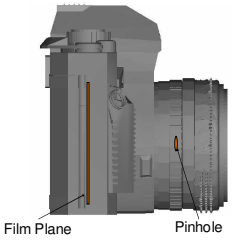
The longer the shutter is open, the more susceptible the image is to motion-blur.

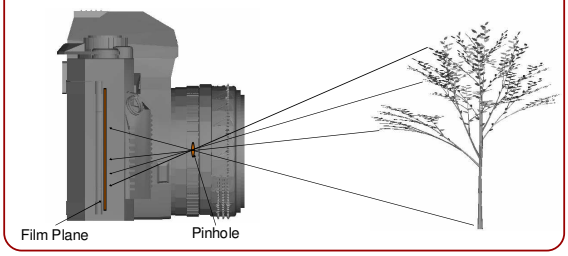
Focus: Traditional Pinhole Camera

- The film sits behind the pinhole of the camera.



Focus: Traditional Pinhole Camera

- The film sits behind the pinhole of the camera.
- Rays come in from the outside, pass through the pinhole, and hit the film plane.



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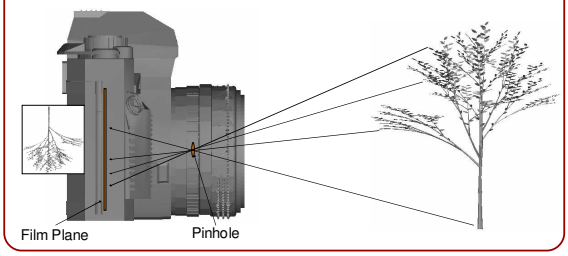
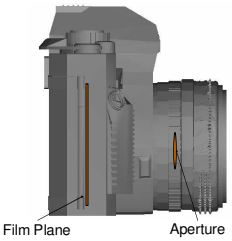


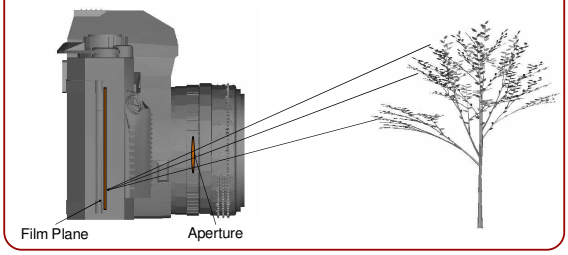
Focus: Traditional Non-Pinhole Camera

- The aperture of the camera is large



Focus: Traditional Non-Pinhole Camera

- The aperture of the camera is large
- Light coming in from different positions can hit the same cell in the sensor



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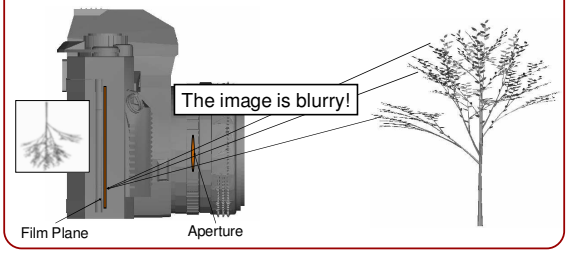

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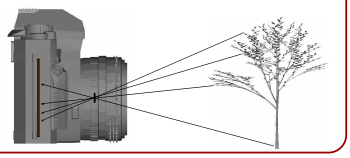
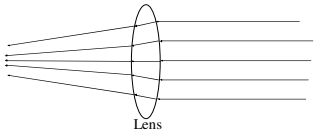
Since in a pinhole camera, only one ray of light will hit a pixel, we would need to leave the shutter open for longer.



Focus: Lensed Cameras

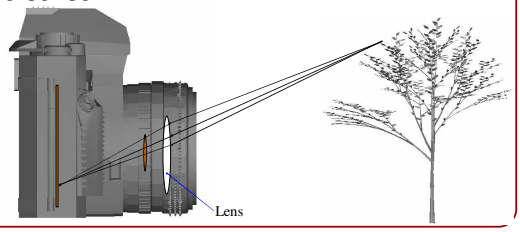
We can fix the problems of large aperture cameras by using lenses:

These are pieces of glass that bend light in a fixed way:



Focus: Lensed Cameras

If the lens is designed/calibrated correctly, then for a fixed focal distance, all the rays from a single point will hit the same point on the sensor.



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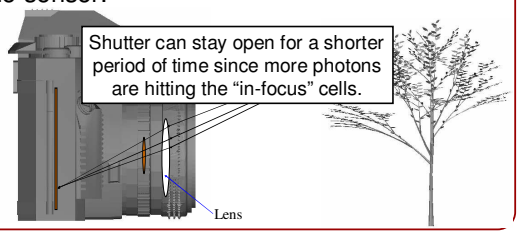

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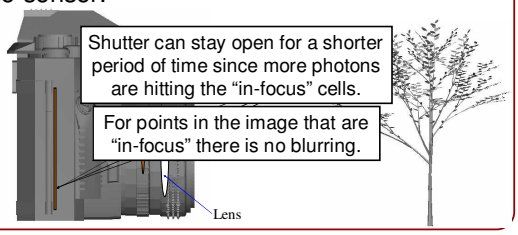
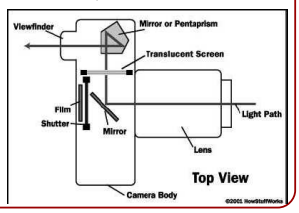


dSLRs

dSLR=Digital Single Lens Reflex

1. Image in the viewfinder is exactly the image the viewer would see
2. Acts like a regular film camera, so lenses are interchangeable.



ISO

This setting represents the camera’s sensitivity to light:

The more sensitive the camera (i.e.higher ISO) the less light the camera needs (i.e. faster shutter-speed)

Since faster shutter speed means less motion-blur, quality images at higher ISO ratings are desirable.

Megapixels

The number of independent cells in the sensor that can capture / process incoming light.

Recommendations:

Print resolution should be at least 200 dpi (dots per inch)

- 2 Megapixels = 1600 x 1200: max 8" x 6 “
- 4 Megapixels = 2240 x 1680: max 11" x 8“
- 6 Megapixels = 2770 x 2080: max 19" x 10"

Raw vs. JPEG

Describes how image information is stored:

Ideally, we want to store all the information (i.e. the number of photon hits per cell, for every cell).

In practice this takes up too much memory.

Raw vs. JPEG

RAW – more like a negative

JPEG – more like a print

Bits Per Channel:

RAW: 12 JPEG: 8

Compression:

RAW: None/Lossless JPEG: Lossy Compression

RAW images are about 3x larger than JPEGs.

Burst Rate

There are two memory components on the camera:

a) The built in memory, meant to house temporary image information (fast access, but expensive)
b) The memory card which is more permanent (slow access, but cheap)

1. When a snapshot is taken, the data gets written to the on-camera memory.
2. As soon as it's written, the camera is ready to take another shot.
3. Independently, the data needs to be written to the memory card.

Burst Rate

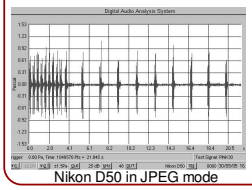
Since the on-camera memory is relatively small, we can only take a small number of pictures before we fill it up.

At this point, we need to move some of the data over to the card to free up space for more pictures.

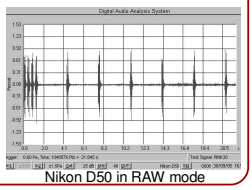
Burst Rate

This can become a problem when:

1. We are taking many pictures in quick succession,
2. and is even worse if each image is high-resolution and un-compressed.



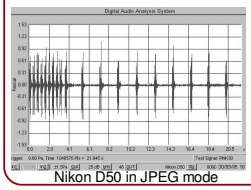
Nikon D50 in JPEG mode



Nikon D50 in RAW mode

Burst Rate

The burst rate isn't too important if we are taking static pictures (it only takes about a second to push JPEG images to the memory card) but it is an issue if we want to take a stream of pictures.



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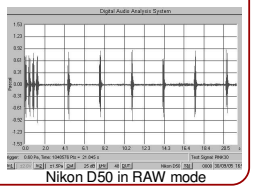

Nikon D50 in RAW mode