M&Ms: Freshman 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

An array of tiny cells converting accumulated light into a digital value.

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.

Light hitting the cells is a random process. The longer the shutter is open for, the more “stable” the image.
Digital Cameras
An array of tiny cells converting accumulated light into a digital value.

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 sensor.

Focus: Traditional Non-Pinhole Camera
• The aperture of the camera is large
• Light from different points can hit the same cell in the sensor.
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Focus: Pinhole vs. Non-Pinhole
Since pinhole cameras are always crisp, why use a large aperture camera?

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

Focus: Pinhole vs. Non-Pinhole
Since pinhole cameras are always crisp, why use a large aperture camera?

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.

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.

Shutter can stay open for a shorter period of time since more photons are hitting the "in-focus" cells.
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.

- Shutter can stay open for a shorter period of time since more photons are hitting the "in-focus" cells.
- For points in the image that are "in-focus" there is no blurring.

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

RAW – more like a negative
JPEG – more like a print

Bits Per Channel:
- RAW: 12
- JPEG: 8

Compression:
- RAW: None/Lossless
- JPEG: Lossy

RAW images are usually about 3x larger than JPEGs.

Burst Rate

There are two memory components on the camera:
1. The built in memory, meant to house temporary image information (fast access)
2. The memory card which is more permanent (slow access)

- When an image is taken, the data gets written to the on-camera memory.
- As soon as it’s written, the camera is ready to take another shot.
- 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 so many pictures before we fill it up.

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

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.