Camera Sensors

An Overview

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Bloomington Photo Club

Sensor Basics

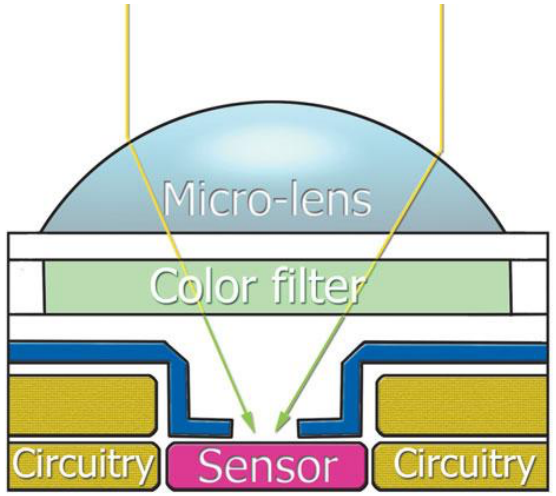
In its simplest form, a camera sensor is an array of “cells” which focus, capture and convert light into electrical signals.

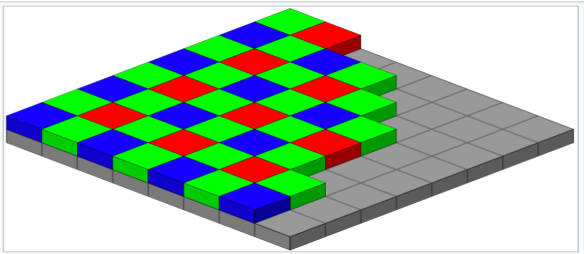
These signals are converted into a range of numbers which relate to the color and intensity of the light. (RAW data)

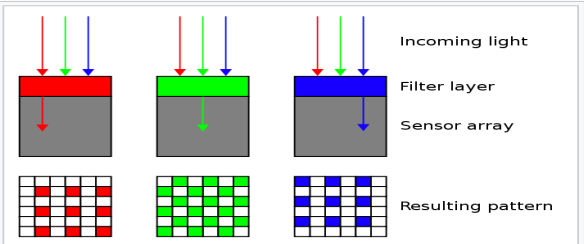
The Raw data is further processed in the camera or in a standalone program to render a “JPG” file. A JPG file is what we look at when we view the image captured.

The sensor is a key element in how well a camera performs in varying light and the amount of resolution (# of pixels).

Sensors determine color using small color filters on top of each pixel, the Bayer Matrix




The Bayer arrangement of color filters on the pixel array of an image sensor



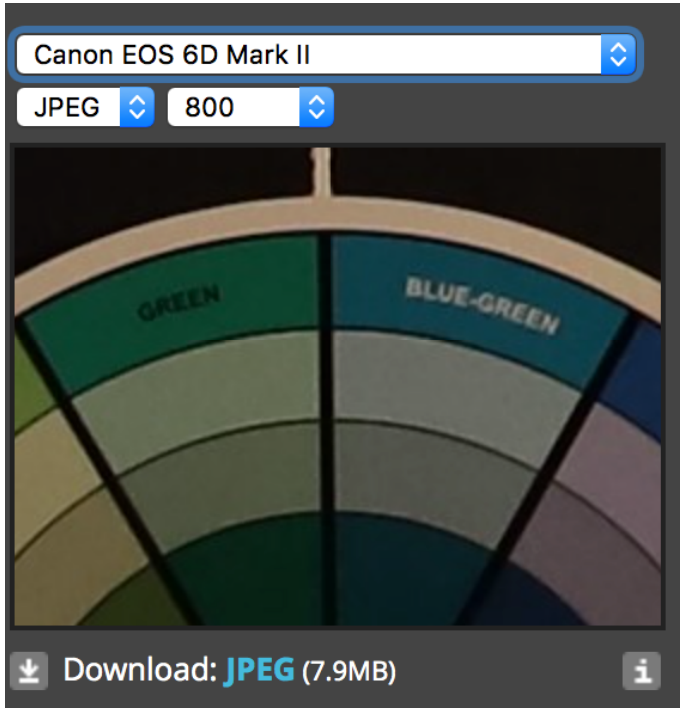
Profile/cross-section of sensor

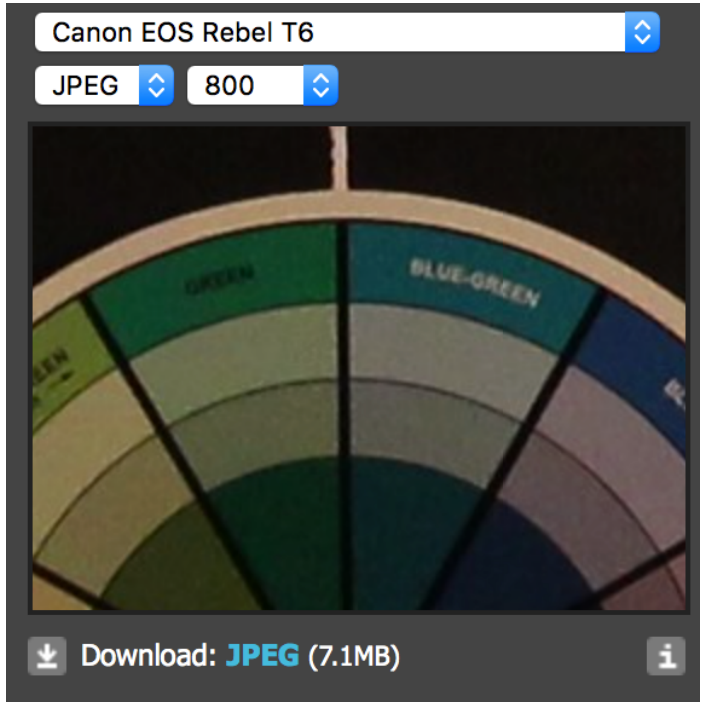
Sensor Sizes

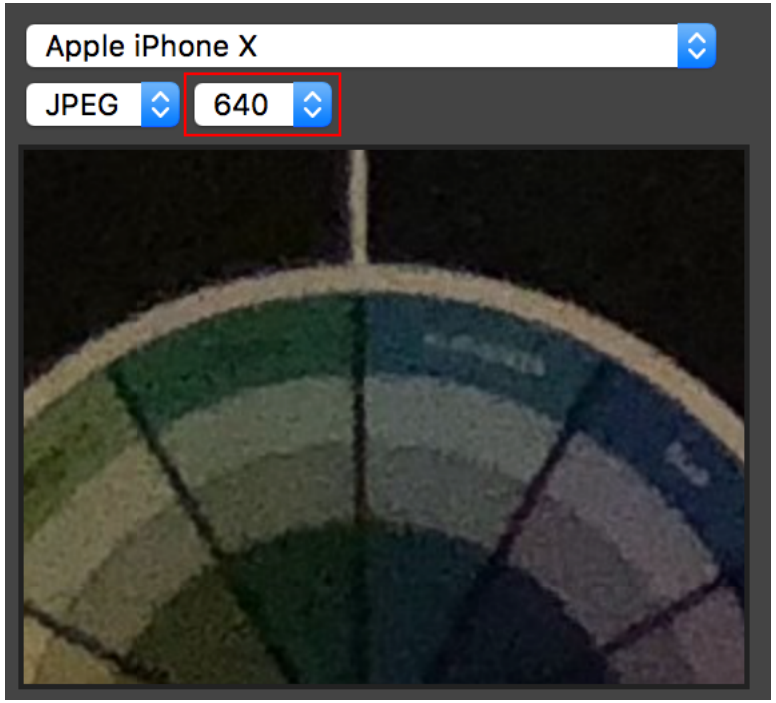
CAMERA SENSOR SIZE COMPARISON CHART

	MEDIUM FORMAT	FULL-FRAME	APS-C	MICRO 4/3	1"	1/2.55"
PICTURE						
SENSOR SIZE	53.0 X 40.20 MM	35.00 X 24.00 MM	23.6 X 15.60 MM	17.00 X 13.00 MM	12.80 X 9.60 MM	6.17 X 4.55 MM
CROP FACTOR	0.64	1	1.52	2	2.7	5.62
CAMERA						

Image Comparison vs Sensor Size







ADDITIONAL READING MATERIAL

Camera Sensor Basics

In its simplest form a camera sensor converts Photons into an electrical signal, The first sensors were Charge Couple Devices (CCD's), Advances in semiconductor manufacturing lead tot eh development of Complimentary Metal Oxide Semiconductor (CMOS) sensors. For all practical purposes, CMOS sensors dominate the camera markets today. There are few niche markets where CCD devices are still used. CMOS sensors use less power, yield more compact cameras and can transfer data much quicker.

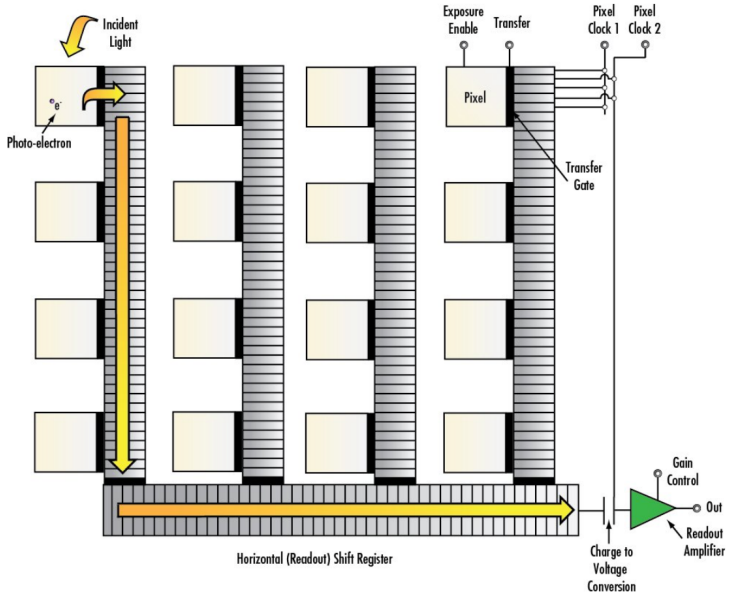


Figure 1: *Block Diagram of a Charge-Coupled Device (CCD)*

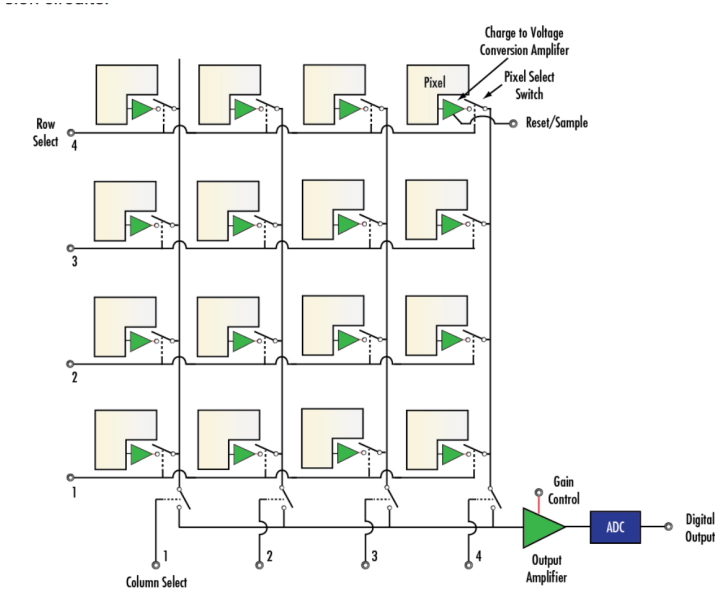
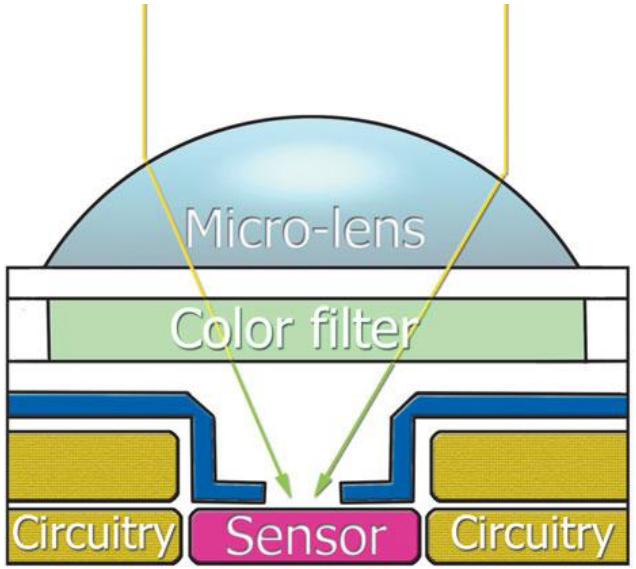


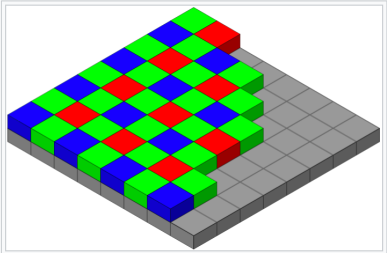
Figure 2: *Block Diagram of a Complementary Metal Oxide Semiconductor (CMOS)*

Typical Sensor Construction

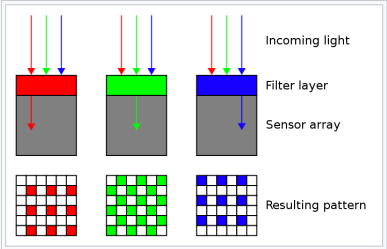


A micro lens concentrates the light. A color filter determines the color*, electronic circuitry converts the light into an electrical signal. This images omits the cover glass and the Filters which limit the light to the visible spectrum. There are camera designs which do not have “color” filters. Ie Monochrome Cameras. There is another type of sensor (Foveon) used by Sigma cameras which omit the color filters as well. Some sensors contain a filter which reduces or eliminate Moire patterns (ie Low Pass filters)

* Color filters- the Bayer Filter. The Bayer filter is an array of R, B, G filters which produce the color in the camera. The Bayer filter uses more G filters to mimic the human eyes greater sensitivity to G light.

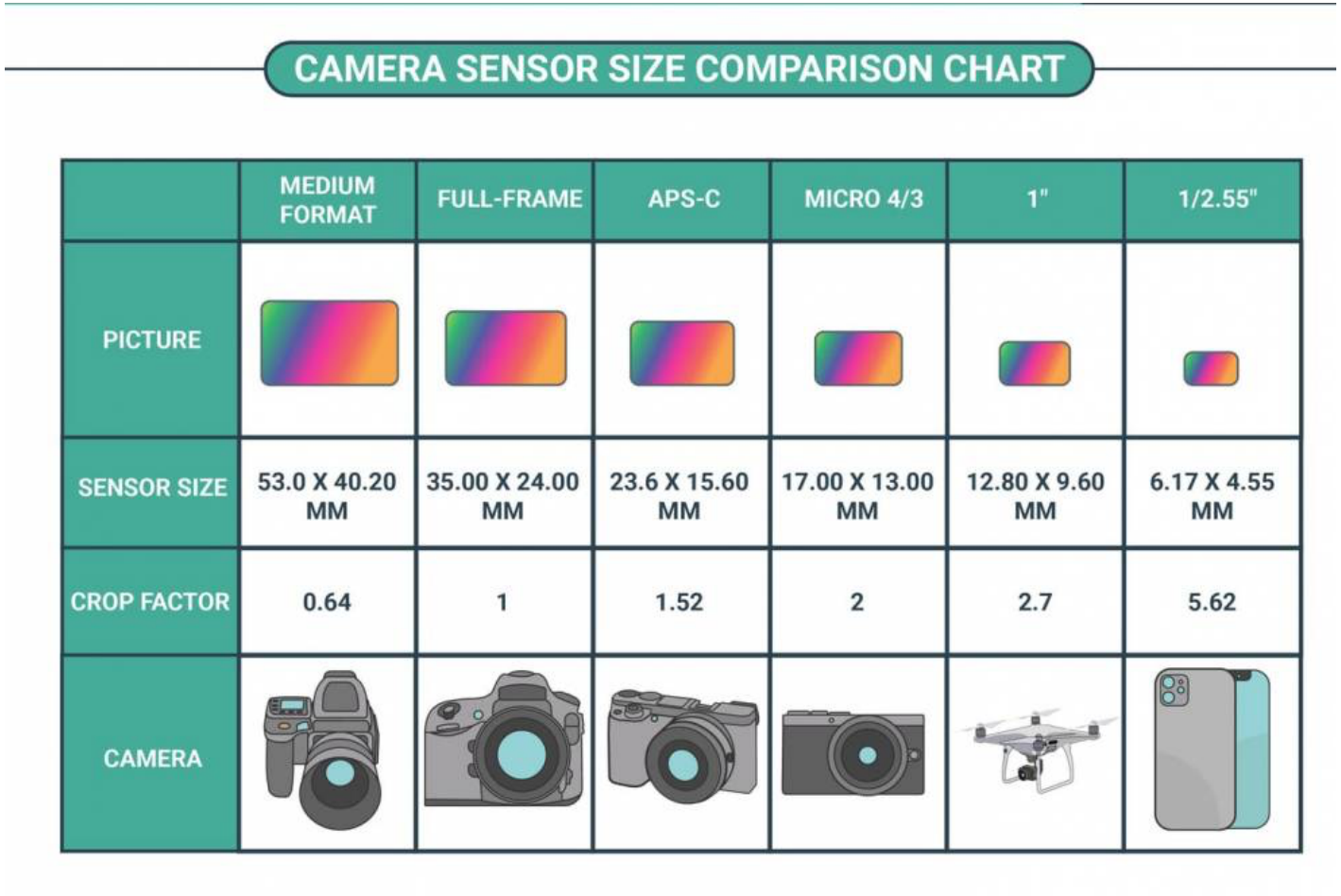


The Bayer arrangement of color filters on the pixel array of an image sensor



Profile/cross-section of sensor

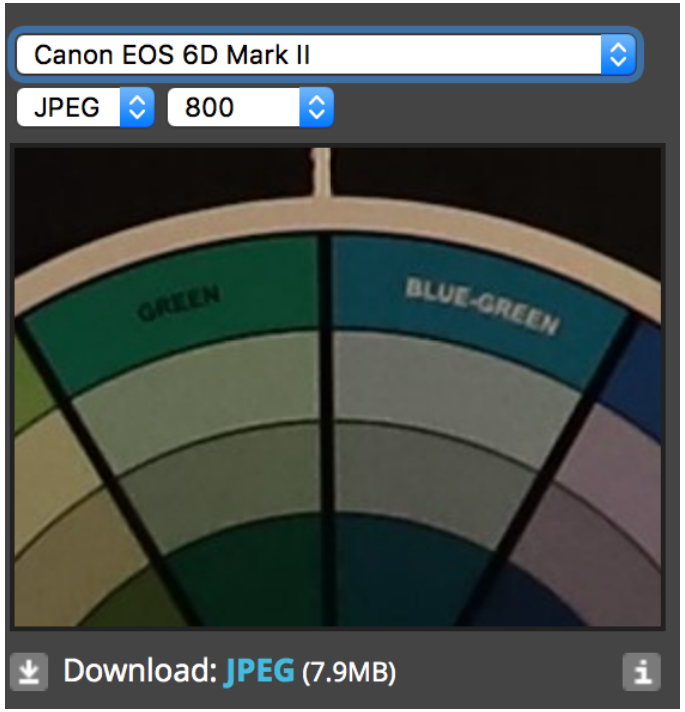
Sensor Size

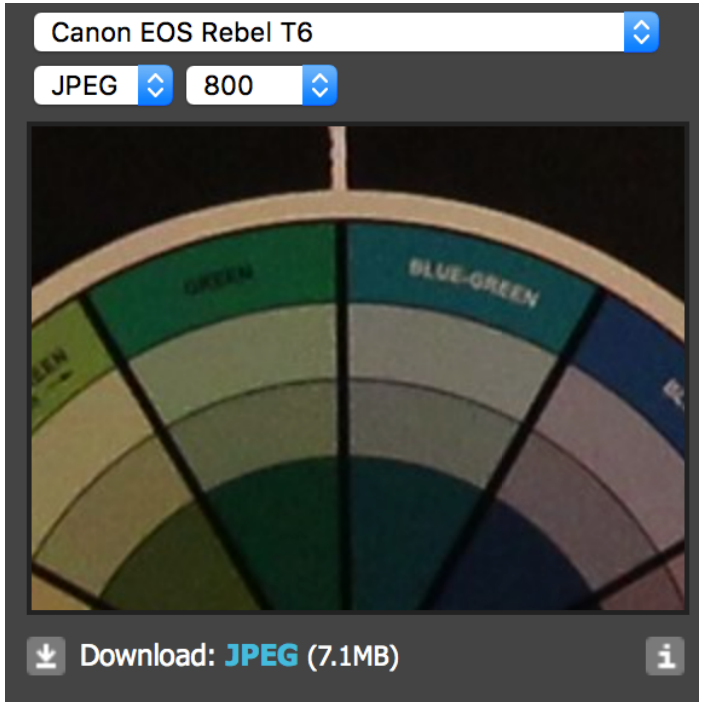


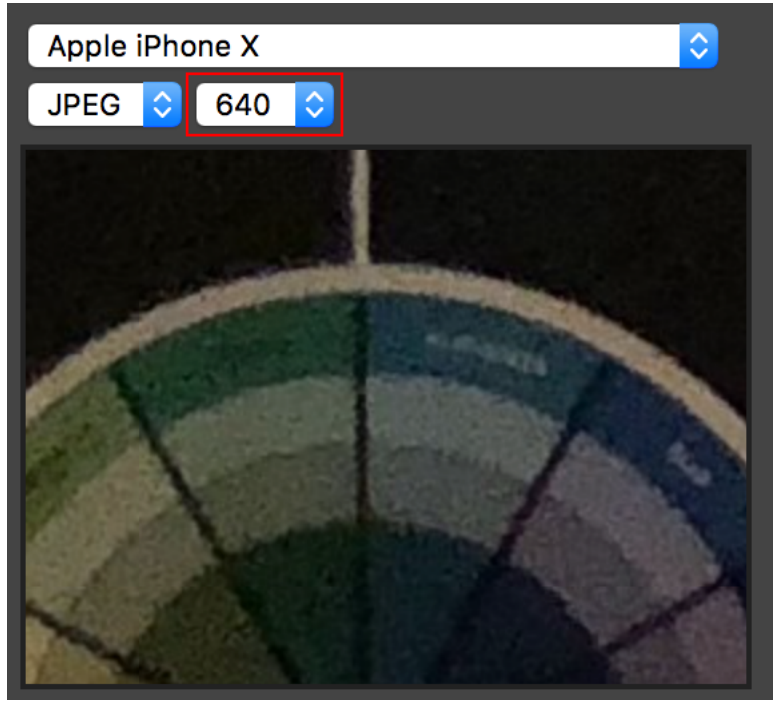
There is a wide variety of sensor sizes. In general, the larger the sensor the greater the resolution ie Pixel count. Sensor size determines the design of the Camera body, Optics design, file size. Larger sensors tend to give better low light/High IOS performance in addition to higher resolution. But there are tradeoffs in the overall camera “System”

Noise in your picture- A Simple View

Noise in cameras arises from several sources. There is noise from the process of converting photons into electrons, there is noise generated when the electrical signal is read from the sensor and there is noise generated when the electrical signals are converted into data used by the camera to create the “image”. For most photographers, noise manifests in our photos. Under low light when we push the exposure in post. An example of this can be banding in shadows. If we shoot at high ISO’s. typically above 1600. This is very dependent on the camera; and If we take very long (> 1-5 seconds) exposures.







Additional Resources

DPReview Scene Comparison Tool- Allows you to compare different cameras on a complex scene with various lighting conditions and ISO’s

https://www.dpreview.com/reviews/image-comparison

DXO Labs evaluates various performance parameters like Dynamic Range, ISO performance. It also shows test data from the camera tested with various lenses and rates sharpness, distortion etc.

https://www.dxomark.com/Cameras/