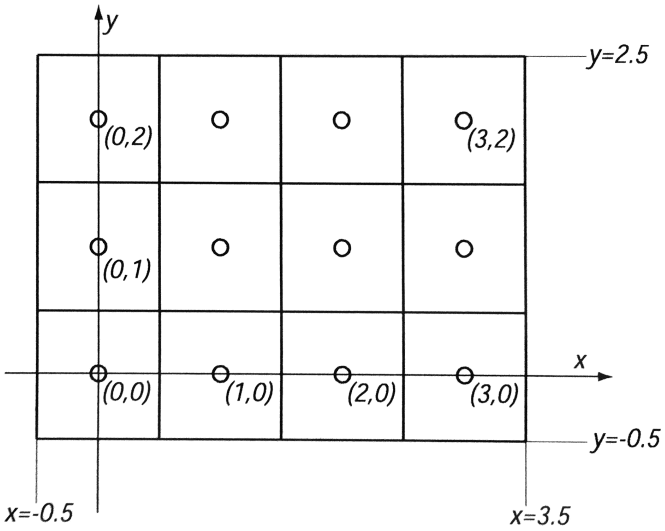
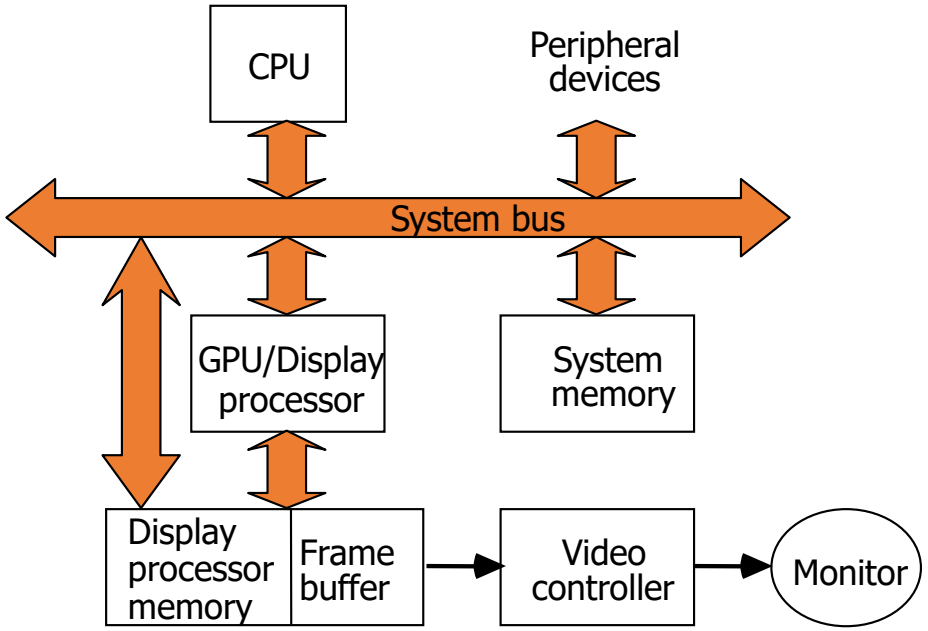
6 – Hardware, raster displays, color

Basic Definitions

- Raster: A rectangular array of points or dots.
- Pixel: One dot or picture element of the raster
- Scan Line: A row of pixels



Example Raster Graphics Architecture

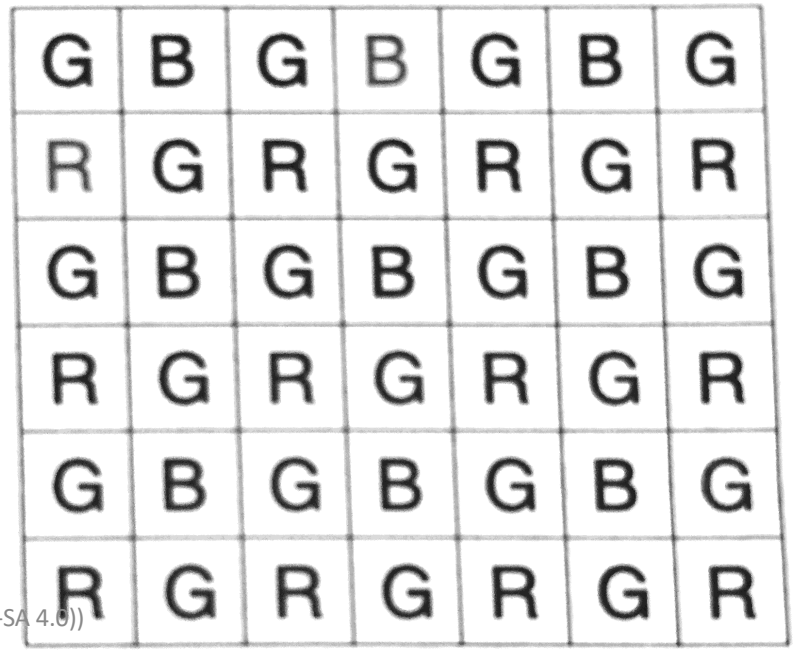


Raster system architecture with a display processor.
(originally from Computer Graphics: Principles and Practice.)

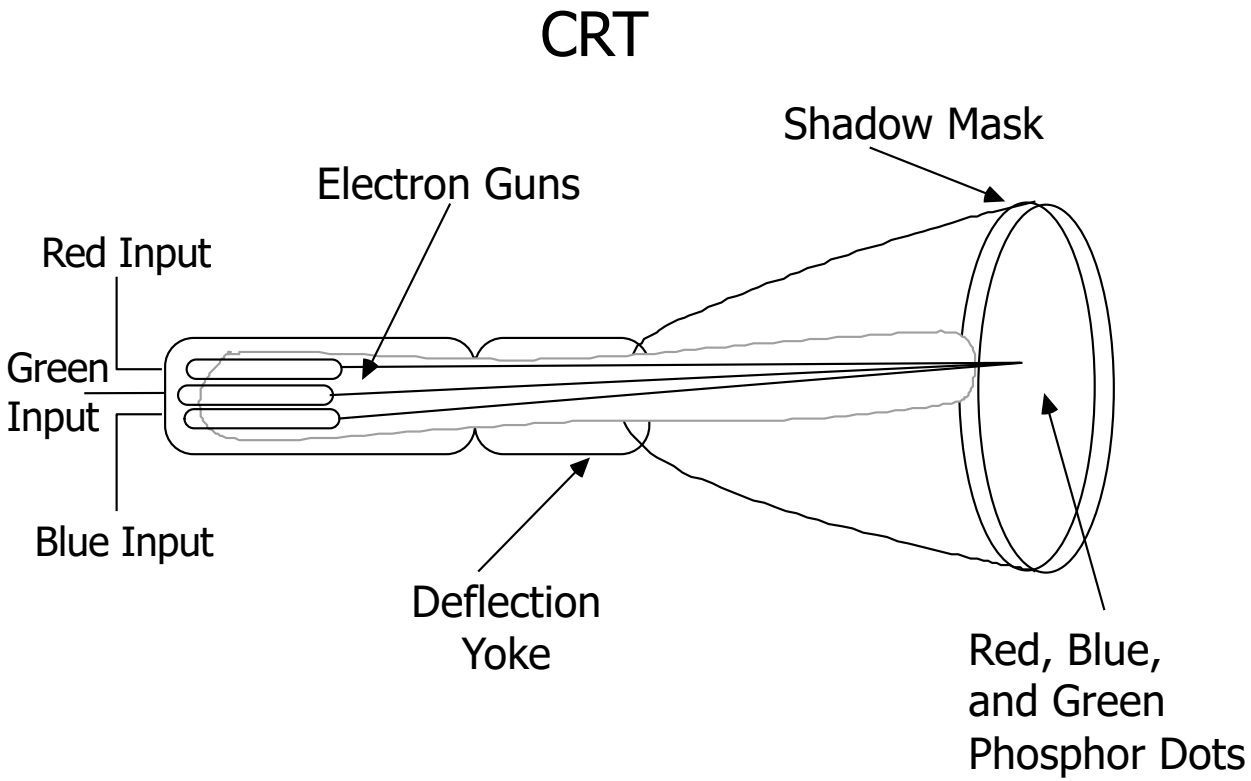
Displays and Cameras

Book covers LED, LCD, ink-jet, dye sub, cameras and scanners

Bayer mosaic

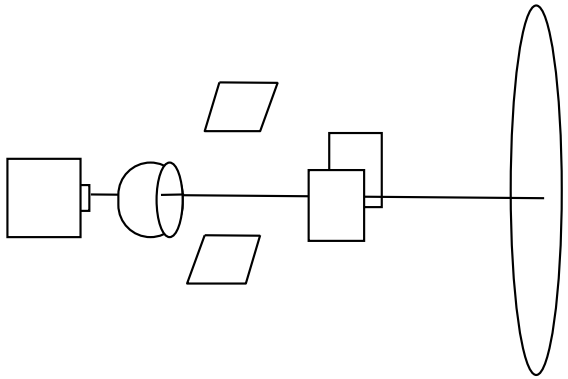


CRT Monitor



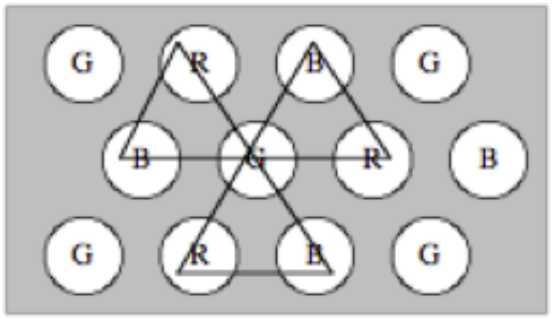
Electron Gun

- Stream of electrons directed to front
  - Num electrons controls brightness
- Phosphor, glows briefly
- Gaussian distribution of electrons, light



Color CRT

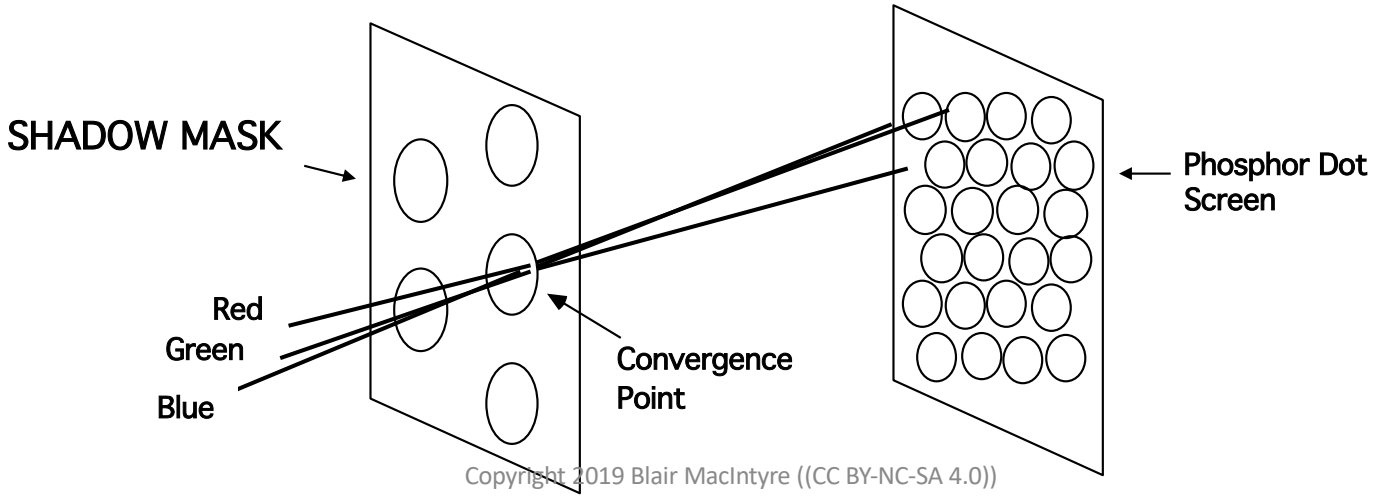
- RGB electron guns
- Screen coated with phosphor pattern



- Fluorescence
- Phosphorescence
- Persistence

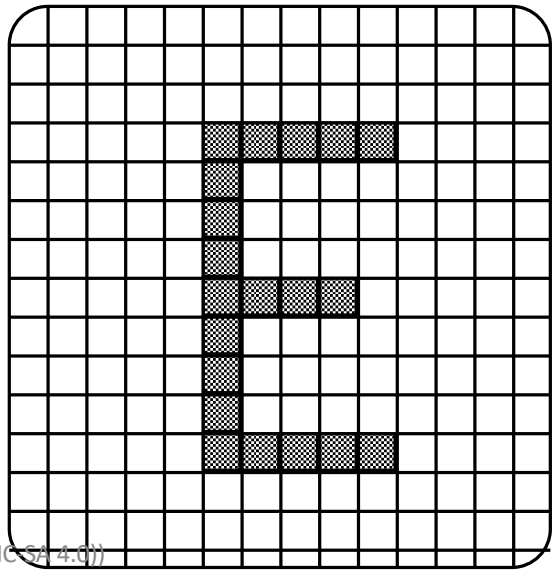
Shadow Mask

- Phosphors arranged in triads
- Each triad has one R/G/B phosphor dot
- Typically 2.3 to 2.5 triads per pixel
- Shadow mask has one small hole for each phosphor triad



Scanning An Image to a Display

- Frame: image to be scanned on CRT/LCD
- Frame must be “refreshed” to eliminate flicker in the image.
- Critical Fusion Frequency
  - Typically 60 times/sec for raster displays
  - Varies with intensity, individuals, phosphor persistence, lighting, …

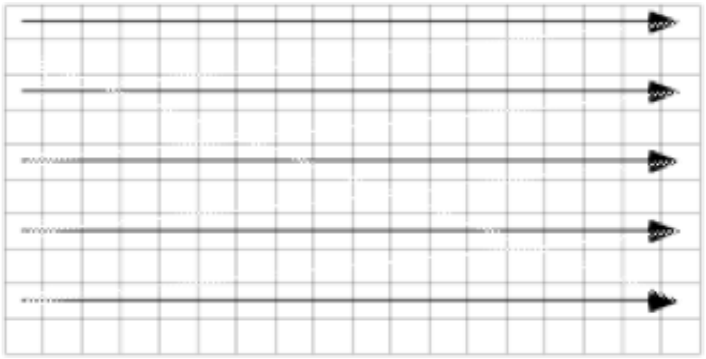


Interlaced Scanning

- Assume can only scan 30 times/sec
- To reduce flicker, divide frame into two “fields” (odd and even lines)

<table>
<tr><td colspan="2">1/30 SEC</td><td colspan="2">1/30 SEC</td></tr>
<tr><td>1/60 SEC</td><td>1/60 SEC</td><td>1/60 SEC</td><td>1/60 SEC</td></tr>
<tr><td>FIELD 1</td><td>FIELD 2</td><td>FIELD 1</td><td>FIELD 2</td></tr>
<tr><td colspan="2">FRAME</td><td colspan="2">FRAME</td></tr>
</table>

Scanning



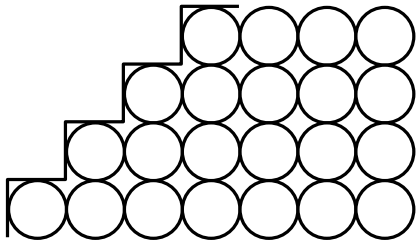
***VERTICAL SYNC PULSE* — Signals the start of the next field.**

***VERTICAL RETRACE* — Time needed to get from the bottom of the current field to the top of the next field.**

***HORIZONTAL SYNC PULSE* — Signals the start of the new scan line.**

***HORIZONTAL RETRACE* — Time needed to get from the end of the current scan line to the start of the next scan line.**

Resolution and Addressability

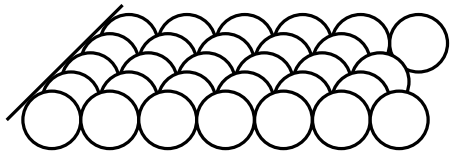


Resolution = Addressability

Resolution is a measure of the width of a single line drawn on the CRT screen (1/spotsize). Usually stated as the number of just merged lines per inch or centimeter.

Addressability is a measure of the spacing between the centers of those lines.

(Everybody, incorrectly, uses **resolution** when they mean **addressability**.)

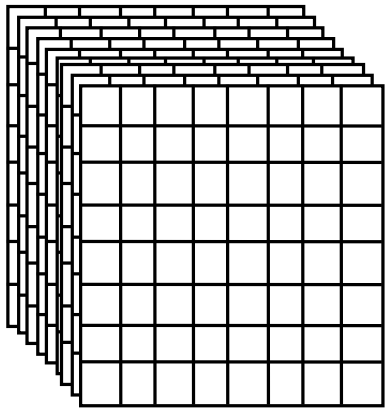


Resolution < Addressability

Smooths out the "jaggies" but the overlap will cause filled areas to be brighter than lines, and lines to be brighter than single pixels.

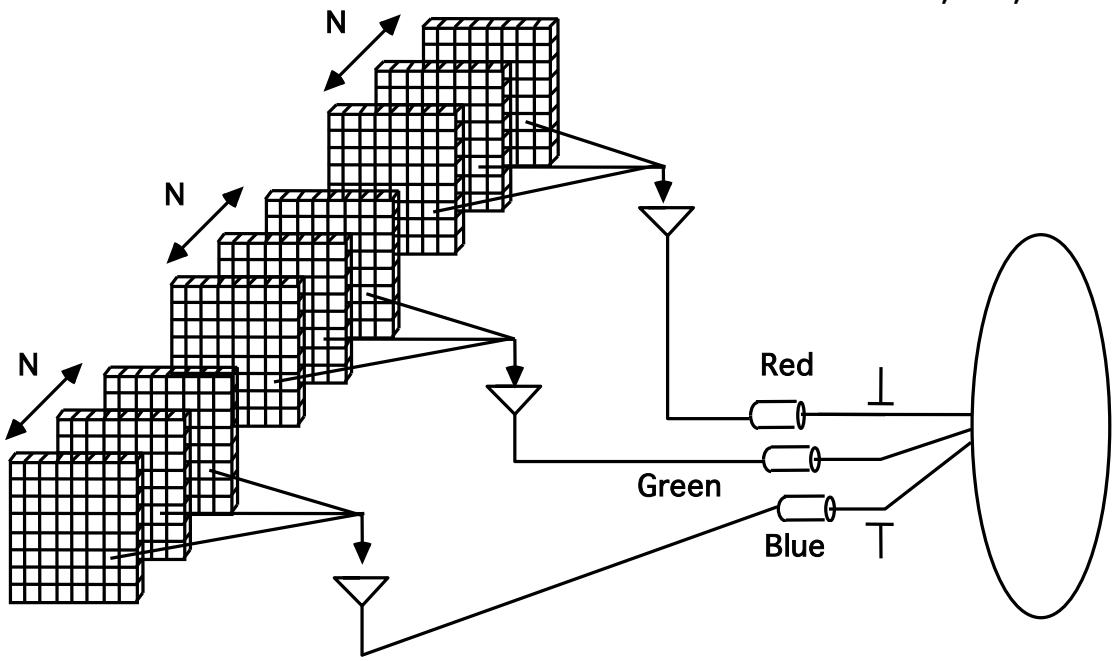
Frame Buffers

- 2D array
  - each (x,y) location = a pixel
- *Bit Planes, Bit Depth*
  - number of bits in a pixel
- Typical frame buffers:
  - 640 x 480 x 8
  - 1280 x 1024 x 8
  - 1280 x 1024 x 24

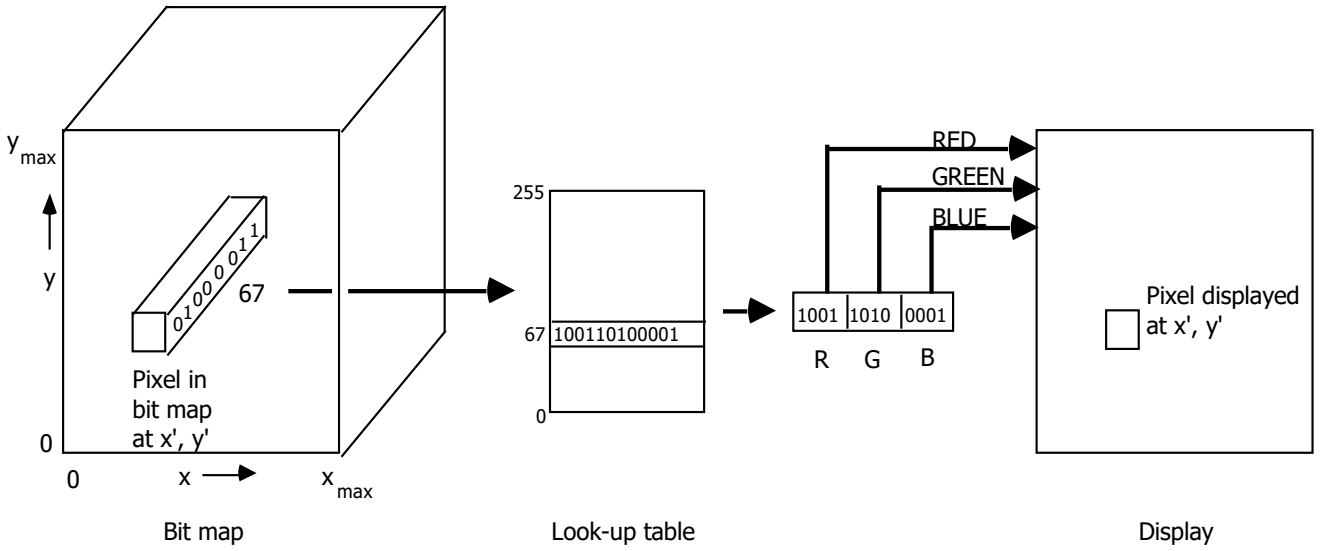


True Color Display
24 bitplanes, 8 bits R/G/B

2^24 = 16,777,216



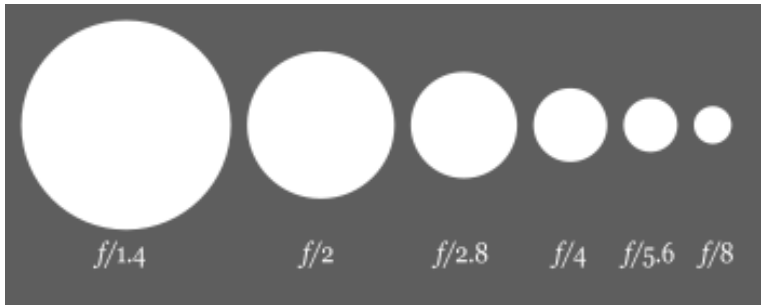
Color Map Look-Up Tables



LUT Video look-up table organization. A pixel with value 67 (binary 01000011) is displayed on the screen with the red electron gun at 9/15 of maximum, green at 10/15, and blue at 1/15. This look-up table is shown with 12 bits per entry. Up to 24 bits per entry are common.

Camera

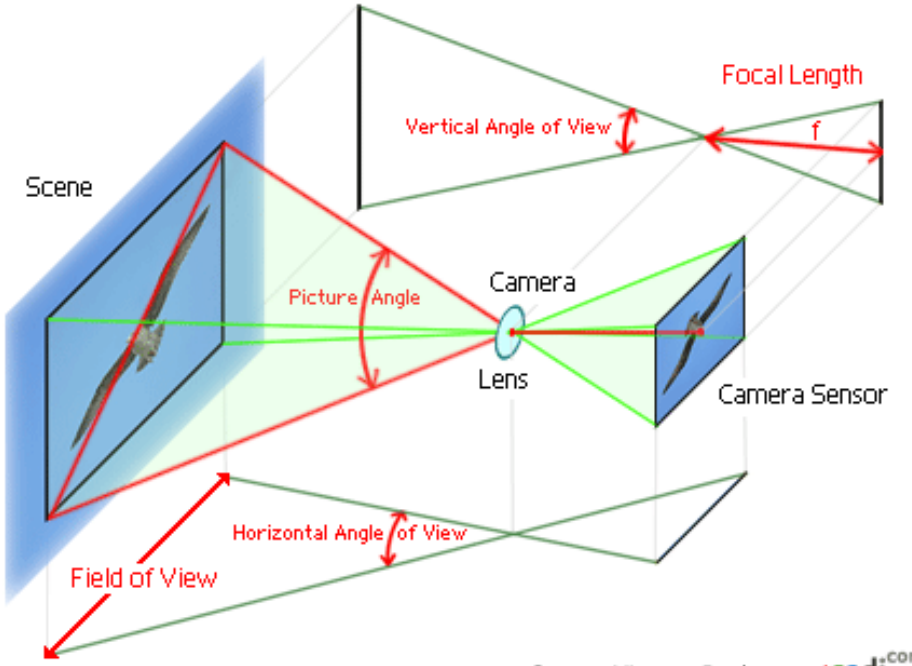
Aperture
Exposure



Images from https://en.wikipedia.org/wiki/Aperture

Camera Focal Length

field of view = 2 atan (sensorsize / (2f))



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http://www.dpreview.com/glossary/optical/focal-length

Aperture, Depth of Field, and Bokeh

"Christmas Tree Lights Bokeh" by Rushilf - Own work

"Josefina with Bokeh" by carlosluis - http://www.flickr.com/photos/paseodelsur/51805888/.