12. Resolution2PixelDepth

Thursday, January 23, 2014 4:36 PM

Today: Finish resolution
Teamwork expectations
Meet your team

Homework: F/ for best sharpness. Resolution of GW image

Best f/	Sensor size
10	DSLR
7.1	DSLR
6.3	DSLR
Around 8	Full frame
12	DSLR
3.5	Small camera
8	mirrorless

Motion Blur: sides of streak will be in focus. Just being out of focus will be an overall blur

GW resolved?	Reason why not
7 said yes 15 no	Pixelization Motion blur /// Hard to tell due to diffusion in subject Focus: limited DOF //// Chromatic aberration

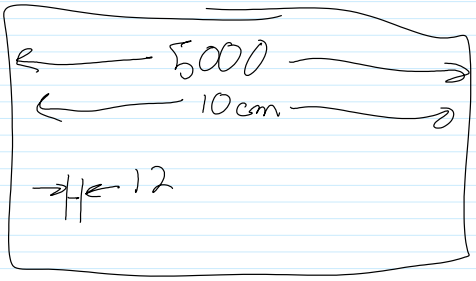
Time Resolution continued:

Motion Blur Example:
Field of view = 10 cm
Fluid moving at 0.5 m/s
18 Mpx sensor
Minute paper: what shutter speed will 'freeze' this flow?

5000 px wide
Allow a smear of how many px?

1/2000 shutter = 12.5 px

5
5
2



$\Rightarrow \frac{50\,000\ px}{m}$

Speed = 0.5 m/s

$= 25\,000\ px/s$

#px to tolerate

$= \frac{1}{5}$ seconds

Can tolerate maybe 5 px blur?
10 Mpx ~ 3750 X 2750
0.1 m / 3750 = 2.6 e-5 = 0.000026 m/px = 26 μm/px
5 px = 1.3 e-4 m = 0.00013 = 0.13 mm estimated acceptable
object displacement *x*
time *t = x/velocity*
1.3e-4 m / (0.5 m/s) = 2.6e-4 seconds
2.6e-4 sec = 1/3750 Very short. Can your camera do this?
5/3750 = 0.0013 = 0.13% of image width

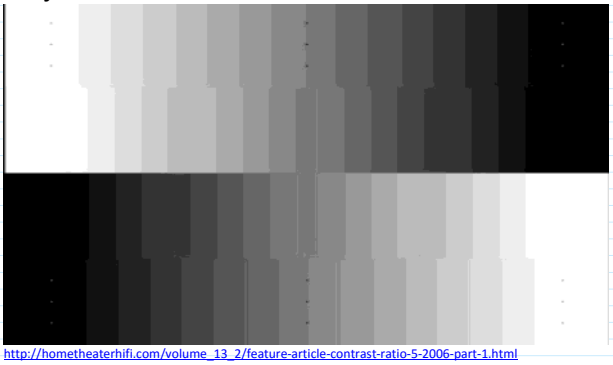
Do this analysis for each image; put in your report. Motion blur is surprisingly common and annoying.

Resolution in the Measurand: Light

Part 1: Dynamic range

Human eye sensitivity, dark adapted ~ 800 ISO
http://clarkvision.com/imagedetail/eye-resolution.html
Human contrast range detection: 24 EV, but is dynamic.
http://www.luminous-landscape.com/columns/eye-camera.shtml

Sheet of paper: at most 7 EV (factors of 2 in brightness) from black to white.
Projector screen?



http://hometheaterhifi.com/volume_13_2/feature-article-contrast-ratio-5-2006-part-1.html

What can your camera detect?
Test: image a gray card. See how many stops of underexposure (hold ISO constant) will make it black, and how many of overexposure will make it white. Probably a total range of 6-9.

Part 2: Resolution=Bit Depth

This total dynamic range then gets *quantized*/digitized into steps. The more steps, the finer the resolution. (http://www.peachpit.com/articles/article.aspx?p=1709190&seqNum=2. Nice discussion of dynamic range vs bit depth)

Part 2B: Counting steps
Bit = off or on, 0 or 1. Binary digit.

Binary= numbers in base 2, a series of bits. 0 1 1 0 = 6 in base 10

8 4 2 1

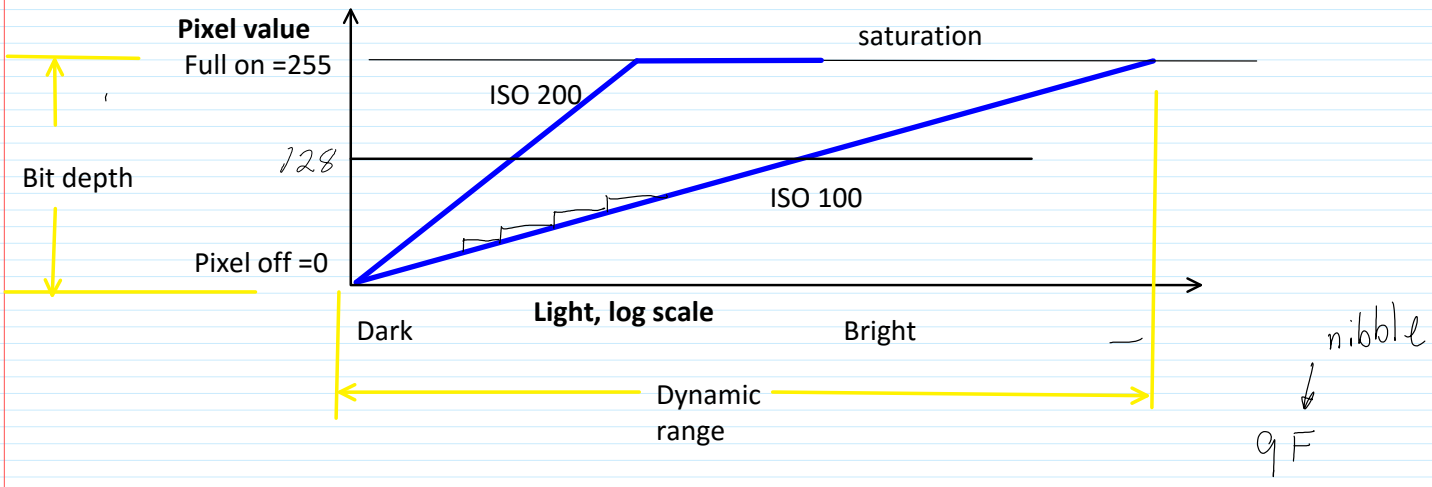
Binary= numbers in base 2, a series of bits. 0 1 1 0 = 6 in base 10

8 4 2 1

$2^3\ 2^2\ 2^1\ 2^0$

With 4 bits, can count to 2^4=16
With 8, can count to 256 = one byte
Hexadecimal: single digit goes up to 16: 0-9, then A B C D E F
16^2=256 , so can express full range of a byte in two digits.

Camera A/D is likely 10-24 bits. That's the number of different levels possible but not the range of brightnesses

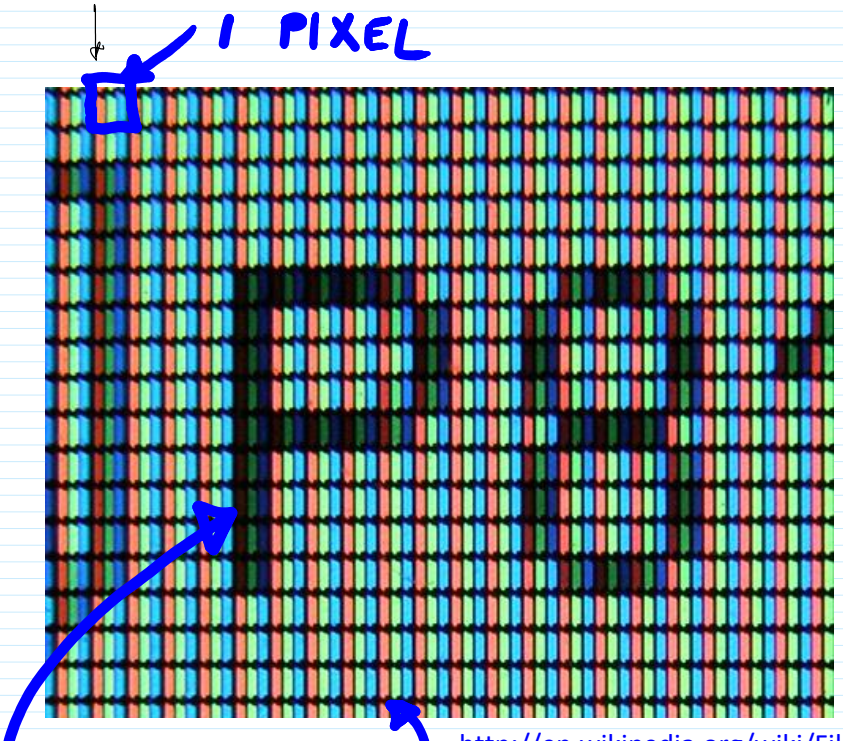


The word *pixel* is based on a contraction of *pix* ("pictures") and *el* (for "element");

Pasted from <http://en.wikipedia.org/wiki/Pixel>

On a screen, = 1 red, 1 blue, & 1 green light emitter.
In Photoshop, access them separately in *color channels*
i.e. can talk to all blue pixels by themselves

0-256



CYMK

RGB is a common color space, good for screens. CMYK (Cyan, Magenta, Yellow and blacK is another color space, good for printing

http://en.wikipedia.org/wiki/File:Closeup_of_pixels.JPG

R,G,B = 0,0,0 = black, off.
R,G,B, = 255, 255, 255 = all full on = white (8 bits = 2^8 = 256 possible levels)
R,G,B = 0,0, 256 = blue

FFFFFF = full white
0000FF= blue
808080=gray