14.Resolution2PixelDepth

Monday, March 19, 2018 5:36 PM

Today:
High speed camera instruction from Mo Woods
Finish resolution

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

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 time/space 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

HOMEWORK: Friday in Canvas? T2 also due.

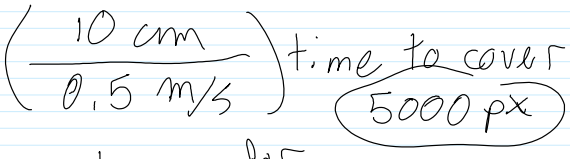
1. At what f/ does your lens produce the sharpest image? Take an object that you can easily focus on, and image it with a range of f/. Then zoom in and check the focus. Try to minimize the effects of motion blur and ISO noise so your testing is valid. Submit at least three images illustrating your results.
2. In your Get Wet image, are all the scales of interest in the flow well-resolved in the image? Is your time resolution good, or was there motion blur? Was your spatial resolution good enough to see both large scale and small scale motion? For example, is there a sharp boundary in the flow that only takes up one or two pixels in the image?Did you choose to lose resolution at one scale to achieve an effect or to gain resolution at a different scale? What was the major effect that degraded the resolution?
3. Test the dynamic range of your camera: at low ISO, see how many stops of underexposure will make it black, and how many of overexposure will make it white. Probably a total range of 6-9. What happens at high ISO?

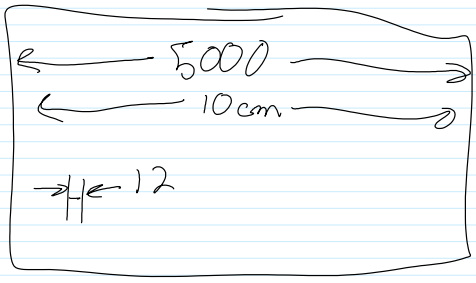
Time Resolution continued:

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





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

Speed = 0.5 m/s

= 25 000 px/s

#px to tolerate

= 1/5 seconds

$\frac{0.2\ sec}{5000}$ = time for 1 px smear = 0.2/5000=0.0 = 40 μs

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? 1/10,000 sec is fast electronic shutter. To go faster/shorter need strobe.
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. At low ISO, see how many stops of underexposure will make it black, and how many of overexposure will make it white. Probably a total range of 6-9. What happens at high ISO?
This is 3rd question on homework.

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

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

nibble

With 4 bits, can count to 2^4=16

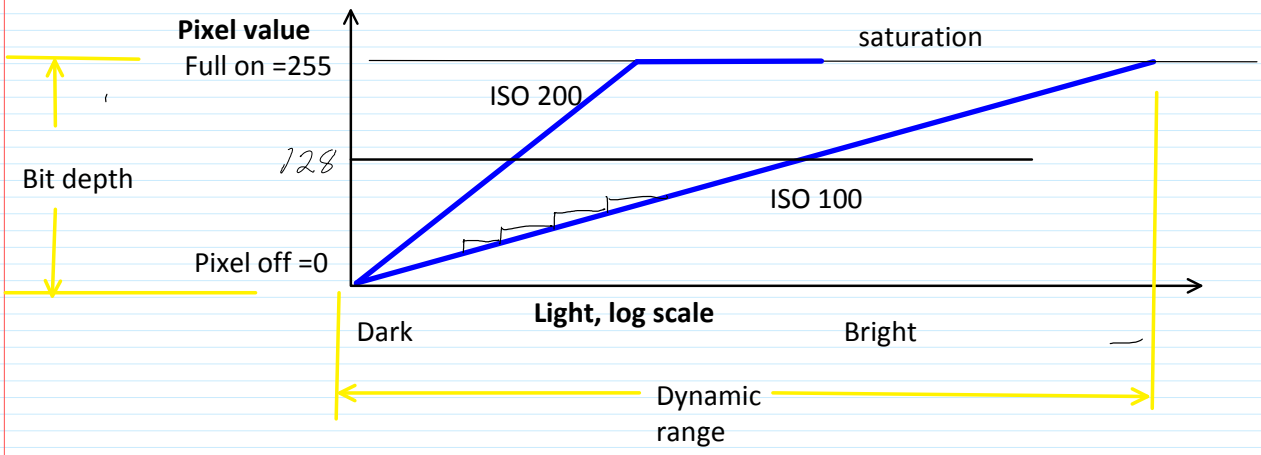
With 8, can count to 256 = one byte

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.

9F

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



HDR = High Dynamic Range

Take multiple images with varied (bracketed) exposures of the same scene, some under exposed, some over exposed. In-camera or post-processing algorithm assembles them together to provide additional measurand (light) resolution in highlight and shadow areas. Can make nighttime images look like daylight.

Here is an HDR image (made with 5 images from -3 to +3 EV) by Phil Nystrom 2018.

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

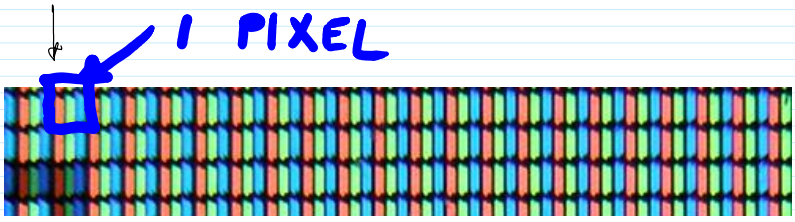
Pasted from <http://en.wikipedia.org/wiki/Pixel>

On a screen, = 1 red, 1 blue, & 1 green light emitter.

In Photoshop, access them separately in *color channels*

i.e. can control all blue pixels by themselves

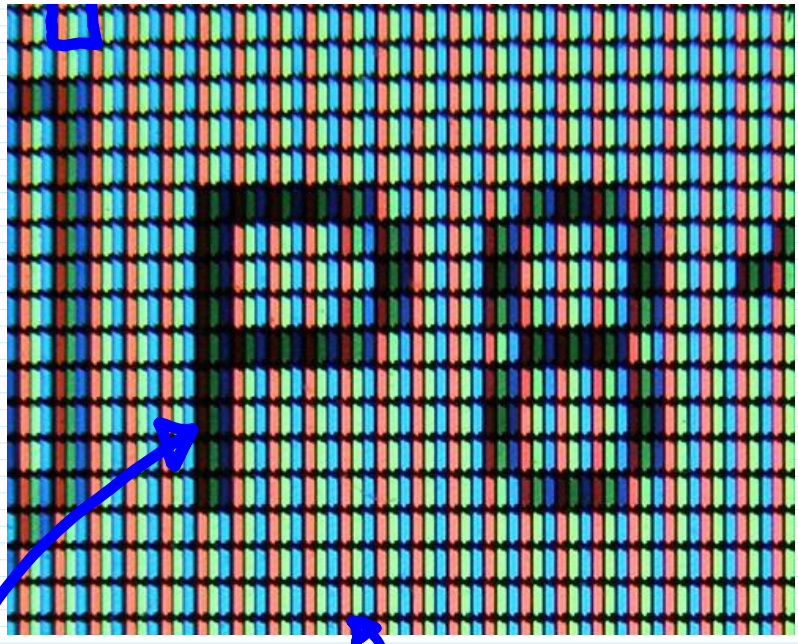
0-256



CYMK

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

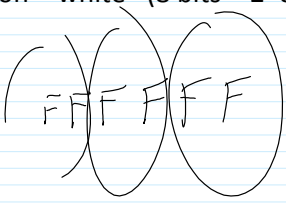
blacK is another color space, good for printing



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



Color channels

Red channel: Can address just the red elements in all the pixels. See histograms, adjust range and contrast