Introduction To Digital Photography

EDay 2003 ECE Short Course

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Why Digital?

- Conventional photos can be scanned, but...
- Film cost
  1. Digital "film" is expensive but reusable
  2. No processing required
- Review & playback give immediate feedback
- Permanence of digital data can be excellent (e.g., color reference is preserved)

Exposure

- How much light energy does the sensor process?
- A function of 4 things:
  1. Available light... which is hard to control
  2. Shutter Speed
  3. Aperture or F/Stop
  4. "Film" Speed (sensor gain)
- Generally, if available light is constant,
  other parameters trade-off

Exposure: Shutter Speed

- The time period during which light is sensed
- 2X time is 2X light energy
- Speeds usually range from about 1 second to 1/1000s
- Things moving faster than shutter are blurred
  (and that's everything if you move the camera ;-)
- Under 1/30s, brace the camera (e.g., use a tripod)

Exposure: Aperture, F/Stop, or T/Stop

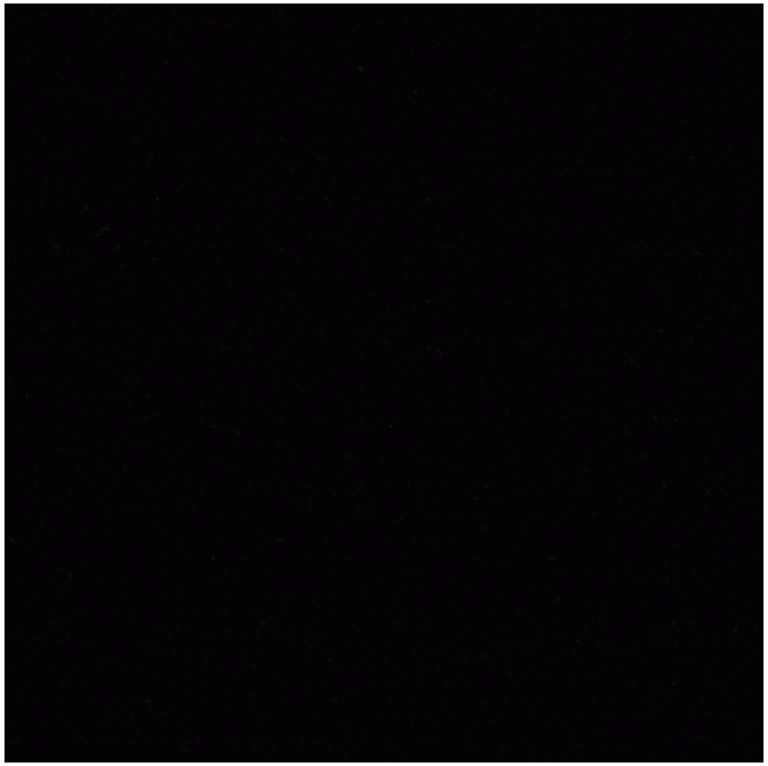
- How much light is admitted (transmitted) by the lens
- Larger aperture is smaller F/Stop number;
  2X steps F2, 2.8, 4, 5.6, 8, 11, 16

Exposure: Film Speed EI, ISO, ASA

- Light measured by electric charge, amplified, & digitized
- Higher is more sensitive; 2X steps 50, 100, 200, 400
- Higher implies more amplification, hence more noise
- Moderate underexposure correctable with higher noise;
  Moderate overexposure clips (looses detail in) highlights
- Example equivalent exposures:
  EI 50, 1/250s @ F2.8
  EI 50, 1/15s @ F11
  EI 200, 1/60s @ F11

Exposure: Film Speed & Sensor Noise

EI 400



EI 50

Photographic Effects

- Focal Length
  - Shorter means wider viewing angle
  - Sensor size varies, so quote 35mm equivalents;
    wide-angle is < 43mm (e.g., 35mm)
    telephoto is > 43mm (e.g., 135mm)
- Depth-of-field
  - Depth-of-field is distance range that is sharp
  - Smaller focal length increases range
  - Higher F/Stop (smaller aperture) increases range

Photographic Effects: Depth-of-field

G1, 7.0mm (36mm) f/8.0

G1, 20.3mm (104mm) f2.5

Photographic Effects: Flash

- A pulsed light source synchronized with the shutter
- Gives fast exposure without enough ambient lighting, but easily yields images of poor quality
- Flash has a limited useful range, images look flat
- *Red Eye* and red-eye reduction flash modes
- Fill-in flash and flash with slow shutter speeds
- Bounce or otherwise soften flash lighting

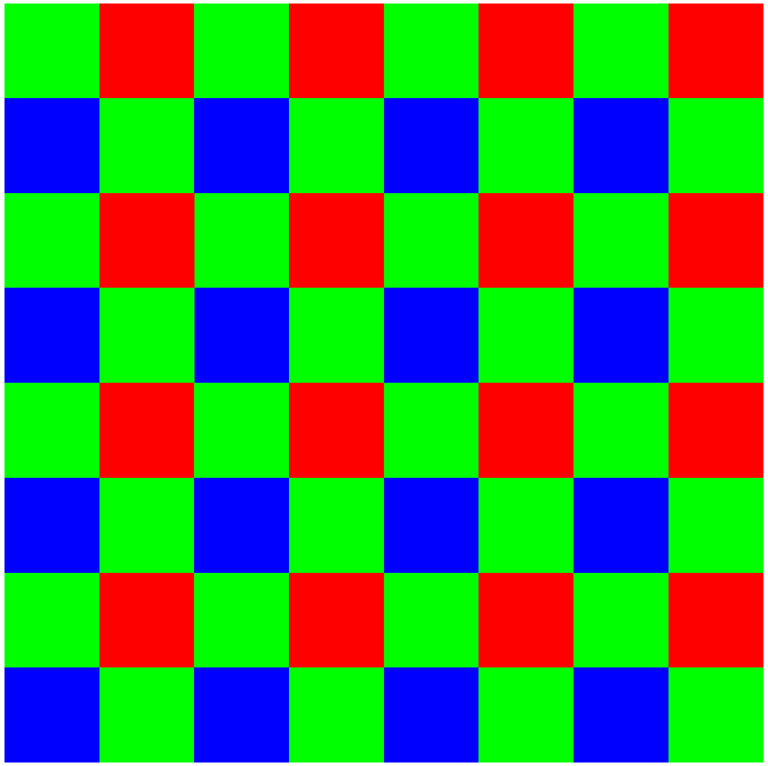
Photographic Effects: Fill-In Flash

Flattens harsh lighting, especially backlighting

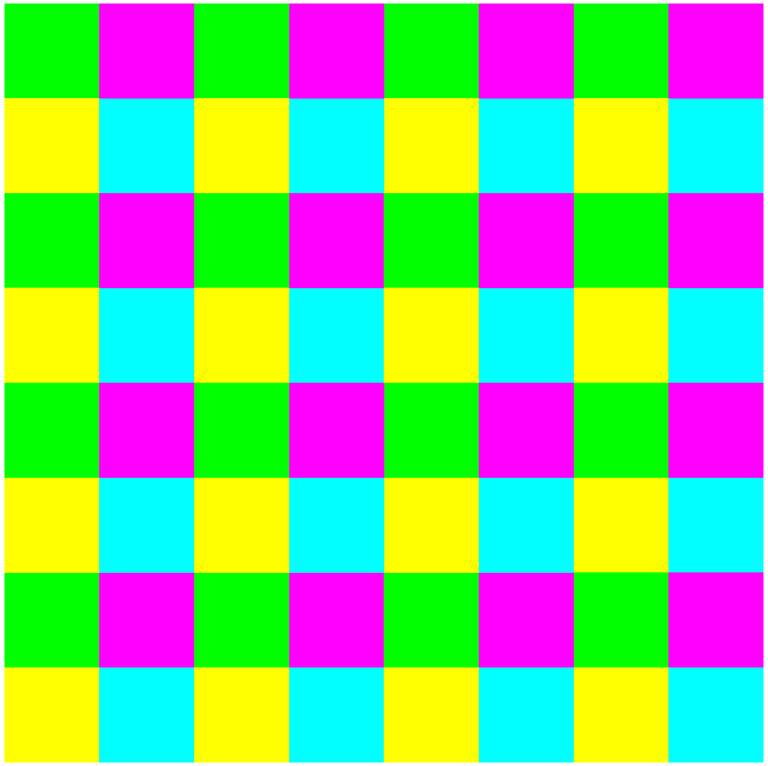
Image Capture: Sensors

- CCD or CMOS arrays with RGB or CMYG filters; Foveon R-G-B sensor stacks
- Analog readings converted to 8, 10, or 12 bit digital
- Each light-sensitive position is called a pixel (1.5-3M pixels is *roughly* comparable to 35mm film)
- *Grain* is mostly noise, but also sensor pixel count
- Sensor noise is less when cold
- Sensor noise is less for fast shutter speeds

Image Capture: Sensor Filters



EOS-1D, GRBG

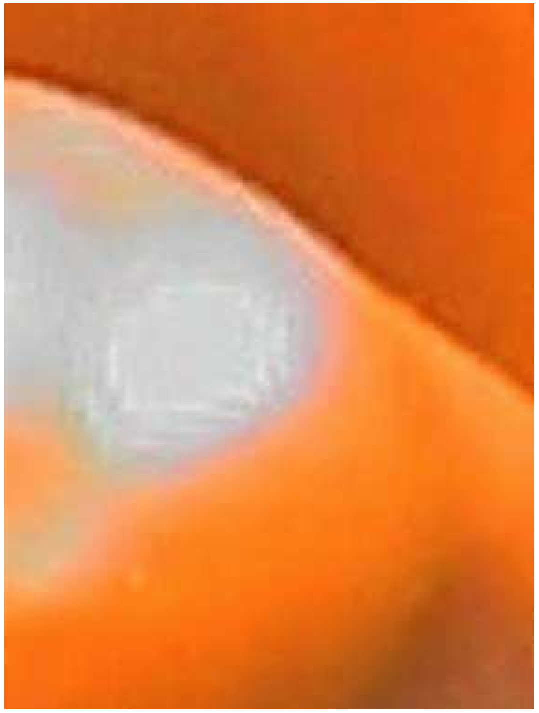


G1, GMYC

Image Capture: Overexposure

Loss of highlight detail; possible local distortion of color

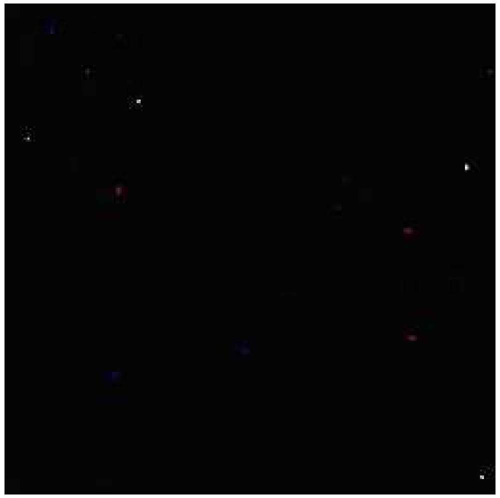
QV100, 640x480 showing crop area



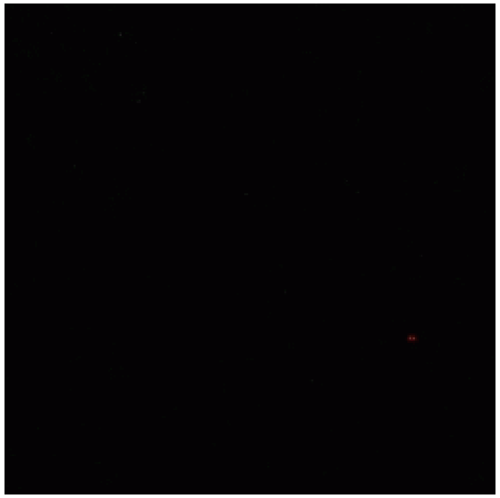
QV100, crop

Image Capture: Speed & Sensor Noise

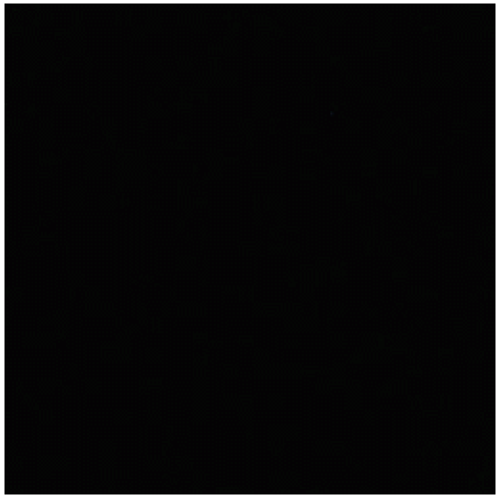
Conventional film has *reciprocity failure* problems;
for digital, very long times increase sensor noise



16s



16s – 16s



1/60s

Image Capture: Storage Media

- Types: CF, SmartMedia, MemoryStick, XD, etc.
- Capacity from 4MB to 1GB, with 50KB to 2MB per image

Image Capture: Resolution & Image Quality

- Resolution (of the sensor):
  - Some sensor pixels are used as a "black reference"
  - Can *interpolate* sensor data to any image resolution
- Image Quality (Compression) Settings:
  - JPEG images are interpolated and compressed
    - JPEG works better with higher resolutions
    - Even "100% quality" JPEGs are imperfect
  - TIFF images are interpolated, saved 24 bits/pixel RGB
  - Raw formats save sensor data to process later
    (e.g., 10-12 bits/pixel one color)

Image Capture: Resolution & Image Quality

196932 Bytes

13687 Bytes

5735 Bytes

JPEG compression is effective for photos

Image Capture: Resolution & Image Quality

61002 Bytes

9025 Bytes

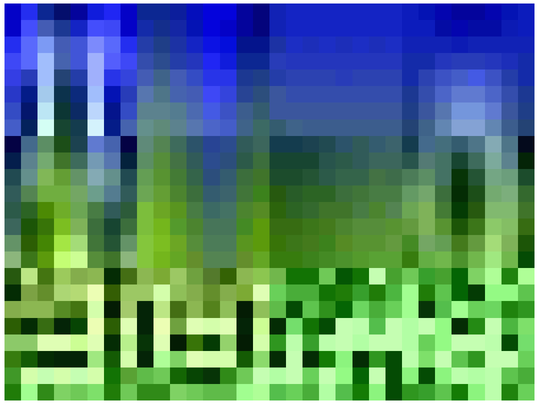
16309 Bytes

JPEG is more effective at higher resolutions

Both `100%` and `50% 256x256` better than `100% 128x128`!

Image Capture: 100% JPEG Isn't Perfect



Master 32x24

100% JPEG
50% JPEG
25% JPEG
5% JPEG

Image Capture: Color Balance

- Color reproduction and perception is tricky stuff
- Use manual white balance where possible
- Can fix later (best using raw format)

G1, JPEG using default color balance

G1, color balance of JPEG adjusted

Digital Darkroom Techniques

- Done with the lights on, no nasty chemicals!
- Can do some on-site using in-camera preview, options
- Corrections:
  - Fixing underexposure increases noise;
    Overexposure clips highlights, information is lost
  - Adjust color, contrast, dodge/burn
  - Can fix RedEye, remove unwanted objects, etc.
- Cropping: sensors are 4:3 or 3:2, not 7:5, 10:8, 14:11, etc.

Digital Darkroom Techniques: Printing

- Various printing techonologies:
  - Dye Sublimation: highest quality, expensive and slow
  - Inkjet: good quality (with the right paper)
  - Laser: fast & cheap per print
- Does the monitor match the printer?
- Want more than 100 pixels per inch for printed image

Advanced/Specialized Darkroom Techniques

- Remove/replace backgrounds
- Panorama stitching:
  Create larger, higher-resolution image
  from multiple lower-resolution images
- Correction of lens/perspective distortions:
  Can undo barrel/pincushion distortion,
  logically tilt the lens, etc.
- Various special effects (to use sparingly):
  Page curl, tiling/mosaics, "old photo" effects, etc.

Advanced/Specialized Darkroom Techniques

Panorama of the KAOS Lab, Summer 2002...

13700x1920 pixels, i.e., about 25MPixels

Non-Traditional Uses (of images)

- Images for the WWW
  - Download time matters; keep image file size small (generally, 640x480 or lower resolution)
  - Use JPEG, GIF, or PNG compression
- Image archiving:
  - CD or DVD as "archival" storage...
    (many DVD players can show JPEGs from a CD)
  - Can easily make slideshows on videotape, etc.

Non-Traditional Uses (of the camera)

- The camera is a (NTSC/PAL) presentation device:
  - Can do slide shows of photos taken
  - Upload and then show any images
    (often, cameras are picky about image format)
- Visual note-taking:
  Photograph where you parked, notes on a chalkboard, etc.

My Most Important Disneyworld Photo

Where did you park? ;-)

References

- Other tutorials:

  http://www.webphotoschool.com/ir/

  http://www.shortcourses.com/

  http://www.vincentbockaert.com/Tutorials/ImagesFramePST_08_PS.htm

- Digital photography equipment reviews, etc.:

  http://www.dpreview.com/

  http://www.imaging-resource.com/

  http://www.dcresource.com/

  http://www.steves-digicams.com/

The Quiz

Hands-On Period

- Digital cameras here (somewhat old):
  - Olympus D320R: 1M pixel, SmartMedia, ...
  - Nikon CoolPix 950: 2M pixel, CF, ...
- Printers here (cheap ones):
  - Lexmark Z35
  - HP 3820