WEEK 9: DIGITAL CAMERAS (CONTINUED)

DIGITAL MEDIA E-10
EXPOSING DIGITAL PHOTOGRAPHY

DAN ARMENDARIZ

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Problem Set 4: due tonight (11:59PM)
Project 4: due next Thursday, November 5
Problem Set 5: released today, due November 12
FOCAL LENGTH AND PERSPECTIVE

SENSOR SIZES

2013: 1/320s, f/5.6, ISO 200, +1EV, 35mm
FOCAL LENGTH AND PERSPECTIVE

SENSOR SIZES

2013: 1/320s, f/5.6, ISO 200, +1EV, 35mm
DEPTH OF FIELD

SENSOR SIZE

Canon 1D Mark II, 28mm f/13 1/8 sec, ISO 640

Canon S70, 8mm f/3.5 1/8 sec, ISO 50

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www.clarkvision.com
FULL-WELL CAPACITY OF PIXELS AT VARIOUS ISO VALUES

DYNAMIC RANGE

100
200
400
800
# Digital Cameras

## Sensor Types

<table>
<thead>
<tr>
<th>Active Pixel Sensors</th>
<th>Passive Pixel Sensors</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMOS</td>
<td>CCD</td>
</tr>
</tbody>
</table>
SENSOR SIZES

PIXEL SIZE
ACTIVE PIXEL

SENSORS

\[ V_{RST} \]

\[ V_{DD} \]

RST \( M_{rst} \)

(Light)

ROW \( M_{sf} \);

COL \( M_{sel} \)
COLOR FILTER ARRAYS

PIXEL LAYERS

Incoming light
Filter layer
Sensor array
COLOR FILTER ARRAYS

adapted from Cburnett’s image from wikipedia.org
COLOR FILTER ARRAYS

demosaic.com
FOVEON X3

SENSORS

Image adapted from http://www.ddisoftware.com/sd14-5d/
LOW-PASS (ANTI-ALIASING) FILTER

SENSORS

Images adapted from http://www.ddisoftware.com/reviews/sd9-v-bayer/
Low contrast allows high range

Dynamic Range

2014: 1/13s, f/4, ISO 200, 76mm.
DYNAMIC RANGE

2014: 1/13s, f/4, ISO 200, 76mm
RISKS OF HIGH CONTRAST

DYNAMIC RANGE

2014: 1/13s, f/4, ISO 200, 76mm
# A Refresher

## Bits & Bytes

<table>
<thead>
<tr>
<th>Bit</th>
<th>0 or 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte</td>
<td>8 Bits</td>
</tr>
</tbody>
</table>
DIGITAL CAMERAS

ANALOG TO DIGITAL CONVERTER (ADC)

Analog Sensor

1.00 V
0.55 V
0.00 V

8-bit Sampling

255
140
0

Digital Output

10001100
**DIGITAL CAMERAS**

**ANALOG TO DIGITAL CONVERTER (ADC)**

Analog Sensor: 1.00 V, 0.55 V, 0.00 V

12-bit Sampling: 4095, 2252, 0

Digital Output: 100011001100
<table>
<thead>
<tr>
<th>512</th>
<th>1024</th>
<th>2048</th>
<th>4095</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 stop</td>
<td>1 stop</td>
<td>1 stop</td>
<td></td>
</tr>
</tbody>
</table>
DIGITAL CAMERAS

Image from http://www.covingtoninnovations.com/dslr/Curves.html
# RAW VS JPEG

## DIGITAL CAMERAS

<table>
<thead>
<tr>
<th></th>
<th>RAW</th>
<th>JPEG</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BIT DEPTH</strong></td>
<td>10-, 12-, 14-BIT</td>
<td>8-BIT</td>
</tr>
<tr>
<td><strong>TONE CURVE</strong></td>
<td>NOT APPLIED</td>
<td>APPLIED</td>
</tr>
<tr>
<td><strong>WHITE BALANCE</strong></td>
<td>NOT SET</td>
<td>SET</td>
</tr>
<tr>
<td><strong>COMPRESSION</strong></td>
<td>LOSSLESS</td>
<td>LOSSY</td>
</tr>
<tr>
<td><strong>PORTABILITY</strong></td>
<td>NONSTANDARD</td>
<td>STANDARD</td>
</tr>
<tr>
<td><strong>POST-PROCESSING</strong></td>
<td>REQUIRED</td>
<td>OPTIONAL</td>
</tr>
</tbody>
</table>
"EXPOSE TO THE RIGHT"

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