Nikon D5100
vs.
Sony Cyber-shot DSC-T700

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PSYCH 221: Image Systems Engineering
Stanford University
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Investigation

Question
• Do you get what you pay for?

Hypothesis
• Yes, you do
• The more expensive camera should outperform the cheaper camera by all metrics and in almost all situations
Profiles

<table>
<thead>
<tr>
<th></th>
<th>Nikon D5100</th>
<th>Sony Cyber-shot DSC-T700</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lens</strong></td>
<td>AFS DX Nikkor 18-55mm f/3.5-5.6G VR</td>
<td>Carl Zeiss 4 x x Zoom lens - 6.18 mm - 24.7 mm - F/3.5-4.6</td>
</tr>
<tr>
<td><strong>Megapixels</strong></td>
<td>16.2</td>
<td>10.1</td>
</tr>
<tr>
<td><strong>Retail Price(^1)</strong></td>
<td>$749</td>
<td>$203(^2)</td>
</tr>
</tbody>
</table>

1. Amazon.com, 3/18/12
2. Model discontinued so selected closest current model (Sony Cyber-shot DSC-T110)
Modulation Transfer Function

Why measure it?
- The contrast at a given spatial frequency relative to low frequencies
  - Typically measured in cycles or line pairs per distance
- The most important measure of device/system sharpness
- Determines the amount of detail an image can convey
Modulation Transfer Function

**Measures of interest:**
1. **MTF50** = Spatial frequency where MTF is 50% of the low (0) frequency MTF

2. \( MTF50 \) \((\text{Line Widths/inch on the print}) = \frac{MTF50(LW/PH)}{\text{Print height in inches}}\)

<table>
<thead>
<tr>
<th>MTF50 (LW/inch on print)</th>
<th>Quality level(^1)</th>
<th>Comments(^1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>Excellent</td>
<td>Extremely sharp at any viewing distance. About as sharp as most inkjet printers can print.</td>
</tr>
<tr>
<td>110</td>
<td>Very good</td>
<td>Large prints (A3 or 13×19 inch) look excellent, though they won’t look perfect under a magnifier. Small prints still look very good</td>
</tr>
<tr>
<td>80</td>
<td>Good</td>
<td>Large prints look OK when viewed from normal distances, but somewhat soft when examined closely. Small prints look soft—adequate, perhaps, for the &quot;average&quot; consumer, but definitely not &quot;crisp.&quot;</td>
</tr>
</tbody>
</table>

**Source:** Imatest, [http://www.imatest.com/docs/sharpness_comparisons/](http://www.imatest.com/docs/sharpness_comparisons/)

1. after post-processing, which may include some additional sharpening
Line Spread Function/Modulation Transfer Function

MTF50 (LW/inch) =

Nikon: 1646

Sony: 1222
## Implications

<table>
<thead>
<tr>
<th>Size</th>
<th>Nikon = 1646</th>
<th>Sony = 1222</th>
</tr>
</thead>
<tbody>
<tr>
<td>5” x 7”</td>
<td>329</td>
<td>244</td>
</tr>
<tr>
<td></td>
<td>Excellent</td>
<td>Excellent</td>
</tr>
<tr>
<td>8.5” x 11”</td>
<td>194</td>
<td>144</td>
</tr>
<tr>
<td></td>
<td>Excellent</td>
<td>Very good</td>
</tr>
<tr>
<td>11” x 14”</td>
<td>150</td>
<td>111</td>
</tr>
<tr>
<td></td>
<td>Excellent</td>
<td>Very good</td>
</tr>
<tr>
<td>18” x 24”</td>
<td>91</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td>24” x 30”</td>
<td>69</td>
<td>51</td>
</tr>
</tbody>
</table>
Chromatic Aberration

**Why test it?**

- One of several aberrations that degrade lens performance
- Occurs because the index of refraction of glass varies with the wavelength of light, i.e., glass bends different colors by different amounts
  - This phenomenon is called *dispersion*
- Minimizing chromatic aberration is one of the goals of lens design and is accomplished to an extent by combining glass elements with different dispersion properties
Chromatic Aberration

• 2 types:

1. **Longitudinal chromatic aberration**
   - causes different wavelengths to focus on different image planes
   - causes a degradation of MTF response—by differing amounts for different colors

2. **Lateral chromatic aberration** is the color fringing that occurs because the magnification of the image differs with wavelength
   - tends to be far more visible than longitudinal CA
Chromatic Aberration

**Measure of interest =**
CA (area) as a percentage of the distance to image center

<table>
<thead>
<tr>
<th>CA (area) in % of distance from the image center</th>
<th>Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-0.04</td>
<td>Insignificant</td>
</tr>
<tr>
<td>0.04-0.08</td>
<td>Low. Hard to see unless you look for it.</td>
</tr>
<tr>
<td>0.08-0.15</td>
<td>Moderate. Somewhat visible at high print magnifications.</td>
</tr>
<tr>
<td>over 0.15</td>
<td>Strong. Highly visible at high print magnifications.</td>
</tr>
</tbody>
</table>

Chromatic Aberration

**Nikon**

- 0.053% Low

**Sony**

- 0.031% Insignificant
ΔE, Noise
ΔE

Nikon

ΔE (mean) = 11.5

Sony

ΔE (mean) = 12.1
Noise

Nikon has a higher noise level at every exposure value.
## Summary

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<th>Sony</th>
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</thead>
<tbody>
<tr>
<td>MTF50 (LW/inch)</td>
<td>1646</td>
<td>1222</td>
</tr>
<tr>
<td>CA (area) as a % of the distance to image center</td>
<td>0.053% Low</td>
<td>0.031% Insignificant</td>
</tr>
<tr>
<td>ΔE</td>
<td>11.5</td>
<td>12.1</td>
</tr>
<tr>
<td>Noise</td>
<td>Higher</td>
<td>Lower</td>
</tr>
</tbody>
</table>
Daytime

Nikon

Sony
Nighttime

Nikon

Sony
Conclusion

• While the Nikon D5100 costs more than 3x the Sony Cyber-shot it does not really outperform
• Nikon has some advantages in high and low light scenes
• Many consumers would not rationalize the higher cost for the Nikon over the Sony
• Possible Limitations
  • Measurement error
  • Lighting issues
  • Specific weather conditions