CHARACTERIZATION OF DIFFUSE REFLECTIONS FROM HANDHELD DISPLAY DEVICES FOR MEDICAL IMAGE VIEWING

Peter Liu and Aldo Badano
Division of Imaging and Applied Mathematics
Office of Science and Engineering Laboratories
Center for Devices and Radiological Health
Food and Drug Administration

CORM 2013 - NIST
Summit on Color in Medical Imaging
An International Workshop on the Technical Framework for Consistency and Interoperability Approaches for Dealing with Color in Medical Images

Co-sponsored by ICC and FDA
Endorsed by AAPM and DICOM

May 8-9, 2013 at FDA White Oak campus
MONITORS VS. HANDHELDs

- Advantages of handhelds: availability in remote places and emergency situations.
- Types of handhelds: phones vs. tablets.
- Important factors to consider:
  - Display must perform in a wide range of ambient illumination conditions.
  - Due to high reflectivity, performance deteriorates as the user moves from dark areas into environments of greater ambient illumination.
PREVIOUS WORK & GOALS


• 2012: The effect of ambient illumination on handheld display image quality, to appear in JDI.

• 2013: Image quality characteristics of handheld display devices for medical imaging, under review.

• How to characterize reflectivity of handheld devices?
  • TG18 (2005) describes methods to characterize specular and diffuse reflectivity on medical displays, but,
  • How do varying display sizes affect the measurement?

METHODOLOGY

• TG18 defines methods for measuring diffuse and specular coefficients for medical displays.
• Does not define method for measuring mobile displays and tablets.
• Follow methodology for measuring diffuse reflectance specified in TG18 with some modifications.
• TG18 defines a integrating sphere (or similar) placed in contact with the display faceplate.
EXPERIMENTAL SETUP

The device was placed inside a box in front of the back panel. For monitors, the box was placed against the monitor with no back panel.
Device was attached to the mask with Velcro.
EXPERIMENTAL SETUP

• Masks as back panels to the white box
• 7 setups:
  • No mask / back panel
  • Mask with 7 x 7 in opening
  • Mask with 6 x 6 in opening
  • Mask with 5 x 5 in opening
  • Mask with 4 x 4 in opening
  • Mask with size fit to screen
  • TG18 setup (Device put in front of back panel)
• Illuminance measured with a T10 (Int’l Light)
• Luminance measured with a CS100 (Konica-Minolta)
# Devices Measured

<table>
<thead>
<tr>
<th>Device</th>
<th>Manufacturer</th>
<th>Display Size</th>
<th>Display Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nexus 7</td>
<td>Asus</td>
<td>7 in</td>
<td>IPS LCD</td>
</tr>
<tr>
<td>iPad 1st Gen</td>
<td>Apple</td>
<td>9.7 in</td>
<td>IPS LCD</td>
</tr>
<tr>
<td>iPad 3rd Gen</td>
<td>Apple</td>
<td>9.7 in</td>
<td>IPS LCD</td>
</tr>
<tr>
<td>Galaxy Tab 10.1</td>
<td>Samsung</td>
<td>10.1 in</td>
<td>PLS LCD</td>
</tr>
<tr>
<td>Galaxy Note 10.1</td>
<td>Samsung</td>
<td>10.1 in</td>
<td>WXGA LCD</td>
</tr>
<tr>
<td>3MP Display</td>
<td>Eizo</td>
<td>20.8 in</td>
<td>TFT LCD</td>
</tr>
<tr>
<td>OLED Display</td>
<td>Sony</td>
<td>25 5/8 in</td>
<td>AMOLED</td>
</tr>
<tr>
<td>5MP Display</td>
<td>Eizo</td>
<td>21.3 in</td>
<td>TFT LCD</td>
</tr>
<tr>
<td>iPod Touch 4th Gen</td>
<td>Apple</td>
<td>3.5 in</td>
<td>IPS LCD</td>
</tr>
<tr>
<td>Galaxy S III</td>
<td>Samsung</td>
<td>4.8 in</td>
<td>AMOLED</td>
</tr>
</tbody>
</table>
DEVICES MEASURED
RESULTS: DIFFUSE REFLECTION COEFFICIENT

\[ R_d \ (cd/m^2/lx) = \frac{L_r}{I_r} \]
RESULTS RELATIVE TO FIT-TO-SCREEN MASK

- Nexus 7
- iPad 1st Gen
- iPad 3rd Gen
- Galaxy Tab 10.1
- Galaxy Note 10.1
- Galaxy S3
- iPod Touch 4th Gen

- No Back Panel
- 7 x7 in
- 6 x 6 in
- 5 x 5 in
- 4 x 4 in
- Fit to Screen Size
CONCLUSIONS

• As opening in mask decreased, both luminance measured on the display and illuminance increased.

• Might need to revise measurement method to provide consistent data for fair comparisons.

• We found differences in the measurements with respect to TG18 method of up to 20%.

• This work might be taken by an AAPM task group under the Working Group on Medical Displays. Contact me if interested in joining!
THE END