Color Error in Mobile Displays and Desktop Monitors

Paul A. Boynton
NIST

John Penczek
NIST & Univ. Colorado, Boulder

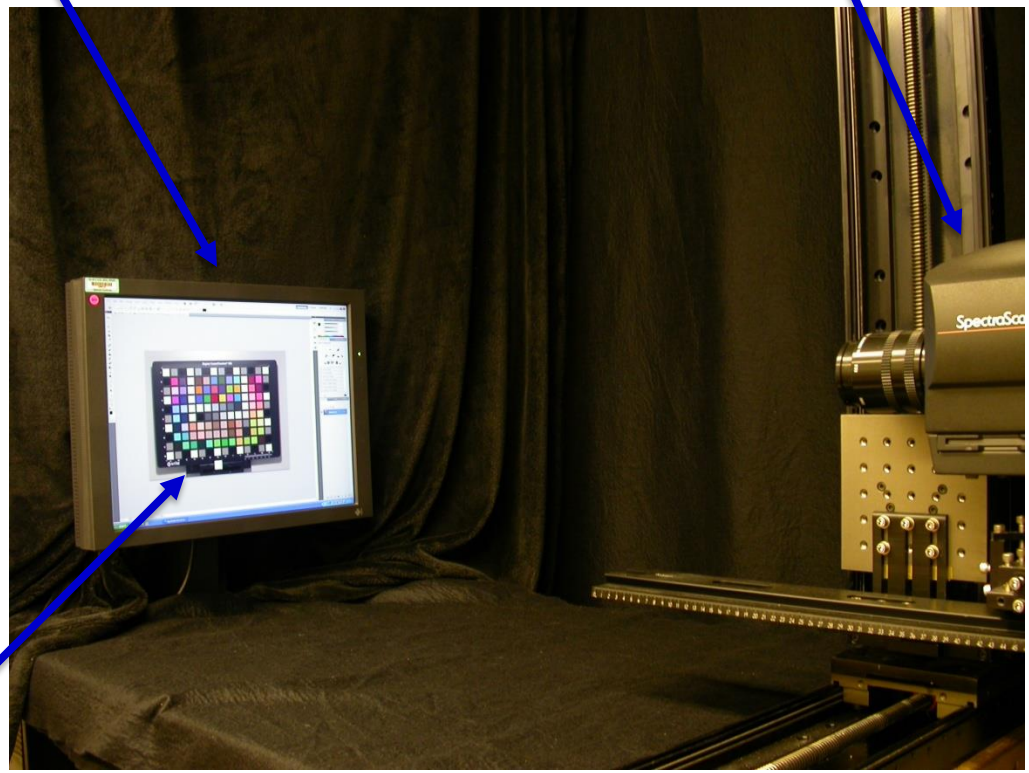
Summit on Color in Medical Imaging

May 8-9, 2013

Display Measurement Setup

Display under test:
Positioned normal to the detector in a dark room.

Reference detector:
High precision spectroradiometer.



Reference image:
Samples a range of color patches

Comparison with Display Technology

Image color error of the NIST CQS color target and flesh tones were also evaluated using a range of display technologies.

Smart phone

Tablet

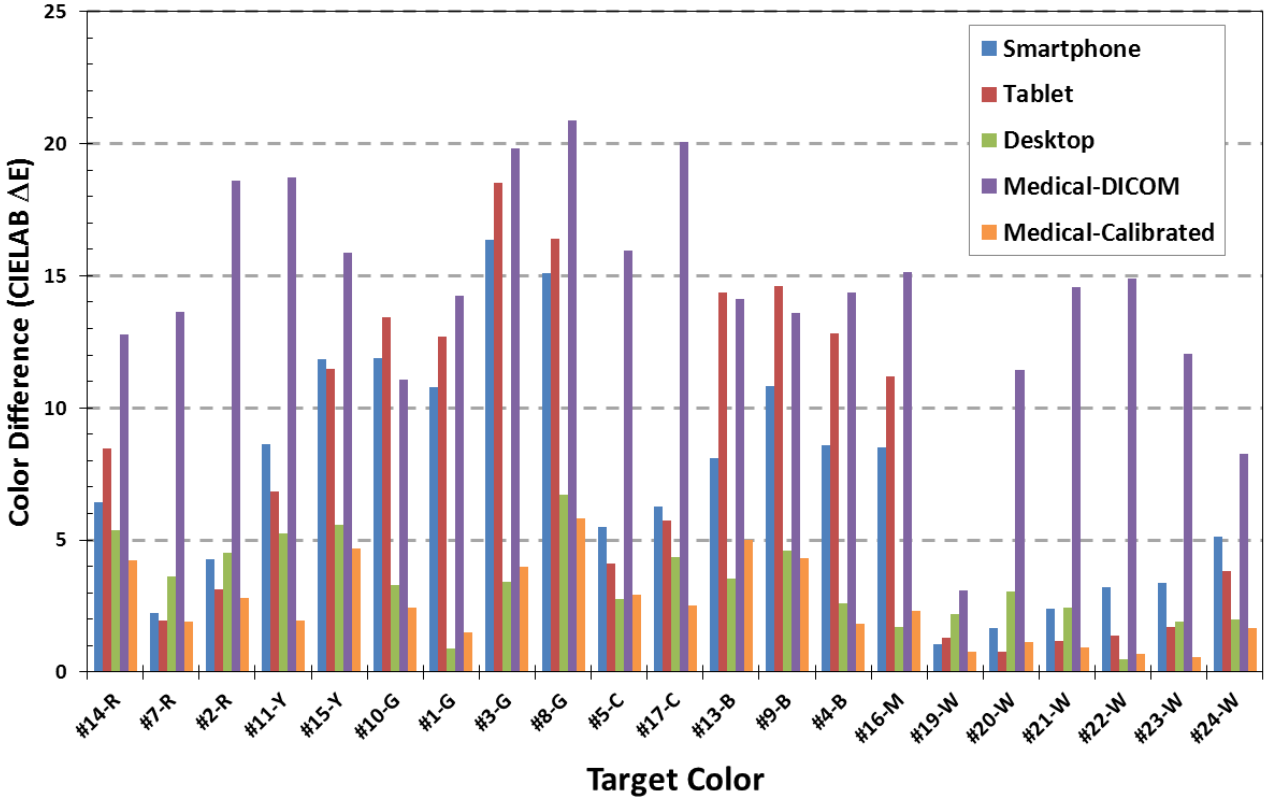
Desktop Monitor

Medical Monitor

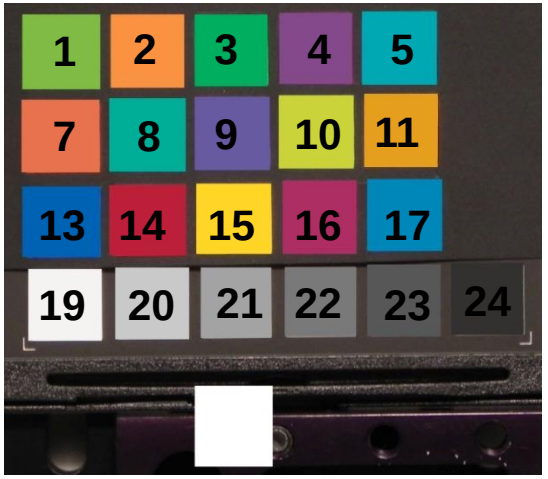
Color patches were generated in a reference image and rendered on the display.

Display Color Error

Various display technologies were evaluated for their out-of-the-box color error using a reference image of the NIST CQS color target.



Display Type	Mean CIELAB ΔE	Mean CIELAB ΔL
Smart Phone (HDR off)	7.0	-2.0
Tablet	6.6	-0.2
Desktop	4.7	0.6
Medical monitor-DICOM Cal	14	-11
Medical monitor-sRGB Cal	2.6	0.6

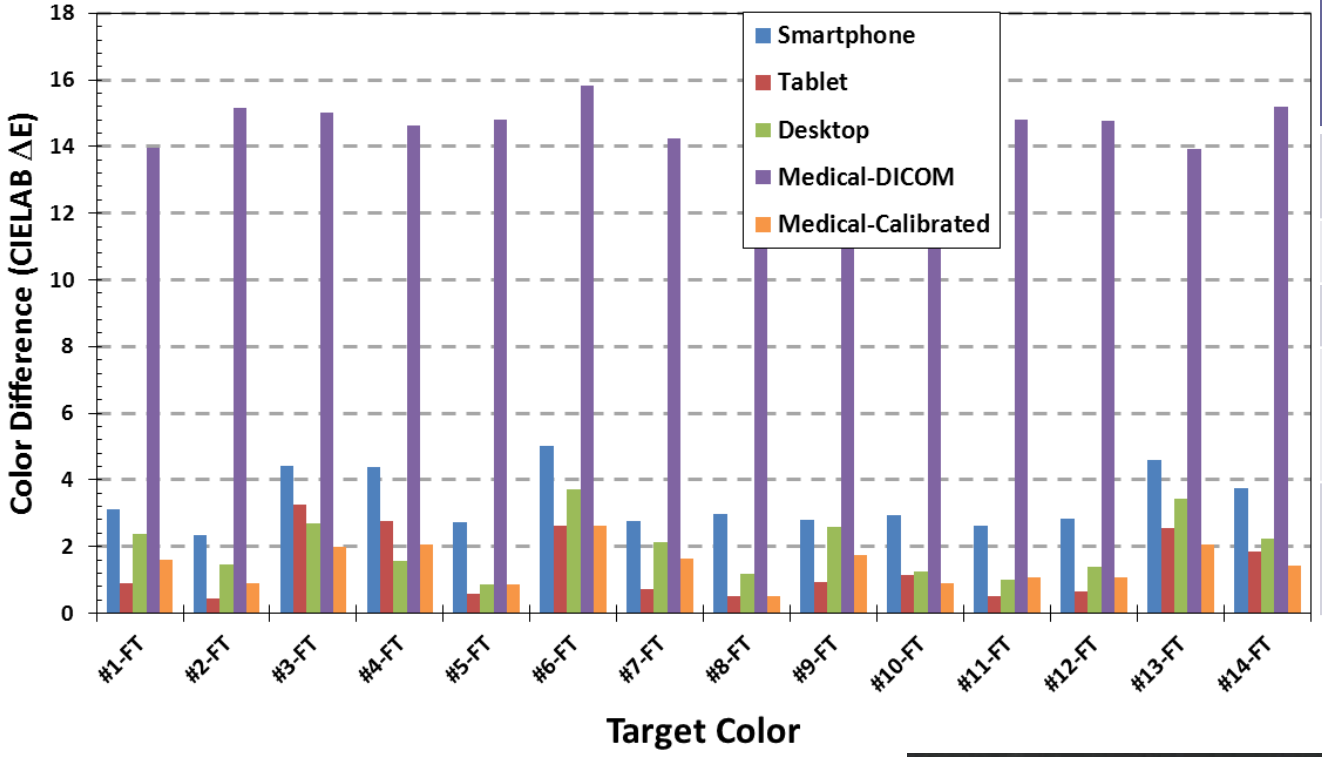


Reference image colors encoded for an sRGB display.

Color code: R=red, Y=yellow, G=green, C=cyan, B=blue, M=magenta, W=white and gray

Display Flesh Tone Color Error

Various display technologies were evaluated for their out-of-the-box flesh tone color error using a reference image of the flesh tone patches in the X-rite Digital ColorChecker SG target.



Display Type	Mean CIELAB ΔE	Mean CIELAB ΔE
Smart Phone (HDR off)	3.4	-2.8
Tablet	1.4	-0.4
Desktop	2.4	-0.4
Medical monitor- DICOM Cal	15	-14
Medical monitor- sRGB Cal	1.5	0.8

Calibrated Medical Monitor Color Error

The color error of the medical monitor is compared between various calibration methods for the NIST CQS and flesh tones color patches.

Display Calibration Type	NIST CQS Post-Cal		Flesh Tones Post-Cal	
	Mean CIELAB ΔE	Mean CIELAB ΔL	Mean CIELAB ΔE	Mean CIELAB ΔL
Monitor vendor – Defined detector	**2.6**	**0.6**	**1.5**	**0.8**
Vendor 2- Detector selectable	**4.2**	**0.2**	**1.8**	**-0.6**
Vendor 3- Defined detector	**6.0**	**-0.3**	**3.7**	**-0.9**
Vendor 4- Defined detector	**3.5**	**0.5**	**2.5**	**0.4**
Vendor 5- Detector selectable	**2.6**	**1.3**	**1.7**	**1.3**