Best Practices for Digital Color Photography in Medicine

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Medical Photography

ICC Medical Imaging Working Group

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Mission & Scope

- **Mission:**

  Collect industry best practices in the field of digital photography and write a guidance document which can be used by the medical industry to minimize the color errors created during the digital color camera image capture process.

- **Scope:**

  This guidance document will apply for a range of digital cameras (from cellphone cameras to scientific grade cameras) and lighting conditions. Recommendations will also be made for camera setup and color correction in post processing.

Contributors

John Penczek, NIST/Univ. of Colorado (project coordinator)

Yves Vander Haeghen, University of Ghent Hospital

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Elizabeth Krupinski, Arizona State University

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Phil Green, ICC

Hong Wei, Datacolor

Draft Outline

Introduction and background
Penczek, Krupinski, Skrovseth

Factors that can contribute to color errors
Penczek, Krupinski

Recommended light conditions
Penczek, Krupinski

Recommended camera setup
Penczek, Krupinski, Skrovseth, Vander Haeghen

Use of reference color charts
Penczek, Vander Haeghen

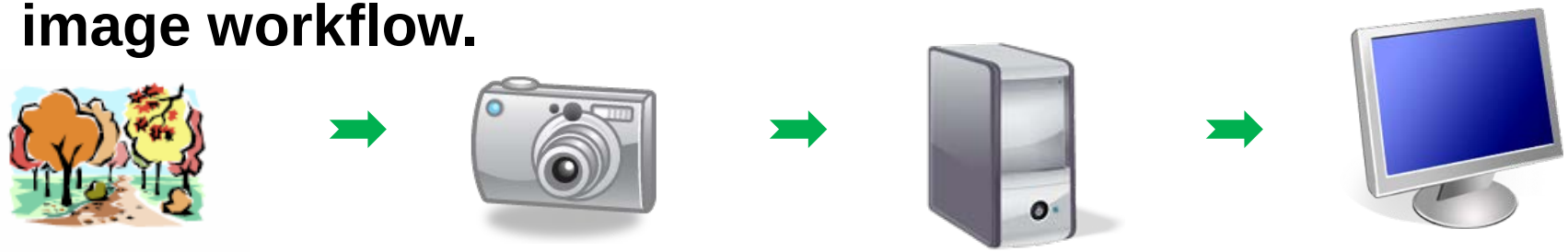
Color correction in post-processing
Skrovseth, Vander Haeghen

Recommendations on color management
Green, Vander Haeghen

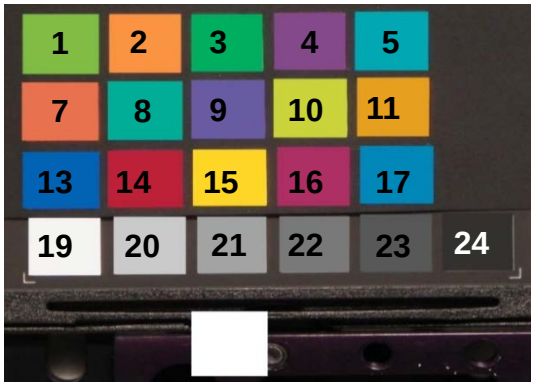
Note: Content should expand on or introduce new information to what is already available (e.g. ATA Practice Guidelines for Teledermatology 2007)

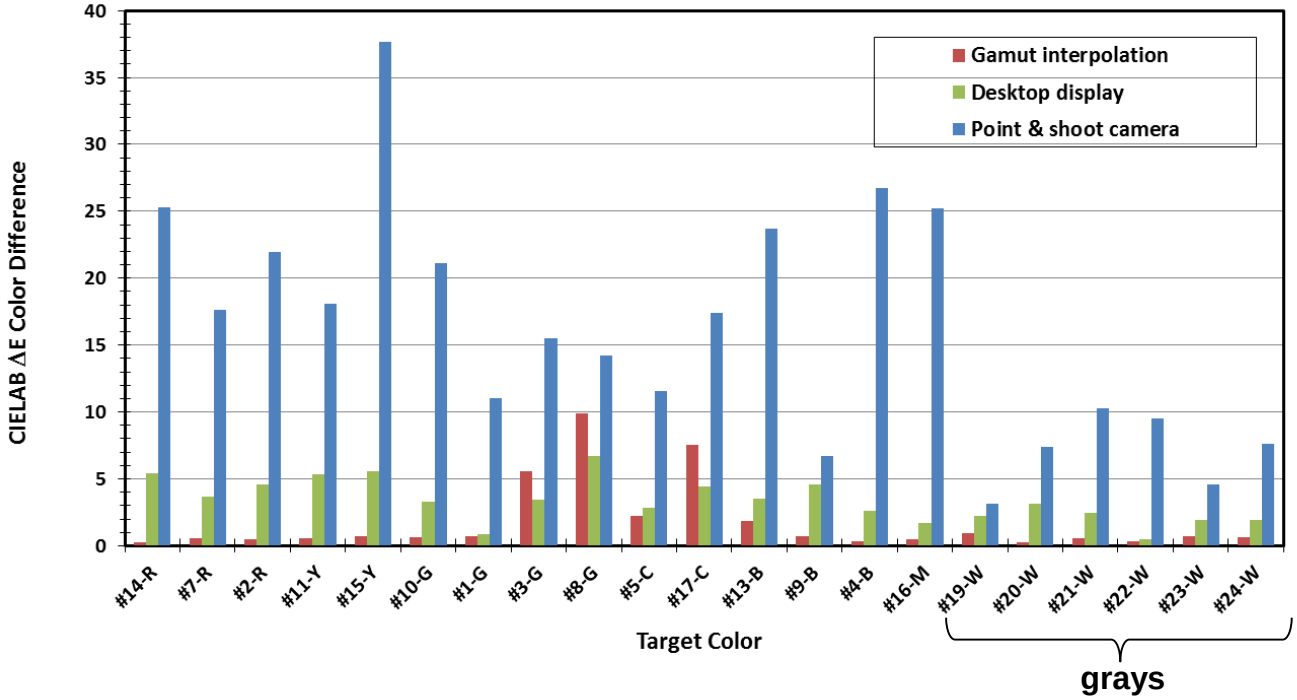
Color Accuracy in Image Workflow

Color error can come from several sources in the color image workflow.



Object → **Camera** → **Viewing Software** → **Display**





Camera color error was determined to be dominant.

Data published at the Society of Information Display Symposium, June 2014

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Camera Color Accuracy Studies

Some studies were conducted to identify the critical parameters that contribute to camera color error.

Camera

Camera image data

RGB → CIE XYZ @ sRGB → External correction → CIE LAB

Perceived color

Dependencies

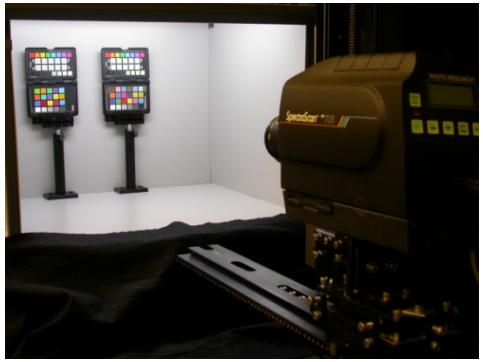
Lighting color
Lighting uniformity
Camera quality

Camera cal
White balance
Camera exposure

Calibration target
Correction software
Reference sample
Reference geometry
Reference cal data

Lighting color
Instrument cal
Stray light

Spectroradiometer



Spectra → CIE XYZ @ sRGB → CIE LAB

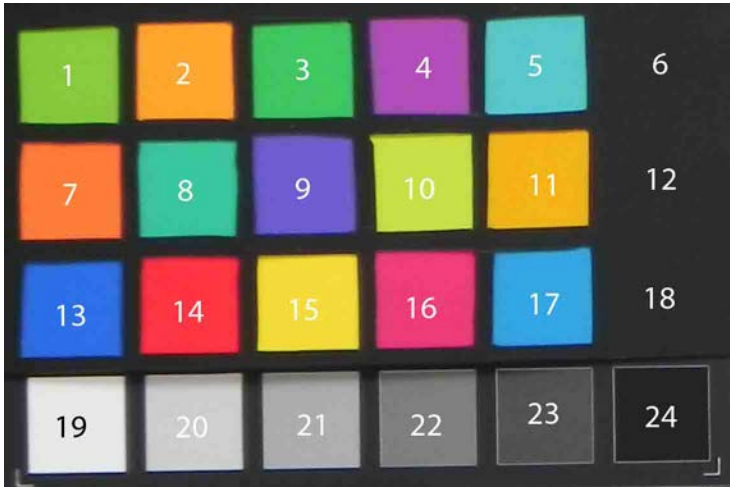
ΔE Color Difference

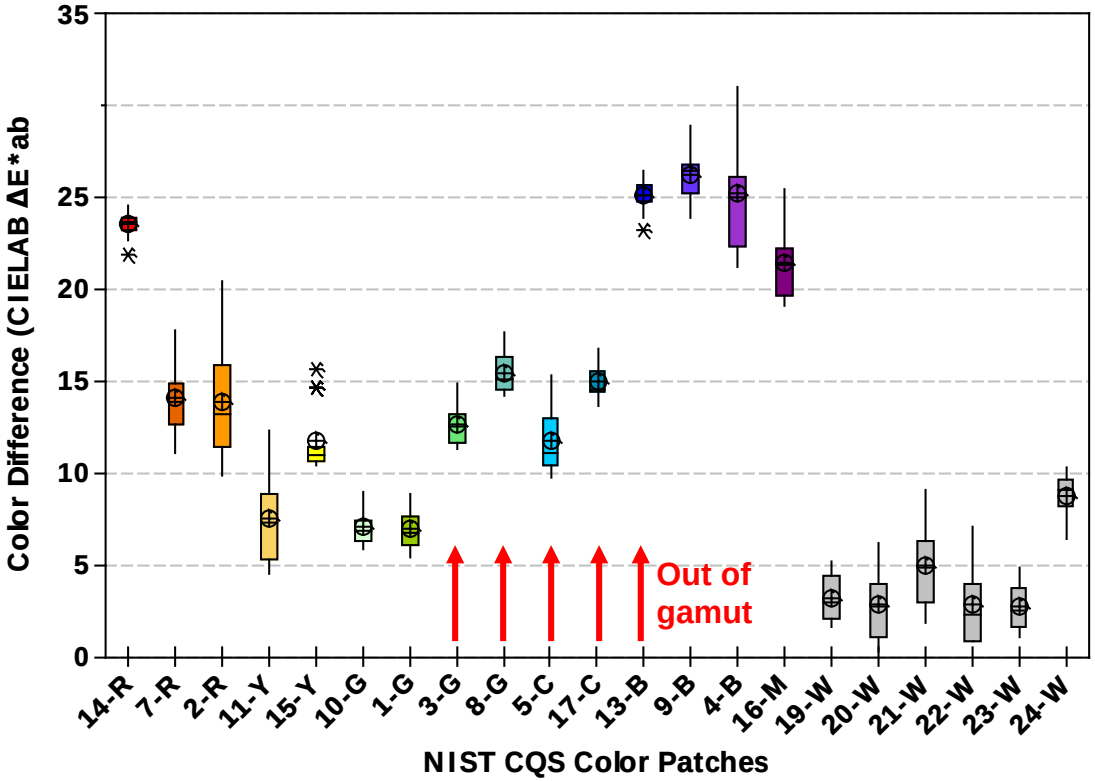
Spectroradiometer data

Camera Color Error Dependence on Color

Image color error of the NIST CQS color target using a mid-priced point & shoot camera under daylight fluorescent lighting conditions.

NIST CQS Color Chart



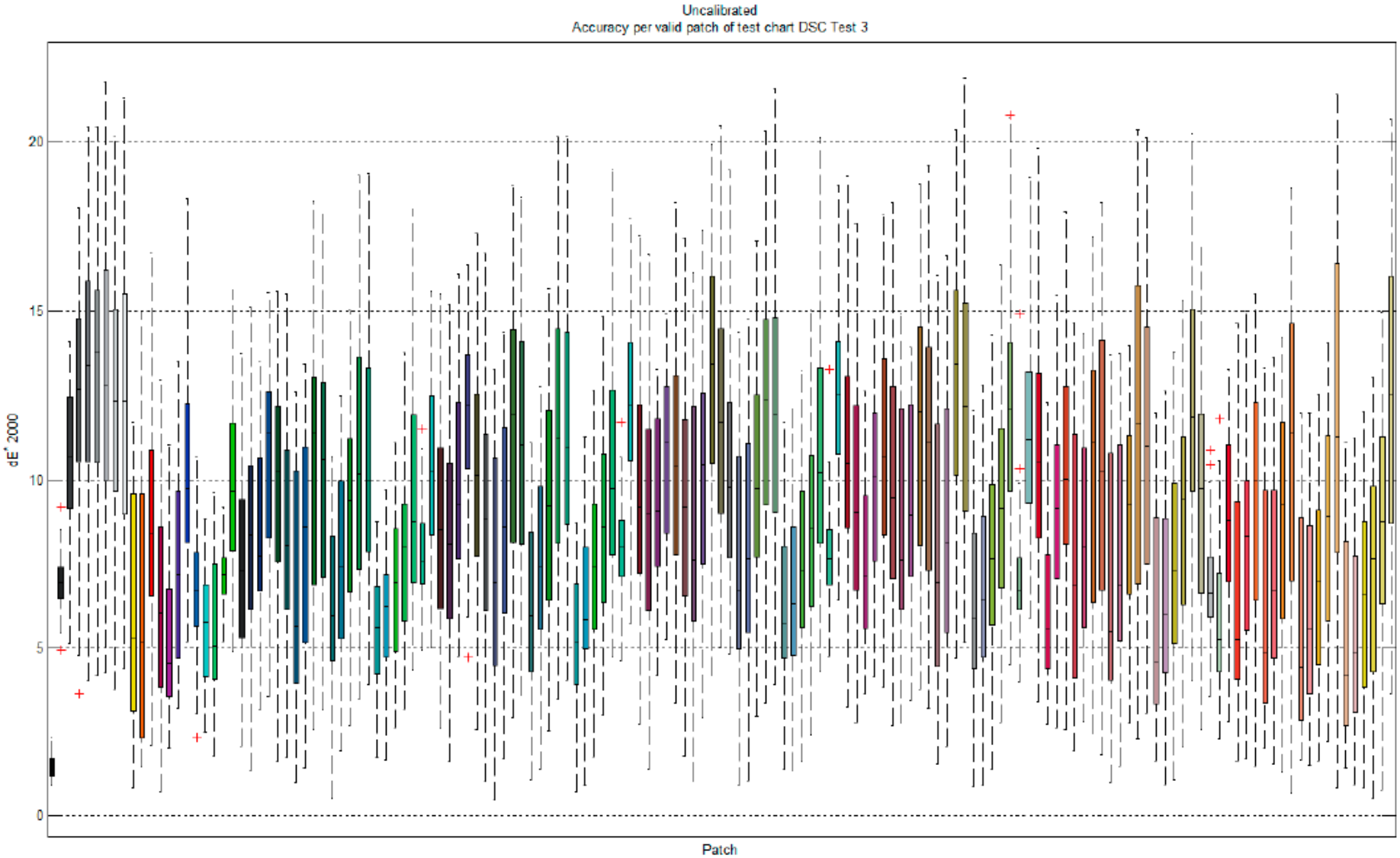


A color difference of CIELAB ΔE^*_{ab}= 1 is considered a just noticeable difference (JND). Color difference is calculated relative to spectroradiometer data.

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

J. Penczek, P.A. Boynton, J.D. Splett, "Color error in the digital camera image capture process," J. Digital Imaging, 27, p182-191 (2013).

Color Accuracy Data from Univ. of Ghent



Unpublished data from Yves Vander Haeghen entitled "Pragmatic color calibration", June, 2014.

Status

- Compiling camera color accuracy data to estimate magnitude of problem
- Identifying dominant factors that can contribute to camera color errors
- Initial recommendations developed for camera setup
- Measured relative improvements in various calibration color charts
- Evaluating various color correction methods
- Datacolor is developing a general camera calibration procedure
- Further discussions needed on color management