

Color in Digital Preservation

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Abstract

To provide practitioners of image capture with practical guidance, the CIE Technical Committee on Archival Colour Imaging (TC8-09) and the Still Image Working Group of the Federal Agencies Digitization Initiative are working together to develop use cases and content type combinations, conducting a series of practical color imaging tests, and evaluating a range of encoding methods. They are concentrating on practical solutions using existing RGB and other tristimulus-based methods to encode the data in a manner that has a known accuracy, can create an accurate representation of the object when displayed, and provide encoding models we believe are sustainable. The work so far on this effort is presented in this paper.

Introduction

Color in digital preservation is a common interest of the CIE Technical Committee on Archival Colour Imaging (CIE TC8-09) and the Still Image Working Group of the Federal Agencies Digitization Guidelines Initiative (FADGI). FADGI is a collaborative effort by federal agencies of the US Government to define common guidelines, methods, and practices to digitize historical content in a sustainable manner. Its Still Image WG [1] was formed to develop common digitization guidelines for still image materials, such as textual content, maps, photographic prints and negatives.

TC8-09 was formed “to recommend a set of techniques for the accurate capture, encoding and long-term preservation of colour descriptions of digital images that are either born digital or the result of digitizing 2D static physical objects, including documents, maps, photographic materials and paintings.” The committee brings together color experts from industry and academia, as well as practitioners in libraries, museums and archives who are responsible for the capture, preservation, reproduction and distribution of images in digital and print format. As a result, many members of the FADGI Still Image Working Group are also members of TC8-09.

In work so far, the group has identified the most useful and highest value topics in archival and preservation color and the parts of the archival color imaging workflow that are most problematic and ambiguous [2]. It has become clear that most practitioners don’t want a single answer because no one answer will work for all original types or capture scenarios. Instead, they want a risk-benefit analysis of the different options that they can use to choose the one that fits best their budget, schedule, resources and quality goals.

It was with this as a backdrop that the TC8-09 in 2010 agreed to undertake an imaging study in which participating institutions would “shoot” the same target or targets using existing protocols, such as the Metamorfoze Preservation Imaging Guidelines [3] or the FADGI guidelines [4], with the goal of establishing a

consistent and fundamental baseline for capture. This baseline could then be adapted to special collections, different types of material and individual pieces according to the need and following documented practices and experiences. This was partly in response to the observed need to adjust both the capture results because of “errors” in the values obtained and the capture procedures according to the material.

The objective of the capture in the context of CIE TC8-09 is creating a master image, which can then be rendered or reproduced according to the requirements of the use case or reproduction medium. The tests described in this paper are intended to be a step toward achieving uniformity in practice so that the master images resulting from the capture of the same object will be the same within some reasonable tolerances independent of where the capture was made, without unnecessarily limiting or otherwise comprising subsequent rendering decisions.

It is recognized that different cultural heritage institutions have differing needs for digital imaging and for the use of the resulting image files. For example, the Metamorfoze Preservation Imaging Guidelines were originally developed with newspapers and other mass digitization projects in mind and are intended to create master image files, with rendering and re-purposing to follow. The FADGI technical guidelines are based on the 2004 NARA guidelines [5], and the primary (but not exclusive) use-case is viewing images on a generic computer monitor. These two different use cases are reflected in the different sets of aims for color and tone reproduction, embedded color profiles, and related color encoding for the final image files.

Imaging Study and Analysis

CIE TC8-09 and the FADGI Still Image Working Group are conducting an inter-lab round-robin test and evaluation of current practices for digital color image capture, color image processing, and color encoding for scanning collections in cultural institutions. Participating institutional labs digitized an identical set of targets and a small sample set of originals representing typical collection content.

The resulting image files were processed for analysis. Participating labs were asked to follow their current standard operating procedures using their production scanning equipment and to document the process in sufficient detail their procedures could be replicated by others. Using the Metamorfoze or FADGI guidelines was not required, unless a lab follows these protocols.

Test Content Preparation and Measurements

Seven test pieces were identified and selected for the color image testing; three ground-truth targets and four sample originals of color print materials. Test targets and prints are illustrated and described in more detail below.

The three commercially available imaging targets that were measured and scanned are shown in Figure 1.

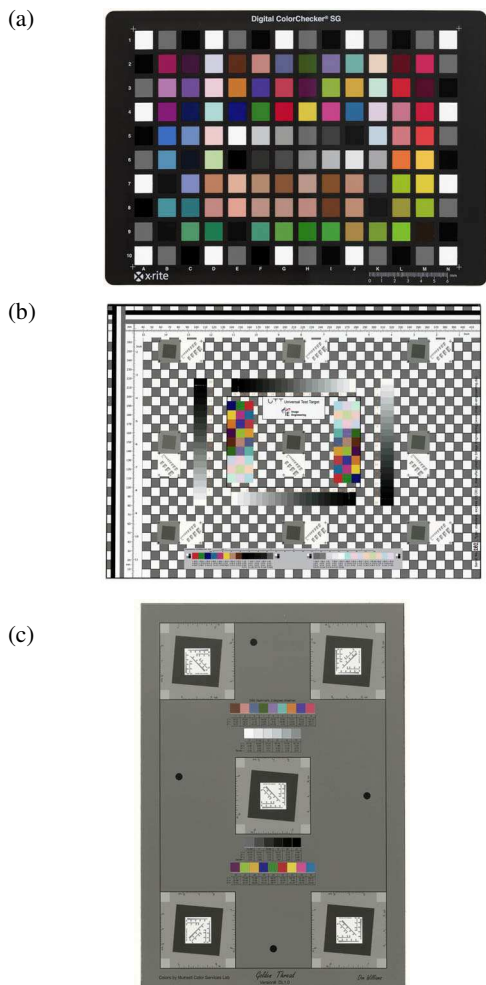


Figure 1. Test targets used in the study: (a) X-Rite Digital ColorChecker SG; (b) Image Engineering Universal Test Target (UTT); and (c) Library of Congress DICE (Digital Image Conformance Evaluation) Object Target (same as the Device-Level Target from Image Science Associates)

The four sample originals scanned by each imaging lab are shown in Figure 2.

CIELAB color measurements were made of the color patches on all three targets and on selected regions of interest (ROIs) on the print materials. The measurements were made by two different labs using different X-Rite 530 spectrodensitometers (both with a 3.4mm aperture); three separate measurement passes were made on each area.

A paper mask was used to identify the ROIs on the prints and provide a record of the locations of the test measures used to compare to the digital images received from the institutions participating in the study. Figure 3 on the left shows the mask with ROIs over the print, and on the right the print without the mask. The ROIs were selected to be representative of the range of colors and densities in the prints. Between five and twelve ROIs were selected on each print.



Figure 2. Sample originals used in the study: (a) Hand-colored photo-gravure; (b) hand-colored etching; (c) hand-colored albumen photograph; and (d) chromogenic print



Figure 3. ROIs on print; see text for explanation.

Imaging Procedures

Each imaging lab used their standard procedures for color imaging, including:

- Device calibration
- Capture settings– bit-depth, exposure, standard or custom color profile, etc.
- Tone and color reproduction
- Color management
- Image processing
- Color encoding for final processed image files

The spatial resolution for scanning was limited to 300 ppi to 400 ppi, or the normal pixel array captured by a digital camera system.

Documentation

Each participating lab was asked to provide the following information:

Type of Institution – library, archive, museum, etc.

- For each device used in the study:
 - Capture device(s)
 - Calibration
 - Capture settings
 - Light source
 - Image processing and sequence applied to images
 - Parameters for final image files
 - Intended purpose for the final images
 - General description of the types of originals that would be digitized using the approach used

Also, labs provided a general description and background describing the intended objectives for and purposes of the imaging performed by the lab; characterization of how well they believe current procedures fulfill the objectives or purposes; any thoughts on how to meet objectives better, particularly with regard to accuracy of color encoding; and any other comments.

This information was used to understand the intended use for the images and rationale for the approach to image capture, the sequence of image processing, and the color encoding used when saving the files.

Analysis

Image analysis software was used to measure the CIELAB values on test images of the color patches for the targets and the

ROIs for the test prints. This data was compared to the measured CIELAB values for the target color patches and test print ROIs.

It was observed that the thickness of the paper mask (.25mm) resulted in a slight decrease in the measured L^* compared to the value measured without the mask and the resulting stand-off. The difference in L^* values was on average about one percent, and the average CIELAB values from all ROI measurements were adjusted to take this effect into account.

The differences in the CIELAB values between the test scans and the X-Rite densitometer for the target patches and the print ROIs were recorded as ΔE and Δa^*b^* values.

Conclusions

The inter-lab round-robin test was ongoing when this was written in March 2011. We anticipate the initial series of tests will allow for preliminary recommendations and identify additional areas of work.

We hope to be able to determine the following:

- The suitability of the commercially available targets for use in:
 - Calibrating imaging systems
 - As reference targets for image processing
 - As reference targets for documenting indirectly the characteristics of the types of originals used in this study
- The accuracy and efficacy of different approaches to:
 - Device calibration
 - Color management
 - Image processing
 - Color encoding
- A generalized assessment of the suitability of different overall color imaging and encoding approaches for meeting the goals of organizations.

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Author Biographies

Robert Buckley is a Scientist in the Department of Electrical and Computer Engineering at the University of Rochester and the founder of NewMarket Imaging, which works with clients on the capture, archiving and interchange of digital color images. He is the chair of the CIE Technical Committee on Archival Color Imaging and a member of the Advisory Board of the Still Image Working Group of the Federal Agencies Digital Guidelines Initiative.

Steven Puglia is a Manager Digital Conversion Services at the Library of Congress. Previously he worked as a Preservation and Imaging Specialist at the US National Archives and Records Administration for over 22 years. He coordinates the Still Imaging Working Group of the Federal Agencies Digitization Guidelines Initiative.

Michael Stelmach has twenty-five years of information management experience, with a concentration on providing digital access to content originating from print. Formerly the Vice President of eBook Production at netLibrary and Manager of Digital Conversion Services in the Office of Strategic Initiatives at the Library of Congress, he is currently an independent consultant. Michael has been active in the research and development of an automated approach to evaluating digital image performance.