

Colorimetric analysis of color image reproduction

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Keywords

Gamut mapping, Tone compression, Tone reproduction, Clipping, Chroma shift

Introduction

The use of color imaging and color reproduction continues to grow at a very fast pace. Every day, most people in the industrialized parts of the world are users of color images that come from a wide range of imaging devices; for example color photographs, magazines, and television at home, computers with color displays, and color printers in the office. All the images are typically analyzed by means of visual judgment, not by quantitative means with the use of test targets. This article is designed to analyze color image reproduction colorimetrically and to correlate such findings with visual perception.

Objective

This study illustrates how ICC color management can be applied from scan to print using perceptual rendering. Colorimetric analysis of IT8.7/1 test target was very useful in analyzing the quantitative and visual relationships between the reproduced images and the original.

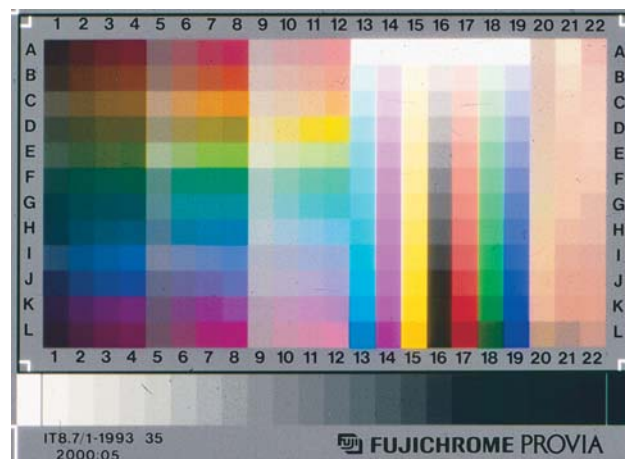


Figure 1. IT8.7/1 Target

Resources

1. Profiling software: GretagMacbeth ProfileMaker 4.1.5
2. Test image: IT8.7/1 target and digital images (courtesy of Professor Patti Russotti)
3. Color measurement: Spectrolino Spectroscan
4. Color conversion: Adobe Photoshop 7.0.1

Procedures

The following procedures are used to prepare color managed reproduction and to obtain data for analysis:

1) Preparation

An IT8.7/1 target shown in Figure 1 is scanned and an ICC profile is built using GretagMacbeth ProfileMaker 4.1.5.

2) Press profiling

The output profile was created by printing the GretagMacbeth profiling target on the Heidelberg Sunday 2000 web offset. The printed target is then measured on the GretagMacbeth Spectrolino Spectroscan. The printer ICC profile is created with GretagMacbeth ProfileMaker using perceptual rendering.

3) Color conversion

After opening the scanned target and the pictorial images in Photoshop 7.0, the raw RGB image is assigned to Nikon Scanner ICC profile. The image in Nikon Scanner ICC profile is, then, converted to Heidelberg Sunday 2000 CMYK space via "Convert to profile." Adobe CMM with perceptual rendering is used in the conversion.

Tone and color analysis

Patches of the gray scale, solid inks, and their overlaps have been used as an indication of color correction. The idea is that if the gray scale and the color patches are

properly reproduced, other colors will also be reproduced accordingly. The measurements from the original and the reproduced were analyzed in various ways and compared with visual evaluations.

The colorimetric analysis procedure used were first published in a paper by Irving Pobboravsky et al. (ISCC Proceedings, 1971) of which three different methods of tone and color analysis were performed as shown in Figures 2, 3, and 4. Some graphs are modified to bring out significant relationship between original and reproduction.

To begin with, lightness (or darkness) of the original is compared with lightness (or darkness) of the reproduced. Similar to densitometric analysis of tone reproduction, the highlight is located at the lower left corner of Figure 2b.

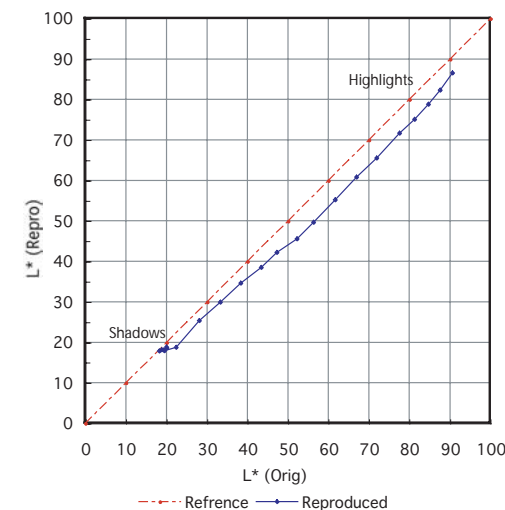


Figure 2a. Tone reproduction of $L^*(orig)$ vs. $L^*(Repro)$

From Figure 2b, we observe that the reproduction is slightly darker than that of the original. Specifically, the highlights and the midtones were reproduced at the correct slope whereas the shadow region of the original was clipped in the reproduction.

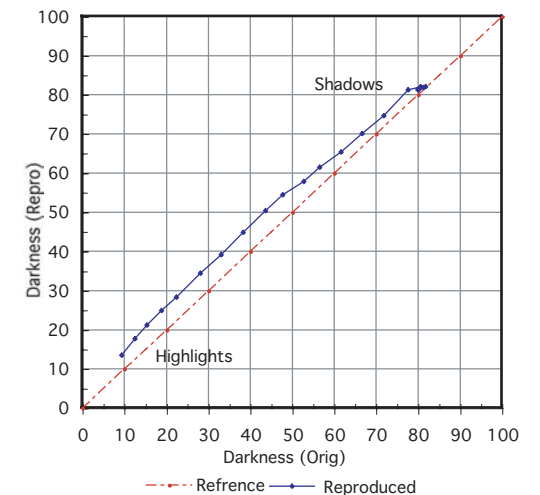


Figure 2b. Tone reproduction of Darkness (orig) vs. Darkness (repro)

Gray scale has been used to visually indicate color balance and tone reproduction in the graphic arts industry. Figure 3 shows the colorimetric analysis of gray scale reproduction in comparison with that of the original. It indicates that the highlight region of the reproduction is closer to neutral, i.e., less C^* or metric chroma, than the original.

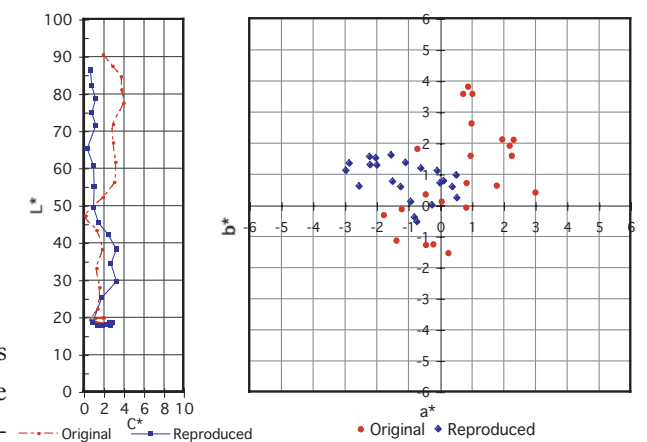


Figure 3. colorimetric analysis of neutrality

The gamut compression indicates a reduction of chroma from original to the reproduction. Using the data of column 8 of the IT8 7/1 target, the graph in Figure 4 shows that the hue angles were preserved, and the amount of chroma compression is indicated by the length of the lines. While gamut compression can be seen very clearly from the graph, it cannot be observed visually if we examine pictorial color reproduction, as shown in Figure 4a-4d.

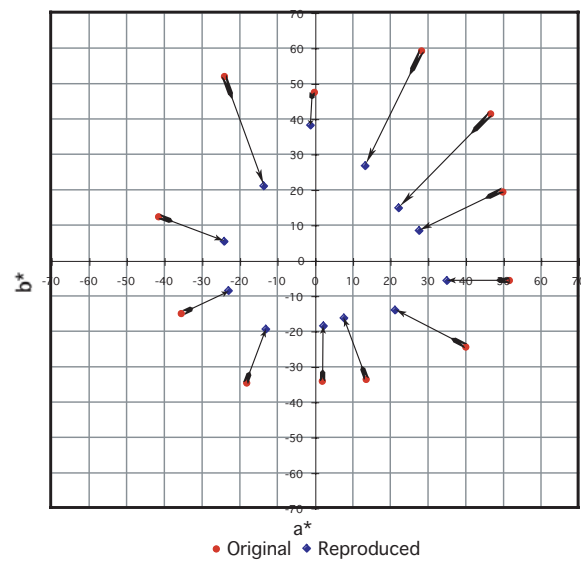


Figure 4 Hue reproduction

Although some compression in the gamut has occurred in the tone scale and color saturation, this is not usually what the poor print quality is primarily due to. It is more often caused by poor color balance, tone reproduction, hue reproduction, loss of highlight and shadow saturation, unevenness, grainy appearance, and sharpness of detail.



Figure 4a Sample of color managed reproduction

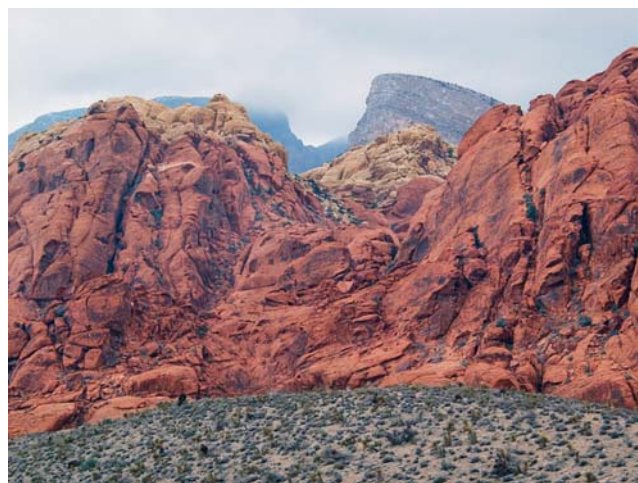


Figure 4b. Sample of color managed reproduction

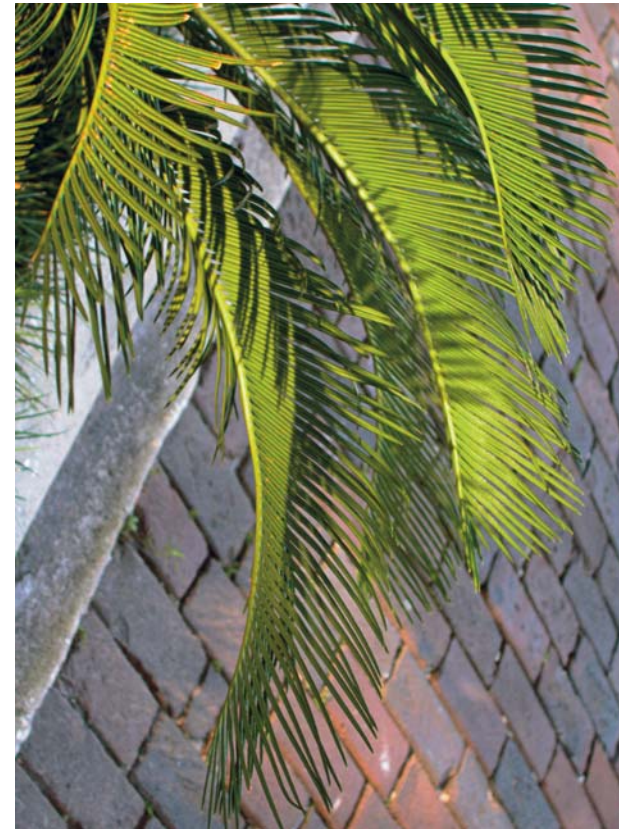


Figure 4c. Sample of color managed reproduction



Figure 4d. sample of color managed reproduction

Conclusion

This article documented a procedure for analyzing the tonal relationship, as well as gray balance and colorimetric relationship, between a source image and its reproduction. Visual assessment and colorimetric analysis agree with each other in that there was no hue shift between the original and reproduction, and that the dark colors were clipped.

The most valuable thing that we have learned from this work is difficult to communicate in writing. It is the experience of working in the lab, using color measurement and analysis tools, observing the results, tending to press runs, and struggling with the surprises on the way. Some changes in the color image reproduction were anticipated due to the color gamut of the inks and the complexity of the color separations and printing process.

Reference

Pobboravsky, I., Pearson, M., and Yule, J.A.C. (1977). *The Relationships Between Photomechanical Color Reproductions and the Original Copy, 1971 Inter Society Color Council Proceedings.*