Comparing Color Image Capture Using Film Transparencies and Digital Cameras

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Keywords

profiling, ColorChecker DC, IT8.7/1

Abstract

When a film scanner is profiled, an IT8.7/1 target is used. The target is factory imaged onto a piece of emulsion that is presumably the same as the emulsion used for image capture. Using this workflow does not take into account any of the characteristics of the scene. Digital camera profiles are built using another target, like the GretagMacbeth ColorChecker DC. The target is placed into the scene, and profile is built that takes into account the characteristics of the scene and the camera. Using the ColorChecker DC profiling target for analog (film/scanner) capture yields better results than just using a stock IT8.7/1 target.

Introduction

In today's workflows, accurate input profiles are important as they can affect color reproduction throughout the rest of the production process.

Objective

The point of this experiment was to determine if there are significant differences between digitally captured imagery and film/scanner capture of imagery, and the effect of applying a profile to correct for exposure inconsistencies in the original images.

Methodology

The procedure consisted of four major steps: capture, scanner profiling, digital camera profiling, and assign ing the profiles to the imagery and converting to Adobe RGB (1998).

Step1: Capture

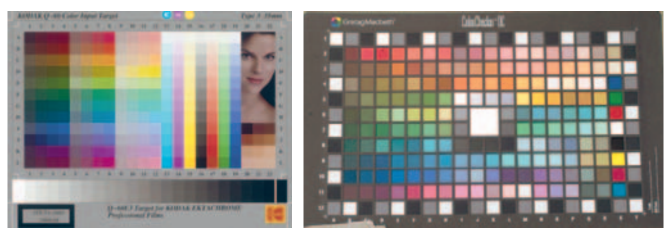
A still life was created using indirect strobe lights. The scene was photographed first with the Fuji FinePix S1, a digital SLR camera. The exposures were bracketed 2 full *f*-stops on either side of the normal exposure: N+2, N+1, N (normal), N-1, and N-2. The Fuji FinePix S1was then removed from the tripod, and the lens taken off and attached to the Nikon N70, a film SLR camera. This was done to ensure that the same lens was used in all image sets, as differences in lenses can affect color reproduction. The film used was Kodak E100-G, a color reversal film.

The N70 was then placed on the tripod, and light meter readings taken to adjust exposure for the differences in ISO film speed. The still life was photographed in the same relative exposures as for the digital camera.

The props for the still life were removed, and the GretagMacBeth ColorChecker DC profiling target was placed into the scene, and photographed with the same set of exposure as the still life was. The lens was then replaced onto the Fuji S1, and the ColorChecker DC was photographed using the same exposures as the capture of the digital still life images. The film capture images were processed normally.

Step 2: Scanner Profiling

The IT8.7/1 target (Figure 1) was scanned with all of the scanner controls turned off, and a standard scanner profile was built. The IT8.7/1 is a target that has been correctly imaged onto a piece of Ektachrome color-reversal film at the factory. The film-captured images were scanned on a Nikon 8000 CoolScan; with everything turned off, i.e., all of the boxes were unchecked. No adjustments were made to the images. To build scanner/film profiles, based on the ColorChecker DC target (Figure 2), the target was cropped and run through the GretagMacbeth ProfileMaker Pro v4.1.5.



Figures 1 & 2: The Kodak IT8.7/1 target (left). The GretagMacbeth ColorChecker DC target (right).

Step 3: Digital Camera Profiling

The images of the ColorChecker DC were opened in Photoshop, and cropped to just the profiling target. The images were then used to build the profiles using the GretagMacbeth ProfileMaker Pro software, in Camera Profile mode.

Step 4: Assign and Convert

The profiles were assigned to the corresponding still life images, and then converted to Adobe RGB (1998) using relative colorimetric rendering. All imagery was evaluated on a monitor display for the observations in this paper. The printed images were converted from Adobe RGB (1998) to the Sunday 2000 (FM) profile used for printing this publication.

Color reproduction from normally exposed photographic imagery

Profiling for scanner/film capture is similar to profiling a digital camera, but there are some fundamental differences (Sharma, 2004, p. 179). When building a profile for film, what is actually being profiled is the combination of film and scanner. The IT8.7/1 profiling target is intended for film scanner profiling (Sharma, 2004, p. 162).

When the IT8.7/1 profile is assigned to the film captured normal exposure image, the results are unsatisfactory (Figure 3). The profile did exactly what it was supposed to, which was to render the information on the film as accurately as possible. In this case, this is not a satisfactory result due to a slight blue cast to the film because the strobe lights were slightly bluer than the white point of the film. The image still retains the slight blue cast; it also appears a bit too light overall, which shows this image was slightly overexposed initially.

Figure 3: The normal exposure image, converted with the IT8.7/1 profile.

The IT8.7/1 target did not account for the conditions in the scene. The profile built from the IT8.7/1 target simply profiled the scanner characteristics, and the characteristics of the emulsion, without consideration to what was actually in the scene. Since the IT8.7/1 profile did not achieve satisfactory results when applied to the film captured normal exposure image, a custom profile was built for the imagery using the same target and process traditionally used for digital capture. By actually photographing the ColorChecker DC profiling target, and building the profile from that image, it accounts for the variables in the scene, the characteristics of the emulsion, and the characteristics of the scanner. This yields a profile that takes into account more variables than the IT8.7/1 target and creates a more accurate profile for the image.

The ColorChecker DC is designed primarily as a digital camera profiling target, thus the DC in the name (Sharma, 2004, pp. 181). As a result, the film profiles effectiveness was evaluated against the normal operating conditions for the ColorChecker DC. The images look fairly similar, but on closer examination, there are some noticeable differences between the two. The two images when placed side by side (Figures 4 and 5) show some differences between the two on monitor display. The color gamut of the film images is larger than the digital images and yields more saturated colors, and a more visually appealing image.

Figure 4: Normal Exposure scanner/film capture with custom profile.

Figure 5: Normal Exposure digital capture with custom profile.

Comparison of the ColorChecker DC normal exposure profiles, for film/scanner and digital capture to each other shows the causes of the color differences without a doubt. An overall view comparing the Lab plots of both profiles shows the film capture has a much larger overall gamut than the digital counterpart. (Figure 6).

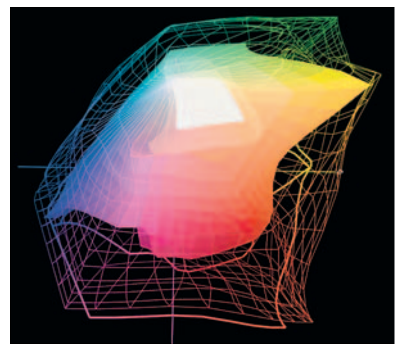


Figure 6: 3-dimensional Lab plots of the profiles. The area in wireframe is the profile built from the film capture, and the solid color is the digital capture profile.

Color reproduction for abnormally exposed photographic images

As photographers in the field often run into less than ideal circumstances, and often over or underexpose film as necessary to retain highlight and shadow detail, it is also useful to examine how well the images hold up when custom profiles are built for various relative exposures. Exposure is essentially setting the L* values of the various colors represented in an image. Light meters are calibrated for an 18% grey midtone (Compton, Current, Stroebel, Zakia, 2000, pp. 49-50). Setting exposure decides how much of an image will reproduce within the tolerances of the capture system. (Compton et al., pp. 56-57).

Using the CHROMiX ColorThink software, it is easy to see the way in which the exposure adjusts overall luminance values. Figure 7 is a pixel map in the Lab color space of the N+2, and N-2 images for digital capture- before profiling. The bright orange data are the pixels for the N-2, and the blue denotes the N+2 image. The way the samples break down shows the amount of compression along the L* axis that takes place when an image is under or over exposed by 2 stops. It is a useful comparison to look to Figure 8; the graph with the purple data is the same kind of pixel map, but for the N (normal) exposure image in this series. Looking at how the data breaks down in this pixel map shows a more even distribution along the L* axis.

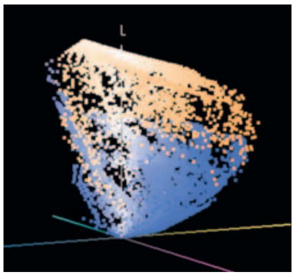


Figure 7: This pixel map shows the distribution of the pixels in the N+2 (orange) and N-2 (blue) digital capture images.

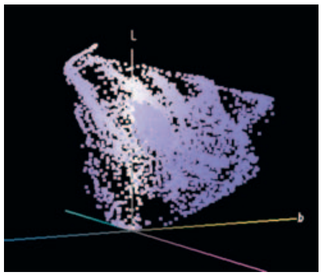


Figure 8: This pixel map shows the distribution of the pixels in the normal (N) exposure image.

Application of a profile will yield a more even distribution of the image data along the L* axis. Figure 9 shows pixel maps of the same images in Figure 7, but *after* profiling. The effect of applying the profile is to more evenly distribute the data along the L* axis. What this means is that to an extent, the incorrect exposure in the original image has been compensated for. This effect is illustrated in Chart 1. The top row of this chart is the digitally captured images, converted directly to Adobe RGB(1998). The bottom is the same images files, but converted to Adobe RGB (1998) after the custom profile was assigned. The exposure is more even across the three images. Notice though that the overexposed image was not restored to the same extent as the underexposed image by the profile. In this instance, so much of the color data was compressed into the white point region of the CCD, that no profile could adequately restore the image.

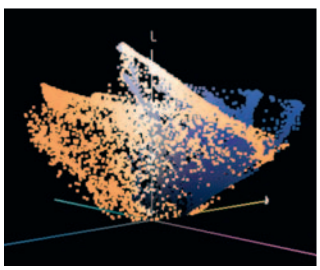
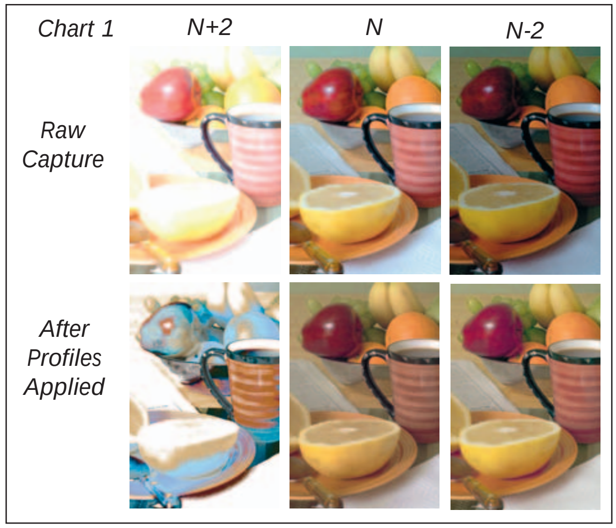


Figure 9: This pixel map shows the distribution of the pixels as above in Figure 7. This chart shows the data distribution after profiling. Blue is N-2 and orange is N+2.



Using digital camera profiling systems to profile film scanners

Scanners are profiled using a standardized target, such as the IT8.7/1, which means the target is correctly exposed onto the emulsion, under the correct lighting to ensure that the colors are accurate. This means that if the imagery was not captured at a normal exposure, with the correct lighting for the film, the scanner profile will be invalid. To create a more accurate scanner profile, one that accounts for the image characteristics, the ColorChecker DC was used to build these profiles.

Overexposed Imagery

In cases of massive over exposure, 2 *f*-stops in this case, the images have some serious problems. (Figures 10 and 11) The bizarre coloration of these images is due to two factors: the limited information the profile building software had due to the image data being compressed into the white point, and the color information in the images the profile was applied to. The results of these factors, and also the different technologies, show the radical

Figure 10: This is the N+2 image for film capture.

Figure 11: This is the N+2 image for digital capture.

differences between these two images. The film capture shows an overwhelming green cast to the image. As a result of the way the eye perceives color, most of the main colors in the scene are close to right, but not quite, the oranges are mostly orange, the apple mostly red. The issue is the information that was actually on the film in this case.

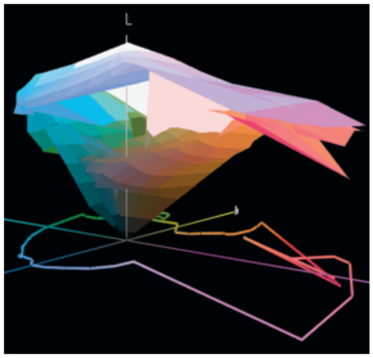


Figure 12: This is the 3-dimensional Lab plot of the film capture N+2 profile.

As this experiment shows, building profiles from images that have so much of their color data pushed into the white point area of the capture system yields rather odd-looking profiles when graphed in the Lab space. The profiles are actually hollow (Figure 12); the internal areas of the color space, where the desaturated colors are, lack that data, and as a result when the profile is applied will not be able to render the image correctly. Without this information, when the profile was applied, the CMM would have mapped the colors to the closest colors in the profile, and with such a large bit of color data missing, undoubtedly, they would be visually the wrong colors.

Underexposed Imagery

Underexposing an image, instead of compressing the color data into white, compresses into black. One interesting observation is that more often than not, there is still differentiation between the various hues; the L* values are compressed, not necessarily all of the color information.

Evaluated individually both N-2 images look satisfactory (Figures 13 and 14). The film N-2 image has some color problems in the deeper oranges, but overall the profile restored the image fairly well. The digital N-2 image is significantly lighter than the scanner/film image. Looking at the Lab plot (Figure 15) the differences between the two profiles are readily apparent. The scanner/film profile is in red, and is much larger in the brighter green and deeper reds and blues. What this means for the images is readily apparent by comparing them side-by-side. One unforeseen effect of having that many of the darker colors in gamut is that the N-2 film image looks a bit underexposed compared to the digital capture; the image can be restored by applying curves in Photoshop.

Figure 13: This is the film capture N-2 image after profiling.

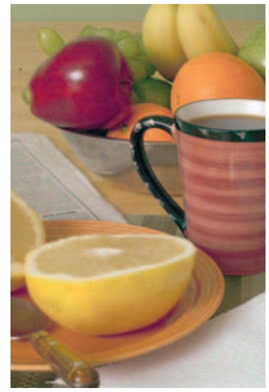


Figure 14: This is the digitally captured N-2 image after profiling.

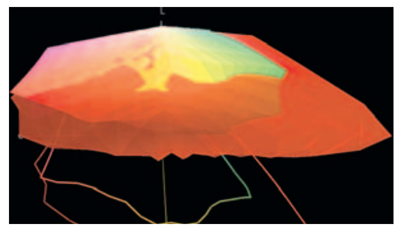


Figure 15: This shows the differences in gamut between the film and digital capture profiles. The area in red is the film capture profile, and the interior colored area is the digital profile.

Conclusions

The ColorChecker DC profiling target is designed solely for use with a digital camera. The IT8.7/1 target is imaged onto a piece of film emulsion at the correct exposure, and is designed for building profiles for the exact film and scanner combination in use. The profiles built using the ColorChecker DC on film capture work surprisingly well. Adopting the ColorChecker DC profiling target for photographic film and scanner profiling is actually fairly effective, and does an adequate job of rendering the full gamut of the film and compensating for exposure and white point mismatch. Using the ColorChecker DC in an analog workflow will yield profiles that take into account the characteristics of a scene than using the standard IT8.7/1 characterization target.

References

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