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IMPACT OF RENDERING WITH PERCEPTUAL INTENTS ON COLORIMETRIC VALUES AND IMPRESSION OF PORTRAIT PHOTOGRAPHS

Mikota, M.[1], Pavlović, I.[1]
[1]University of Zagreb, Faculty of Graphic Arts, Zagreb, Croatia

***Abstract**: Professional shooting with digital photographic camera includes shooting in wide Adobe RGB color space. However, the output units in the field of digital photography usually see colors in the narrower sRGB color space. Because of this, the basic processing of digital photographs involves mapping photographs from Adobe RGB color space to sRGB color space with so called rendering, and in photography, in principle, the rendering with perceptual intents is used. Portrait is one of the most demanding photographic motifs. In this paper the impact of rendering with perceptual intents is analyzed on the portraits taken with the appropriate white balance. Results of tests show that with the rendering all colors in a portrait change, but that there had been no essential changes in impression of portraits and that this rendering may be considered appropriate in the field of digital portrait photographs shot with appropriate white balance.*

***Key words:** portrait photography, color spaces, rendering, skin colors, impression of portrait photography*

1. INTRODUCTION

The total color space that can be experienced in reality is significantly higher than the color space that can be recorded with shooting with photographic cameras, displayed on the monitor, or realized with printing. As the human brain can accept the image as a real when it is realized in such a constrained color space, the portrait photography photographed with the appropriate white balance and an adequate way of measuring light is accepted as highly iconic (Hurter B., 2005; Mikota M., et al. 2008). Professional digital photo cameras now allow the recording in a relatively wide - Adobe RGB color space and shooting in this color space is considered for a professional standard. However, as the majority of output devices (monitors, printers, projectors) "see" colors in a narrower - sRGB space, as a rule, in a basic photo editing, color space is redefined in sRGB color space. This redefining of the color space, that is mapping colors from one color space to another is called rendering. As, after shooting, colors from a wider color space are transferred to a narrower one, it is expected that it comes to essential changes of colors that can significantly affect on the impression of photography, especially in demanding motives such as portraits are appeared (Mikota M. et al, 2006:, Nelson P., 2007).

2. THEORETICAL PART

There are several approaches to rendering, i.e. the so-called rendering intents: rendering with absolute colorimetric intents, rendering with the relative colorimetric intents, rendering with saturation intents and rendering with perceptual intents (Figure 1). When rendering with absolute colorimetric intents is used, colors from one color space are translated into another color space, with, at colors present in each color space, absolutely keeping of their colorimetric values, and colors from wider color space (Adobe RGB), whose saturation is greater than the maximum saturated colors of narrow color space (sRGB) are translated into the corresponding maximally saturated colors of narrower color space. The same principle is adhered to rendering with the relative colorimetric intents, but with taking into account the shift of white in the new color space in relation to the white of the starting color space. If for the switch of colors of digitally recorded/taken/shot photographs (Adobe RGB to sRGB) one of the colorimetric principles of rendering is used, in the narrower color space (sRGB) color differences that are not covered with narrower color space are completely lost (sRGB), and also problems with sharp crossings of fine tones occurs.
Therefore these principles of rendering are not normally used for switching photographs taken in the Adobe RGB color space to the sRGB color space – except eventually if photograph does not use saturated colors, for example, photographs based on pastel colors. Rendering with saturation intent "switches" maximally saturated colors of one color space to the maximally saturated colors of another color space neglecting differences in tone, brightness and color saturation, but as the principle of rendering is inappropriate for transferring colors from

Adobe RGB to sRGB color space in the area of digital photography, except if the photographs are based on a intensive colors on the border with unnatural colors. Rendering with colorimetric and saturation intentions are irreversible. (Mueller F. 2007; Mikota M. et al., 2008)
For transferring colors of shot photos (Adobe RGB) in the sRGB color space rendering with perceptual intents also called photographic rendering is normally used. The main idea with the rendering with perceptual intent is to transfer colors from one color space to another so that perceptually the overall impression of photographs changes as less as possible, although a certain colorimetric changes in practically all colors including the ones that exist in both color spaces exist. When colors are "compressed" in a smaller color space, less saturated colors change less, and more saturated colors change more, but with the securing of distinction of all colors of broader color space in inner color space, so that this rendering is also the only reversible rendering. (Mueller F. 2007; Mikota M. et al., 2008)

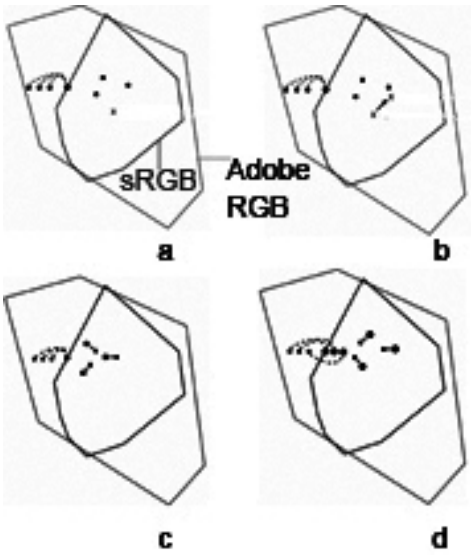

Figure 1 Rendering: a) with saturation intents, b) with the relative colorimetric intents, c) with absolute colorimetric intents, d) with perceptual intents

In order to make rendering possible, in addition to rendering intent should also be determined the model of calculating of colors (“engine"). Thereby, different manufacturers (Apple, Microsoft, AGFA, Linotype, Kodak, and Adobe) offer different methods of calculating. As in the area of digital photography as a professional standard for work in digital photographic laboratory imposed Adobe Photoshop, as the standard model, as a rule, the Adobe (ACE) is chosen, and as an alternative solution Microsoft ICM is selected. With choosing one of these rendering calculators negligible differences in color are gained. (Mikota M. et al., 2008)

3. EXPERIMENTAL PART

Standard Munsell Colour Checker colour table was shot with the leica format digital photographic camera Canon EOS 5D and with the lighting from the photographic camera with Canon Speedlite 430 flashlight for the measure estimation. White balance was determined by photographic camera and manually set to 6000 K. ISO speed was 100/21 ISO and the exposition elements were determined with TTL camera system, by segment metering on the skin colors and over all metering of other colors. The photograph was shot with aperture 5.6 and exposure time of 1/60 s in the finest JPEG format with resolution of 12.7 MP. In the same way the face portrait for the visual estimation was shot. Editing of the digital format of photographs included changing the color space from Adobe RGB to sRGB with rendering with perceptual intent.
In Adobe Photoshop CS3 certain L, a and b values for the light and dark skin color and primary colors of additive and subtractive synthesis for the shot color table (before rendering - Adobe RGB) and for edited color table (after rendering - sRGB) are measured. From the obtained values color differences ΔE_{00} were calculated: the motive (photographed color table) - shot color table (Adobe RGB), motive (photographed color table) – edited color table (sRGB) and photographed color table (Adobe RGB) - edited color table (sRGB).
Shot (Adobe RGB) and edited (sRGB) portrait were visually rated - 20 experts in the standard conditions, by memory (not in a direct comparison) estimated whether with the rendering with perceptual intents came to visible changes in the portrait and, if it is, whether they influenced the impression of portrait photography.

4. RESULTS

Table 1 shows L, a and b values for the standard, shot and by rendering in the sRGB color space edited color table and color differences ΔE_{00} compared to the standard values.

Table 1 L, a, b values for standard, shot and edited photographs and color differences ΔE_{00} in relation to the standard

Color	Phase	L	a	b	ΔE_{00} standard
Dark skin (DS)	standard	37,99	13,56	14,06	0
	shot	38,00	13,00	14,00	0,4476
	edited	38,00	14,00	15,00	0,5897
Light skin (LS)	standard	66,71	18,13	17,81	0
	shot	66,00	17,00	13,00	3,0081
	edited	68,00	17,00	12,00	4,1311
Cyan (C)	standard	51.04	-28,63	-28,64	0
	shot	51,00	-27,00	-35,00	2,9827
	edited	52,00	-20,00	-33,00	5,1136
Magenta (M)	standard	51,94	49,99	-14,57	0
	shot	60,00	50,00	-14,00	7,5306
	edited	60,00	50,00	-14,00	7,5306
Yellow (Y)	standard	81,73	4,04	79,82	0
	shot	87,00	3,00	72,00	3,9332

	edited	88,00	4,00	72,00	4,4942
Red (R)	**standard**	42,10	53,38	28,19	0
	shot	51,00	54,00	30,00	8,6659
	edited	52,00	53,00	31,00	9,7847
Green (G)	**standard**	55,26	-38,34	31,37	0
	shot	64,00	-39,00	32,00	7,7318
	edited	63,00	-38,00	30,00	6,9133
Blue (B)	**standard**	28,78	14,18	-50,30	0
	shot	24,00	22,00	-63,00	4,4594
	edited	25,00	21,00	-62,00	3,7603

ΔE_{00} color differences for shot (Adobe RGB) and edited (sRGB) color table are shown in table 2.

Table 2 ΔE_{00} for shot and edited color table

	ΔE_{00}
DS	0,8105
LS	1,7529
C	3,3462
M	0,0000
Y	0,8822
R	1,2662
G	1,1455
B	0,7974

Figure 2 shows the chromaticity diagram of a standard, recorded, and with rendering in the sRGB color space edited color table.

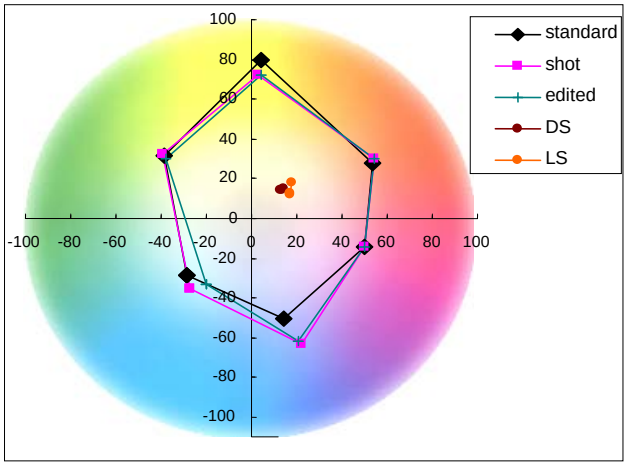

Figure 2 Chromaticity diagram for standard, shot and edited color table

Table 3 shows the results of visual evaluation.

Table 3 Visual evaluation of portraits - comparison of shot and with rendering edited photograph

DIFFERENCE DOES NOT EXIST	**14** experts
DIFFERENCE EXISTS	**6** experts
DIFFERENCE INFLUENCES ON THE IMPRESSION OF THE PORTRAIT	-

5. DISCUSSION

The results of determining color difference ΔE_{00} between the photographs taken in Adobe RGB color space, and those transferred to sRGB color space by rendering with perceptual intents show that in all observed colors, except for the magenta, comes to certain changes (Table 1, Table 2). However, these changes are within the acceptability limits, even in the direct comparison. To significantly larger color changes comes in the previous phase of the digital portrait photography system (Table 1), but previous tests (Mikota M., et al. 2008; Mikota M., et al. 2008) showed that these changes, on the impression level, were completely acceptable and thus taken portrait photographs observers accept as highly realistic. It is confirmed that the skin colors are primarily merits of impression value of portrait photographs (Table 3) and it is essential that skin colors have largely retained its colorimetric values after rendering with perceptual intents (Table 1, Image 2). It is important that, practically, changes in brightness (L) of skin colors did not occur (Table 1) because it was shown that, as it is a matter of colors that are relatively close to achromatic point (Figure 2), the brightness primarily affects on the impression value of skin colors, i.e. portrait photographs.
Visual estimation (Table 3) showed that rendering with perceptual intent of portrait photographs taken with the appropriate white balance did not (significantly) affect its experience. Chromaticity diagram (Figure 2) also shows that the rendering with perceptual intent major changes show in the cyan, but these changes are within the limits of acceptability, even in the direct comparison of colors (Table 2).

6. CONCLUSION

By rendering with perceptual intents practically comes to changes in all colors on a portrait photograph. However, assuming the shooting with the appropriate white balance and the proper measurement of the light, shooting and rendering with perceptual intents will keep information on chromaticity, but what is for the impression value of portraits especially important, and the brightness of skin colors and portrait photographs retain a high level of iconic values.
For this it can be concluded that the rendering with perceptual intent is appropriate for portrait photographs shot with the appropriate white balance, and that with the mapping in the sRGB color space impression value of portrait photographs will not be lost.
Further testing will be focused on rendering with perceptual intents in portrait photographs shot with the different light sources and the ISO speeds and the results

will be put into the context of realization of portrait photographs with different printing techniques. Also part of the further testing will be directed to visual assessment of portrait photographs before and after rendering.

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