Effect of the changes in the RGB digital image channel on the perception of fashion photography while retaining its iconicity

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The significance of fashion photography is in technical terms related to its reproducibility, while semantically it primarily results from the fact that it is a medium perceived as highy iconic. Since consumers perceive fashion photographies displaying a model's face as a portrait, it is possible to make acceptable modifications of skin colours so as to affect the perception of photography while still retaining its iconicity. In the experimental part of the paper a test portrait photography was made by altering the channels by +/- 3 and 6 %, and standard skin colour areas, altered in the same manner, were determined and their colour differences defined. Photographies were assessed in a survey by 100 participants. The survey showed that the perception of the photography can be influenced by making acceptable changes in the RGB channel of the portrait photography while retaining its high level of iconicity. Regulation of the effect by means of the red channel in the phase of digital image processing was proven optimum.
Key words: *RGB channels, fashion photography, skin colour, colour difference, perception of photographies*

1. Introduction

The development of fashion photography can be traced back to the very beginnings of photography in the 19th century as photographies of the aristocracy featured popular fashion in the period. However, fashion photography as such emerges in 1913, when Conde Nast hired Adoplhe de Meyer to shoot experimental photographs for the fashion magazine "Vogue". Ever since the 1920s, and especially since the 1950s with the development of colour photography, fashion photography dominates fashion magazines.

The significance of fashion photography is in technical terms related to its reproducibility in print and digital media, while semantically it primarily results from the fact that it is a medium perceived as highy iconic – a picture with a high level of analogy with the object, which is why a consumer trusts it more than any other depiction. Current digital photographic system enables various manipulations of digital photographies, which reduces the iconic character of each photography but photography as a medium retains its trustworthy character nevertheless. Prior surveys have shown that consumers accept a moderate reduction in the iconic character of the photography, even in the case of catalogue fashion photography [1]. It was also established that in the case of fashion photography portraying a face, consumers view such photography as a portrait. It is in this sense perhaps possible to conduct technical modifications of the face colour throughout the phases of the shooting process and digital image editing so as to affect the overall perception of fashion photo-

graphy, while at the same time retaining its high degree of iconicity [2].

2. Theoretical part

Digital photographies are made with digital camera. Technically, the process is based on the exposure of a photosensitive medium. In the case of digital camera this is a sensor consisting of a series of diodes which, when exposed, generate signals representing the basic element of digital photography – a pixel. Professional digital cameras nowadays usually use APS (Active Pixel Sensor) CMOS (Complementary Metal Oxide Device) sensors, which are quicker and consume less electricity than the CCD (Charged Coupled Device) sensors. As photodiodes of CCD and CMOS sensors are sensitive to the whole visible spectrum, in order to produce colour photography, it is necessary to "sensitize" each diode only to the blue, green or red spectrum, which is achieved by applying a blue, green or red filter in front of each element (diode), thus following the so called Bayer pattern. According to the Bayer pattern, since human vision is most sensitive to the green segment of the spectrum, for every two green filters one red and one blue is applied. So as not to reduce the resolution of digital photography, the software is set to regard the value of adjacent pixels by means of interpolation, whereby R (red), G (green) and B (blue) value (i.e. information) are attributed to each pixel. An alternative solution to the Bayer pattern is the Foveo X3 sensor using the property of silicon to transmit different vawe lengths at different depths, which enables the creation of an RGB digital photography. However, as it is also accompanied by a series of problems, technology based on the Bayer pattern (interpolation) prevails. Regardless of whether CCD or CMOS (APS) sensors, the Bayer pattern or the Foveon X3 technology are involved, the result is an RGB image which enables the construction of colours in colour photograph based on additive colour mixing. The principal technical image characteristics are its format, its colour space, resolution and image depth [3, 4].

There are formats without data compression and those involving data compresson with and without losses. The shooting process itself employs RAW, format without compression – "raw" format which enables maximum image quality but it also uses a lot of memory and presupposes image pre-editing. JPEG (Joint Photographic Expert Group) format with compression reduces the file size but by increasing compression there is often data loss. JPEG is the most widely used format, both during shooting and in the digital imaging process. An alternative to JPEG is the TIFF format without compression or with compression with losses [4, 5].

Digital image is defined in the RGB colour space usually by processing in a wider Adobe RGB, which, if required, is compressed into a narrower, usually sRGB colour space, by rendering with perceptual intent, depending on the output device [4, 5].

The resolution of a photographic image is expressed in megapixels (MP) and it presupposes the number of sensor elements used during shooting, i.e. pixels. This number also affects the sensor size. The minimum resolution ensuring quality image in the case of the most widely used Leica format is considered to be 6-8 MP [4, 6].

Colour image depth determines how many colour tones can be discerned in each photograph. Standard in shooting photos in JPEG format is an 8-bit image per each channel, which enables 2^8, i.e. 256 different tones for the red, blue and green channel, in total 16.8 million colours. This is in most cases also a standard in digital image processing and realisation of photographic image. RAW formats also permit 10, 12 and 14-bit images per channel, depending on the concrete RAW format, i.e. sensor, although such image should generally be converted into an 8-bit image whilst processing [3, 7].

Even representation of R, G and B channels of the digital photographic image generates achromatic colours, whereas their uneven representation creates chromatic colours [7]. The high degree of iconicity of the photographic image is the result of proper colour reproduction ensured by appropriate white balance while shooting with a digital camera. Using the appropriate white balance while shooting, thereby increasing and decreasing a respective channel, either while shooting, RAW image preprocessing or digital image processing, can enable intentional colour deviations so as to alter the sintactic or semantic image properties.

However, in order to maintain its perceptual trustworthiness, conducted colour alteration must remain within the boundaries of acceptability. In the case of the portrait, as well as fashion photography (also) featuring human face, these boundaries are determined by skin colours [2]. For objective quantitative assessment of colour alterations through photographic system CIE Lab system is used. It represents a unique colour space of even spatial and visual differences (distances) between colours and describes colours with chromatic coordinates a and b as well as lumination *L* [8]. This system also enables qualitative assessment of colour alterations (ΔE), originally determined by the formula (1):

$$\Delta E = \sqrt{\Delta L^2 + \Delta a^2 + \Delta b^2} \quad (1)$$

This formula was transformed in 1994 (ΔE_{94}) and 2000 (ΔE_{00}) [9].

The calculated difference enables the evaluation of differences at a direct comparison based on the following criterion: if colour difference is smaller than 0.2, the deviation is considered visually unnoticeable; if it is between 0.2 and 1, small deviations are perceived; a difference between 1 and 3 and 3 and 5 is still considered acceptable, whereas that bigger than 6 is regarded unacceptable [10].

3. Experimental part

For the experimental part a test portrait photography was made under the studio softbox light with a studio flash of 200 Ws^{-1}. Light temperature was determined with the Seconic C-500R (6000 K) color meter, which also defined the white balance. Exposure elements were determined by measuring facial illumination by means of the Seconic L-358 illuminometer. Sensitivity was 100/21 ISO, exposure time 1/125 s and aperture 8. The picture was taken with a Canon 5D MkII digital camera, in the finest JPEG format at a resolution of 21 MP in the Adobe RGB colour space without effect on colours depending on the style of shooting.

The image was processed in the PhotoShop CS6 program and certain channels were enhanced and reduced by 3 and 6%, while other channels remained intact. This resulted in 12 different digital images with enhanced or reduced channels and a digital image with correct colours (Fig.1).

Areas of standard skin colours, altered in the same manner as portrait photographies, are defined in the same program. For these areas L, a and b values were determined, but also colour differences (ΔE_{00}) with respect to the standard source colour.

Portrait photographies from the Adobe RGB colour space are printed in the 10 x 15 cm format with the Hi Fi bubble jet Canon iPF6100 printer on Pro II PR-201 Canon Photo Paper. The photographs were then shown to 100 examinees (50 male and 50 female) who were under standard conditions asked to do the following [11]: 1) choose photographies which they find acceptable from the standpoint of skin colour; 2) choose among these photographies one that they find most acceptable according to the same criterion; 3) choose three photographies which feature a person who appears to be the youngest of all; 4) choose three photographies showing people who appear the healthiest.

Prior to the survey the examinees had to pass the Ishihara colour test.

4. Results

Tab.1 and 2 show L, a and b values of the standard fair and dark skin colour without the changes in the RGB channel and with gradual enhancement and reduction of respective channel by 3 and 6 %.

Fig.2 and 3 demonstrate colour differences (ΔE_{00}) of fair skin colour with gradual enhancement and reduction of the respective channel by 3 and 6 % in relation to the standard fair skin colour.

Tab.3 displays the survey results.

5. Discussion

From the histograms in Fig. 2 and 3 it is evident that the differences in skin colour are expressed as ΔE_{00} values within the boundaries of acceptability (ΔE_{00} is smaller than 6), based

Fig.1 Test portrait photographs

Tab.1 *L, a, b* values for light skin colour

	RGB 100	R 94	R 97	R 103	R 106	G 94	G 97	G 103	G 106	B 94	B 97	B 103	B 106
L	66	65	65	67	66	64	65	67	67	66	66	66	66
a	13	8	10	15	17	18	16	11	8	12	13	13	14
b	16	14	15	17	18	13	15	18	19	21	19	14	12

Tab.2 *L, a, b* values for dark skin colour

	RGB 100	R 94	R 97	R 103	R 106	G 94	G 97	G 103	G 106	B 94	B 97	B 103	B 106
L	38	37	38	38	38	37	37	39	39	38	38	38	38
a	12	9	10	13	13	15	13	11	9	11	12	12	12
b	14	13	14	15	15	12	13	15	16	17	15	13	12

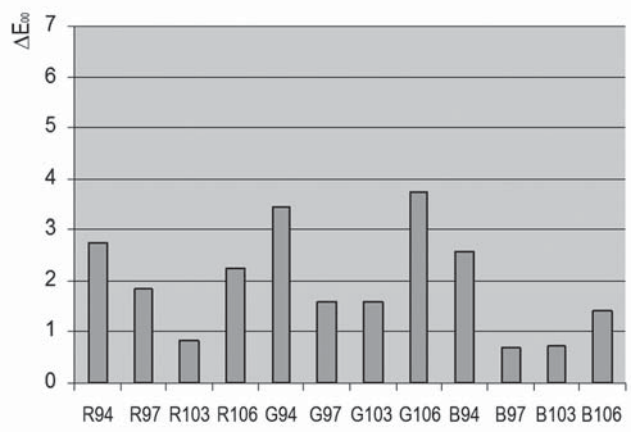

Fig.2 Colour difference (ΔE_{00}) of light skin colour with reduced and enhanced each channel for 3 and 6 % compared to the standard light skin colour

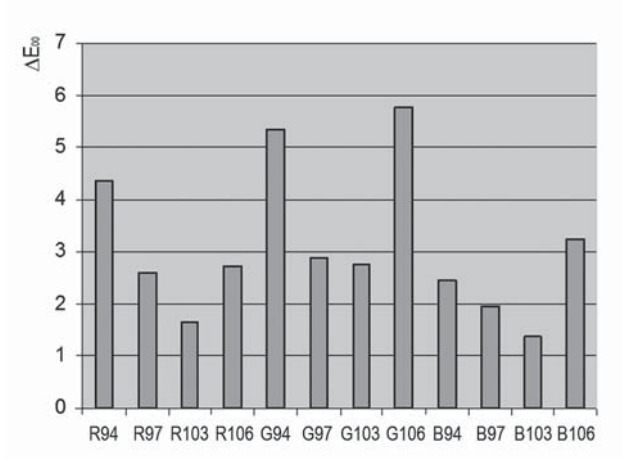

Fig.3 Colour difference (ΔE_{00}) of dark skin colour with reduced and enhanced each channel for 3 and 6 % compared to a standard dark skin colour

Tab.3 The number of respondents who selected each photograph as acceptable and most acceptable by the criterion of color reproduction and have estimated that on each photo model acts healthiest and youngest

	Acceptable photograph			Most acceptable photograph			Model acts youngest			Model acts healthiest		
	M	F	Total	M	F	Total	M	F	Total	M	F	Total
RGB 100	43	47	90	5	5	10	10	12	22	7	8	15
R 094	28	33	61	2	3	5	9	14	23	3	6	9
R 097	41	41	82	1	4	5	6	5	11	3	5	8
R 103	44	38	82	5	6	11	4	6	10	16	22	38
R 106	41	22	63	7	3	10	5	4	9	16	9	25
G 094	16	8	24	1	1	2	3	1	4	8	0	8
G 097	36	28	64	2	0	2	4	4	8	6	5	11
G 103	40	38	78	7	2	9	6	10	16	7	4	11
G 106	17	23	40	0	1	1	12	13	25	2	6	8
B 094	27	32	59	11	11	22	8	8	16	13	10	23
B 097	39	29	68	5	9	14	9	10	19	17	12	29
B 103	35	38	73	2	2	4	12	9	21	5	4	9
B 106	33	33	66	2	3	5	15	14	29	4	3	7

on the criterion of direct comparison with standard skin colors. These differences in comparison to standard skin colours are, generally speaking, somewhat more notable for dark skin than for light or fair skin, but they are for both skin types more notable when the green channel is enhanced and reduced by 6 %. As these colours are close to the achromatic point, slight differences in the "lightness" of the skin (L), resulting from enhancing and reducing of the channel with respect to standard skin colours (Tab.1 and 2) are of particular importance. In this case also the greatest change in the L value is noticeable when reducing the L channel by 6% for the colour of the fair skin.

The results of visual evaluations of the examinees (table 3) correspond essentially to the conducted measurement analysis. The examinees given the opportunity to choose an arbitrary number of photographies which they find acceptable according to the criterion of skin colour reproduction were inclined to choose the photographies without value alterations (90 examinees), or those with 3 % changes in the red channel (82 examinees). Very few examinees decided in favour of the photographies with green channel reduced (24 examinees) or enhanced (40 examinees) by 6%, which corresponds to the calculated ΔE_{00} colour differences and in the case of the 6 %-reduction in the green channel to a bigger difference in lightness than in other analysed cases (Tab.1).

From the choice of one photography found to have the most acceptable skin colour reproduction (Tab.3) it is evident that in the case of portrait photography the examinees tend to prefer warmer colours rather than cooler ones, which resulted in the fact that the photographies with reduced blue channel (by 6 % - 22 examinees; by 3 % - 14 examinees) i.e. enhanced red channel (by 3% - 11 examinees; by 6 % - 10 examinees) were considered most acceptable by the majority of the examinees. On the other hand, the portraits subjected to the reductions in the green channel by 6 % by 3% were chosen as most satisfactory by very few examinees (1 i. e. 2), whereas a portrait with enhanced green channel was pointed at by 9 examinees.

In this case too changes in the green channel affected the perception of the examinees, so it corresponds to the results of the determination of colour differences (Fig.2 and 3) and can be explained with enhanced sensitivity of human vision to the green part of the spectrum.

As far as the effect of skin colour on the perception of the portrait photography is concerned (table 3), it is evident that models on the portraits featuring warmer skin colour reproductions are perceived as healthier, while they appear younger on the portraits with cooler skin colour reproductions. The effect of the model appearing healthy can equally successfully be achieved by enhancing the red and reducing the green channel, whereas the reduction in the red channel may result in the model appearing younger. The same effect can also be produced by enhancing the green channel but since the alterations in the green channel are generally not well accepted, a better solution for both cases is to intervene into the red channel.

The difference in the results between male and female examinees is primarily visible in the assessment of acceptability of portrait photography with red channel enhanced by 6 %.

6. Conclusions

By making acceptable changes in the blue (B), green (G) and red (R) channel of the portrait fashion photography it is possible to influence the perception of the photography. This may be of special relevance in the field of applied photography, which serves to promote and sell a certain product, since it enables the manipulation of the perception of photography within the boundaries of its high iconicity.

Fashion photography which features the face of the model is perceived as portrait photography. The analysed changes in skin colour can be performed by altering the R, G and B channel throughout the phases of the production of photography – shooting, pre-processing and processing of digital image. In the case of fashion photography featuring model's face such changes are best performed while processing the digital image, when it is possible to intervene only in the facial area, thus leaving the rest of the motive (clothing) intact. A research has shown that the modifications of skin colour, primarily by altering the R and B channel by not more that 6 %, can influence the perception of photography while at the same time retain its iconicity, i.e., its trustworthy character.

Regulation by reducing and enhancing the red channel was proven the optimum regulator since it affects the perception of the portrait photography while fully retaining its iconic character.

Further researches will aim at analyzing different perceptions of photography after conducting changes in the R, G and B channel, as well as establishing the applicability of measurement determination of colour differences on the interpretation and description of analysed phenomena. Studies will also concentrate on determining the possibilities of a targeted effect on the colour of ambience and background, within the boundaries of acceptability and while retaining a high level of iconicity.

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