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Optimizing Separation Parameters for Dedicated CMYKIR Reproduction Purposes With Hidden Double Information

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Abstract:

Contemporary programming support for image correction and manipulation for graphic arts purposes implies partially regardless RGB/CMYK separation options, where particular parameters can be adjusted separately or by means of ICC profiles. As input image information can be reached from different dynamic range devices or can be generated, output reproduction devices can use various substrates and media, so additional adjustments and researches have to be carried out. CMYKIR reproduction has specific demands, while through the visual part of the spectrum (VS) colour management controls response and experience outside the visual, i.e. hidden information in the near infrared (NIR) domain, and claims to find dedicated adjustments for specificities of VS-CMYKIR reproduction.

Keywords:

Colour Management, CMYKIR Reproduction, Selection Parameters, Dedicated Colour Settings, Hidden Information

1. Introduction

Graphic arts reproduction, informatics supported, variety of reproduction parameter specifies and defines in respect on input/output system characteristics. Dynamic range varies from one image to another, so certain tones, highlights or shadows could be incorrectly reproduced or can vanish. There is no need to process all images within HDR technology, for a range of reasons; adjusting the tone reproduction curves is helpful, however at least a three-point-control is recommended (Hunt R.W.G, 2004). If reproduction system is not strictly profiled, dot gain control is necessary. Input/output system gamuts can also be possible distortion parameters. The input system often renders a larger gamut then the output system, while certain tones and hues may not be reproduced correctly. By generated images of defined coloured patches on the screen, where screen gamut (profile) is relatively large, can also lead to reproduction deviations. In such situations image analysis has to be carried out, in addition to the appropriate rendering intent chosen in respect to image colorimetric information, generated colours, but also output system (printer) possibilities (ISO 1996). As CMYKIR system basically supposes a CMY+K colour system, the presumption is a visual spectrum picture, but also additional picture information in NIR domain. This implies CMY separation settings, as well as broadened settings for the channel where NIR image will be defined, basically K channel for (carbon) black (*Žiljak et al., 2010*).

2. Basic NIR/CMYKIR settings

Starting settings for CMYKIR purposes are basically performed by means of achromatic (CMY) reduction, but it has to be mentioned that dedicated (multicolour) separation for any dye expressing Z-parameter can be performed (*Žiljak et al., 2012*). Basic subtractive components (CMY) in graphic arts reproduction are supplemented with black, forming screening colour system, Fig.1.

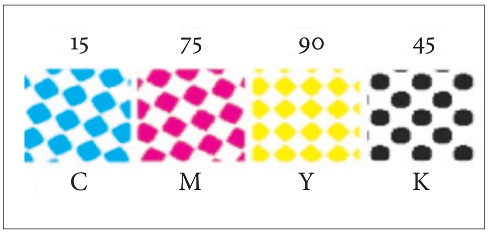

Figure 1. Graphic primary reproduction colours displayed as standard screening system

Tone reproduction curves, range of screening elements and the screening system, except ISO recommendations for a desired printing system, can be compared by equipment producer, verified systems, but dedicated attested settings are also possible.

3. Achromatic substitution

Achromatic substitution assumes the substitution proportion of basic (CMY) dyes with an adequate part of the K component (*Enoksson, E. 2008*). Basic subtractive CMY components and the achromatic component K are realized as process inks coverage (%â). It must be remarked that in a real situation this rendering process is not linear in the addition process or in the reduction process, as supposed in PostScript equations. Those are second order transfer functions, which are partially covered with profiles, but in many practical (custom) situations they have to be provided separately. In relation to the same colour defined in the CMY process, the space that expresses relatively large reflection in the NIR domain and the possibility of achromatic substitution with (carbon) black, expressing low reflection in the NIR domain, there is a variety of substitution combinations commutating achromatic coverage CMY part with K coverage. Theoretically, in all possible combinations, visual (and colorimetric) response would not be altered. Basic and substituted colours can be expressed, measured as CMYK coverages (â) but also in other colorimetric systems. Fig.2 presents a colour, basically defined as CMY coverage 80_c-60_m-40_y (patch A), and its achromatic reduced versions (patch B) altering 10K, 20K, 30K, 40K, through adjusted profile (e.g. adjusted Fogra 27 profile), displayed in the NIR domain. This is presented as linear reduction rate, which is not entirely exact. Sample 40K coverage substitution in this case would represent the maximum possible substitution, often incorrectly described as a 100% reduction. Theoretically, all samples would perform the same visual output, but in practical situations some deviations are present.

If colorimetric values are examined, 10 and 20 âK chromatic substitution patches express low ΔE difference (about $\Delta E_{76} \approx 1$), which is acceptable, but a major substitution, â 40K would be colourimetrically critically acceptable (*Cholewo, T.J, 2000*). According to the referred, in the NIR domain only patches containing achromatic component âK (10K, 20K, 30K i 40K) would indicate higher absorption, while CMY patch (A) would induce a response similar to that of paper or substrate.

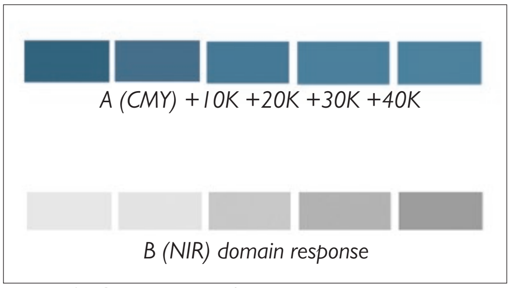

Figure 2. Colour sample A and reduced derivatives with 10, 20, 30 and 40 K coverage substitution: B possible experience of these samples in the NIR domain

The observed system gamut is the environment where some changes can have a significant effect on the visual response and on the NIR image (*Žiljak et al., 2011*). For successful operation of the CMM module (colour management module) input and output gamut should be defined, while possible changes lead to colours remapping.

Input gamut, according to device, is often larger then the output device gamut, which is indirectly connected with a (dynamic) range of the image. Fig. 3 schematically shows different gamuts (*Bunting F, 1998*). Dedicated input device profile is wanted, as assigned (common) profile can have different (larger) gamut, while transfer function to another gamut (Homan J.P, 2007) can present RGB values of starting (patch) colour in a different way, which would probably influence the output values.

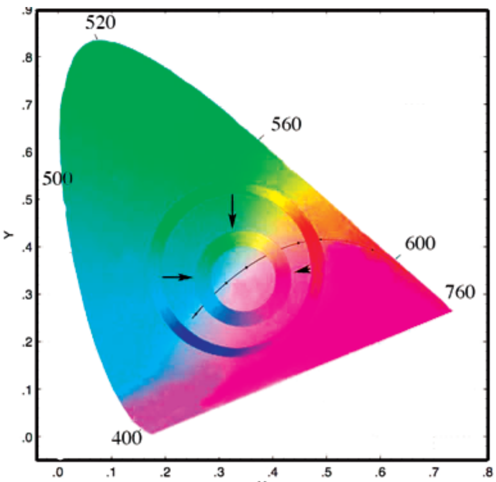

Figure 3. Schematic presentation of two different colour gamuts

With such conditional transfers variations are possible. It is thus advisable to select the optimal or even the best fitting, appropriate rendering intent (RI) within the system, while the remapping of colours by such transitions can differ, as seen in Fig. 4.

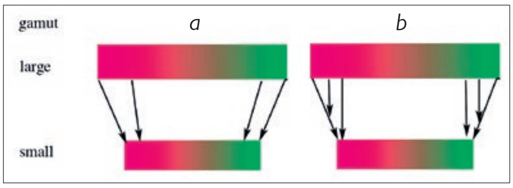

Figure 4. Possible remapping while transfer from larger to smaller gamut, for perceptual model (a), and colorimetric model (b).

As presented in Fig. 4a model, colour compression of tones and hues appears within the gamut, while in 4b model out of gamut colours are reproduced on the border of the gamut (locus), and are reproduced equal. This means a decision what colour in which model is permanently present.

Suppose a custom defined colour, as in Fig. 2, or some concerned alternative choice, as in Fig. 5, that are within the gamut and support the reduction model. Defining in CMY (K) system for CMYKIR purposes, within the supposed profile, is a suitable combination. Depending on the achromatic reduction rate range, a possible tone range is defined in the CMYKIR model. For example, yellow (Fig. 5a) is highly saturated (90 $â_Y$, 10 $â_{M,}$ 10 $â_C$), the possibility of the K reduction is rather limited, but green (G) ($â_C$ 80, $â_M$ 40, $â_Y$ 60) expresses broad substitution possibilities and a higher black tonal range, till 40 $â_{K.}$ The ”multicolor” 5b figure shows how each patch makes at least medium reduction possible.

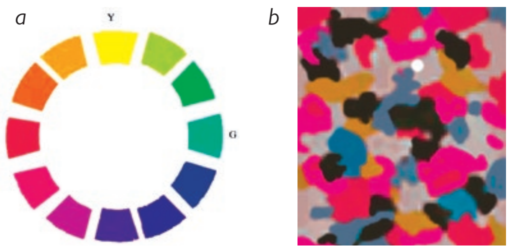

Figure 5. Defining series of single-hue samples within selected colorimetric model (a), combined patches varying hues (b)

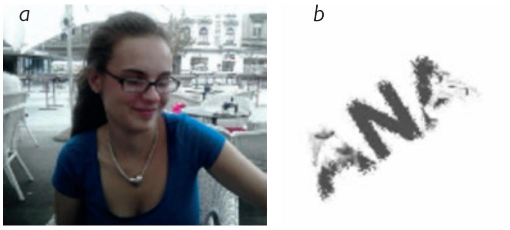

Figure 6. Picture example (a): open air image, CMYKIR hidden information (b)

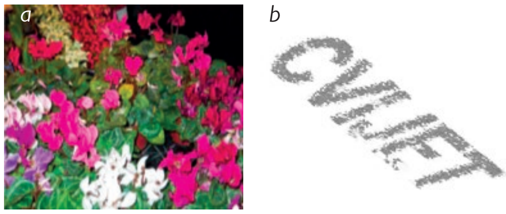

Figure 7. Scanned image, highly saturated, but partially only two primaries present (a), CMYKIR hidden image (b)

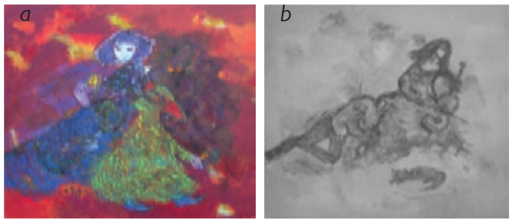

Figure 8. Example of image reproduction in VS (a) and a second in NIR response (b) (Courtesy of CMYKIR Team)

As previously mentioned, if selected colours are beyond the proposed gamut or different intend applied, unwanted deviations, as well as unwanted non-system additional adjustments, are possible. Gamut defining and tone range are the first necessary steps for reproduction.

Besides the motive, the observed images also differ in imaging conditions, colour range and colour and tone distribution. Fig. 6a is a high range, exposed at daylight in open space, where large areas contain only few colours, so placing the extended NIR image (Fig. 6b) has to be carefully designated, otherwise some parts of the extended image may be missing. CMYKIR separation is carried out by means of an algorithm for maximal value state in the K channel (Pap K. et all, 2010). A similar situation is visible in Fig. 7, which is a scanned picture, lower range but rather highly saturated. Some flower parts are also combined from only two primaries, what is adverse for the hidden (extended) image. By this picture separation model is based on CMY***F***IR system (Stanimirović et all, 2013). In channel K the maximum is defined for all tones and hues as a 40% Z-value amount in NIR domain till 1000nm. Hidden information "CVIJET" can be recognized with IR glasses or *Z*RGB double camera. This information is hidden in visual with a naked eye too.

Fig. 8 is a studio imaged artwork, not very large range, but mostly saturated, meaning in the reproduction surrounding all three primaries are present. The analysis carried out for CMYKIR additional IR image indicates that all (or usable) image area should be "covered" with (subtractive) primaries, so substitution with âK would be possible, which is a presumption for defining the NIR image. An example for double image, in VS and NIR, is presented in Fig 8. It is and original artwork, acrylic on canvas, created with double acting paints, for VS and NIR and carries two items of information. They are imaged with a ***Z***RGB camera. Two images are merged for the CMYKIR reproduction, meaning to hide the second image incorporated in original artwork image. This expands the idea that graphic reproduction should have two stages, visual and NIR (Čaklјušić et all, 2013). This should be a way of establishing the originality of artworks.

4. Conclusions

CMYKIR reproduction ensures image design not only in the visible part of spectrum (VS), already additional image in NIR domain. Basic system implies standard graphic CMY(K) separation, where according to subtractive principles and achromatic substitution proportional-common part of CMY coverage can be substituted by K coverage. Parameters/settings that have to be dedicated, defined and adjusted, starting with gamuts, defined profiles, as well as defining inside working CMYK space are necessary for the procedure. The situation that CMY coverage colour combination can be reduced with K coverage in a variety of combinations ensures obtaining and modulating tones in the NIR domain, as well as a possible reproduction on various substrates. One of the subsequent research objectives will lead to a multi-separation and the possibilities of substitutions with the system and custom colours.

All presented images and designed CMYKIR separations can be found on www. tiskarstvo.net

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