Preliminary report

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# Degradation of Dual Image for Visual and near Infrared Spectrum at repeated CMYK/RGB Rendering

**ABSTRACT**

*A near infra red (NIR) designed image is a dedicated image containing additional information in a spectral domain between 700 and 1000 nm. Throughout management in visual spectrum z-parameter properties of selected separation or custom dyes are adjusted for NIR visualization. If such reproduced image is rescanned, Z-parameter properties of a CMYKIR designed image vanishes, or is seriously damaged.*

**KEY WORDS**
separation transfer functions, NIR CMYK design, Z-parameter, colour management

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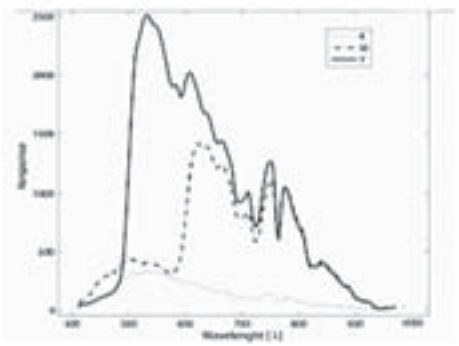
## Introduction

To setup a image for a reproduction, colour management has to be enforced, meaning appropriate profile for selected input as well output system, specially if NIR image is provided. Changing any parameter in the system routes to re-profiling or generating a dedicated profile. This contemporaneously means that output RGB/CMYK transfer functions are not linear according to theoretical PS equations, and their customization has to be managed carefully. It must be stated that NIR image properties are designed assigned and routed through visual colour arrangement.

Not any dye (or pigment) reflection or absorption ability is suitable to display a extended NIR image.

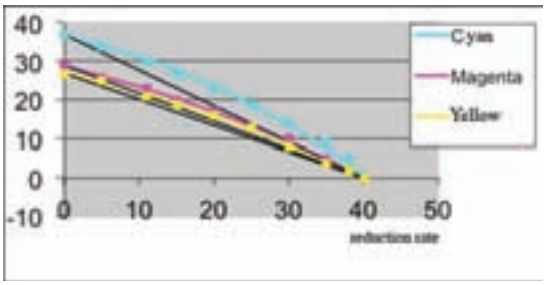


» **Figure 1:** *Response curves of dyes (K, M, Y) , in 400 to 1000 nm domain*

As reported (Agić D. et al., 2012), some dyes independently from their visual domain properties, in NIR domain show relatively high reflection, and some render relatively strong absorption (Fig 1). That fact is the basic of quantification of NIR behavior dyes, specified as Z-parameter (Žiljak V. et al., 2012), and their behavior and appearance in NIR domain. That manifestation is of course associated to the structure complexity of chemical properties dye used (Grande B. T. 2012). Common example for this behavior is (standard printers) carbon black, but there is variety of other dyes (pigments) expressing that NIR absorption, and can be used as a NIR image host.

## Colour system transitions

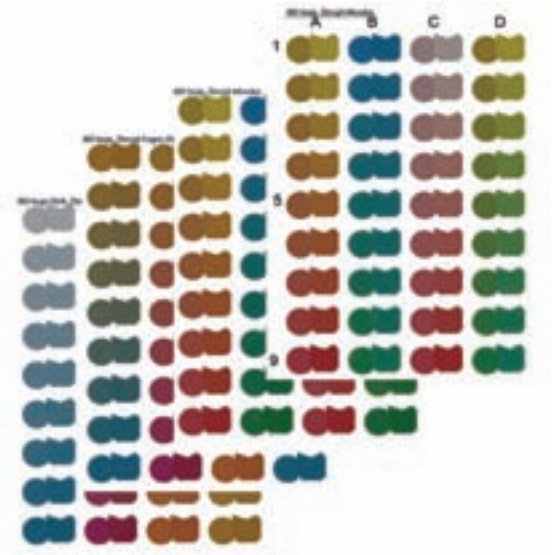
Images, but also a designers coloured patches, can be defined through RGB system, as a scanned picture or colorimetric defined colour, but for output purpose must be rendered to a standard CMYK separation, or any dedicated custom separation system. As stated, RGB/CMYK transformations are not linear, reach different slopes and gradients, Figure 2 (Žiljak-Stanimirović I. et. al., 2012) what differ from theoretical PS equations.



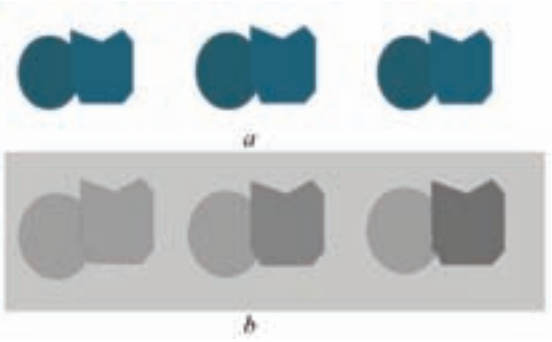

» **Figure 2:** *Slope of a set of CMY dyes by achromatic reduction, FOGRA coated profile (CMY coverage 39, 29 26)*

By standard CMYK separation often achromatic reduction principles are applied (Enoksson&Bjursted, 2007),what is suitable for NIR designing. That connotes or implies rather delicate colorimetric equilibrium, while the same colorimetric output and experience (in visual) through RGB system, can be achieved with various separation combination values CMY+K, with the same (according to the profile accuracy, in practical situation similar) colorimetric and visual values output. In that way also the NIR image is defined, and various amounts (of reflections or absorptions) are achieved, that can be visualized as various shades of gray. In this considerations standard separation is applied, and carbon black was practiced for achromatic principles exchange, simultaneously modulator for the NIR image response. Some, (mostly hi-res ink jet) systems instead carbon black use other dyes, different chemical composition, probably according their mechanical characteristics and particle size distribution. (ICBA, 2011).

As shown on Fig 3, selected patches generated with various CMY+K combinations showing similar visual output, meaning similar (theoretically the same) colorimetric Lab values, reproduced within ΔE 1.6, but vary gray shades in NIR. Selected patch (B5) as reproduction stable, is further developed to series of CMY+ K re-combinations.



» **Figure 3:** *One of the series of programmed reproduced sheets, B-5 (IRD Minolta) patch, is considered for further arrangements*

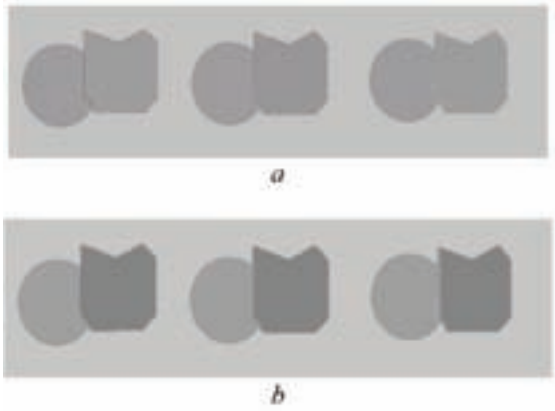


» **Figure 4:** *Selected patches reproduced (visual same output) in different reduction amounts varying K coverage percentage content (a),*
*(basic coverage CMY 80, 60, 40), and appropriate NIR image, where gray shades differ according to reduction recalculated K content (b)*

## CMYK RGB re-rendering

If reproduced-printed image with NIR specification is repeated to RGB system, meaning re-scanned or re-imaged, existing CMYK system is converted to RGB system. As visual output of printed image shows similar (or the same) values (e.g. in Lab) to RGB, the conversion by that rendering would show similar values within scanner or camera environment, producing related RGB

values in behavior as a input device. In dependence of settings, white point, gamma and profile, reproduction curves, possible range etc, this rendering causes differences in scanned values (in visual), but leading to further changes in NIR domain. If such rescanned image is further processed through some image editing program, in this second stage program settings, non appropriate profiles and possible implementation of achromatic methods, influences changes in visual as well the NIR image. According to the changes in reproduction surrounding, shifts in visual can occur and related (degrading) response changes in NIR domain. (Figure 5)




» **Figure 5:** *Examples to rescanned image-NIR response is similar to substrate (a), the response is damaged and gray shades seem to be similar (b). In visual domain color and hue shifts are possible*

Stated situation by re-rendering, meaning rescanning or reimaging a system developed and designed for NIR domain, indicates a non usable reversibility in reproduction. Reimaging printed image and its simple conversion and rendering from CMYK system to RGB system, and again to CMYK for printing purposes, causes distortion not only in visual, but also in image designed for NIR domain. Visual image could be adjusted by means of image editing program, but NIR image either fades or is significantly damaged.

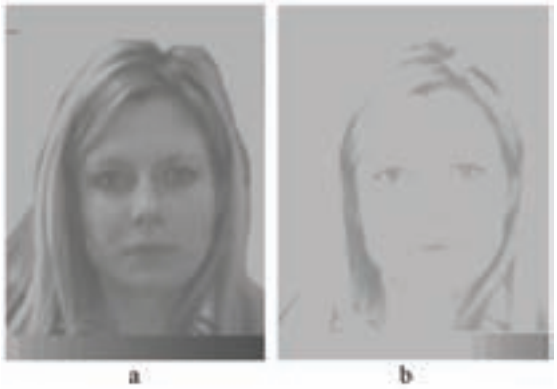
As a example for a hidden image in a file, Figure 6, visual response gives uniform greenish (defined for CMYK output system dedicated profile, as for example 80C, 60M, 40Y) hue in proper setting and no re-rendering. For each pixel various or possible reduced or equivalent CMY+K values have to be defined for IR image purposes. In that case only in black channel appears the image, also when image reproduced, appears in IR domain, Figure 6a.

» **Figure 6:** *visual, uniform hue, response of the image, a: image in K channel, b: " ghost " image, c:*

If the image file is re-rendered or reproduced image rescanned, the situation is that the colour model as well profiles and settings are changed meaning entering RGB values. That leads to changes in retried separations, particularly alterations in K channel, effecting variances of Z parameter. Actual alteration means detriment of basic effect, where in visual can occur some "ghost" image, and in K channel or IR domain image vanishes or expresses degradation in its contrast or tonal range, Figure 7.

For a simple demonstration and valuating of gray shades just a appropriate gray scale step wedge was imaged and merged for observing behavior of the K image. Just observing "low", "middle", and "high" values of the wedge indicates the degradation of the K image. (Figure 7.)

Some usable reconstruction of the image or some image parts or reproduction seems to be unacceptable particularly in IR domain, so NIR designed systems lead not only for broadening visual output, but also for steganographic purposes.




» **Figure 7:** *Undersized range of gray tone on K channel (a), strong reduced (degraded) gray range (b) by improper profile setting or rescanning*

## Conclusion

Implementation of colour management in reproduction in present is very high and precise (Sachs, 1999). Accurate measurements, white point adjustment, gamma compensation and overall colorimetric features are carried out by means of management and matching with profiles. Designing in NIR utilizes standard color management and absorption or reflection specificity of some dyes (pigments) in NIR. As often example in standard graphic reproduction is carbon black, situation to achieve same or similar colour response of single colour with a variety of CMY or CMYK allow rather simple programming and designing for NIR purposes. If visual is an multicolour image, for each pixel possible CMY and CMY+K reducing substituting combinations has to be defined. It must be stated that the profile must be exact, in most cases strictly dedicated for the output system, while reproduction and transfer functions are not linear. If carbon black is used as NIR design carrier, compensation of black is often used, however dedicated reduction is recommended.

Basic, file for NIR based reproduction has to be prepared in CMYK system with appropriate output profile. If profile is mismatching, the NIR effect will be spoiled. Some output systems (RIPs) accept RGB system files, but in that case file for printing reproduction must be seriously rearranged, profiled and adjusted for such purpose, although that way could cause deviations. Basically, only primary print will appropriate reproduce both images. That contemporaneously specifies the situation by re-rendering, rescanning or reimaging the printed picture and deviations that will occur by such conversions. As stated, visual image can be, time consumption, rearranged, but the CMYKIR one is irreversible vanishing or hardly damaged. Designing in NIR, along understanding materials, besides graphic systems, can be carried out on a wide variety of various media and colours. Color management defines situations and tolerances in visual part, Z-parameter describes behavior of specific dyes in NIR, but the NIR image degradation grade by probable re-rendering has to be still quantified. In this work control wedge (carefully chosen) indicates only approximately how some gray tones shadows-middle or low are (or are not) reproduced, comparing original situation with re-rendered brightness on the screen, or relative D on print. Any possible changes or alternations due to primary print (made from original prepared file) implies re-rendering or profiles/materials mismatch. Development of determination method is one of further tasks. Similar situation occurs by alternating profiles and changing CMYK system to RGB and vice versa on screen.

Knowledge about materials, its optical, physical, chemical, mechanical and other properties allow designing in NIR as a new system, and its appliance in various fields. According to materials used, such method applied as a steganographic image is stable, in mechanical optical and security implementations. Various CMYKIR examples can be contemplated at www .infrared.net

## References


1. Agić, D, Rudolf, M., Agić, A., Stanić-Loknar, N. (2012) Case Study: Carbon Black Separation Extended Features // Proceedings- The Sixth International Symposium GRID 2012 / Novaković, D. ed. Novi Sad : Faculty of Technical Science, Department of Graphic Engineering and Design, 2012. pp 187-194 (lecture, international peer-review, published, scientific).
2. International Carbon Black Association (ICBA): Carbon black: Physical & Chemical Properties, [Online] Available from: www .cancarb.com/ Physical_Chemical_Properties.pdf, 3-6. [Accessed 9.2012]
3. Enoksson E, Bjurstedt, A (2007) Compensation by black (CB) – a new separation?, Royal Institute of Technology, Sweden, 2-14. [Online] Available from: www. academic. research.microsoft.com/ Author/34351484/ emmi [Accessed 10.2007]
4. Grande B.Th: Offset Printing Inks, Bergheim, (2012), 5-8, [Online] Available from: www. offset-druck-farben.de/ download/english/inksoffs.pdf [Accessed 10.2012]
5. Sachs, J (1999) Color Management, Digital Light and Color, 10-14, [Online] Available from: w ww.dl-c.com/.../PWP%205.0/downloads/Color%20Management.pdf [Accessed 2002]
6. Žiljak, V, Pap, K, Žiljak-Stanimirović, I, Žiljak-Vujić, J (2012) Managing dual color properties with the Z-parameter in the visual and NIR spectrum. // Infrared physics & technology 55 (2012) ; 326-336.
7. Žiljak-Stanimirović, I, Agić, D, Žiljak Vujić, J (2012) Hidden Infrared image in a Uniform CMYKSeparation Hue, JGED Volume 3 (2012) 2, 8-11