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REDUCTION RATE STRATEGIES BY PROGRAMMED NIR DUAL IMAGE REPRODUCTION PROCESS

STRATEGIJA IZNOSA ZAMJENE KOD PROGRAMIRANE DVOJNE SLIKE U NIR REPRODUKCIJSKOM PROCESU

Ana Agić[1], Ivana Žiljak Stanimirović[1], Darko Agić[2], Miljković Petar[3]

[1]Sveučilište u Zagrebu, Grafički fakultet,
[2] ATZH Zagreb
[3]Sveučilište Sjever

Abstract

Autotypic reproduction used in printing procedures as opposed to standard subtractive system used in color photography, except CMY system components, usually adopts black carbon ink within practiced screening system, commonly denoted as four-color printing. Black color incorporated as black printer or K-channel replenish various features including undercolor adjustments and achromatic interchange, which is crucial for achieving secondary, only near-infrared, NIR detectable image.

Keywords: *NIR technology, K-separation specification, secondary image features*

Sazetak

Autotipijska reprodukcija koja se primjenjuje u tiskarskim postupcima za razliku od standardnih postupaka kolor fotografije, osim sustava CMY uobičajeno primjenjuje i carbon crnu boju u kombinaciji sa primijenjenim rasterskim sustavom, što se obično označava kao četverobojni tisak. Crna boja, prikazana kao crni izvadak ili kanal K podržava razne prednosti obuhvativši akromatska podešavanja, uključujući zamjenu, što ima krucijalnu ulogu pri stvaranju sekundarne slike, koja se može detektirati samo u NIR području.

Ključne riječi: *NIR tehnologija, spesifikacija K separacije, značajke sekundarne slike*

1. Introduction

1. *Uvod*

Each object, matter, stuff, material that surrounds us reflects, absorbs or flows through light. Generally, people talk and operate in "visible part of the spectrum, VS" although we know that there is a wide range of frequencies (spectra) that can be only inspected and visualized instrumentally (1). At standard reproduction, black ink and black printer are used, but its specification is crucial for NIR system, according to its absorption behavior in visual as well extended domain, what is explicitly important for secondary image. It must be noticed that, except system dyes and carbon black, there are other pigments and dyes that express the same or similar absorption behavior as carbon black. Reproduction curves (trendlines) have to be dedicated to reproduction for each dye, while black printer is separately custom setup, while it is adjusted for the whole reproduction, particularly for the secondary image. Most input images in the reproduction system are presented in RGB mode. For graphic reproduction they should be rendered to CMY+K mode, what in application support is displayed as CMYK channels that would drive inks in the output device. Basic principle is that CMY(+K) colors in visual domain cause colored visual output, while in NIR, they differ in their absorption behavior meaning carbon black renders much more absorption ability than others, thus facilitates secondary image information not disturbed by other inks. Of course, discriminating principles must be stated in visual domain as well as in extended domain, NIR domain, and be appropriate to be recognized. In NIR domain recognition - visualization is carried out instrumentally. Visual and NIR domains must not interfere.

2. Separation and achromatic interchange

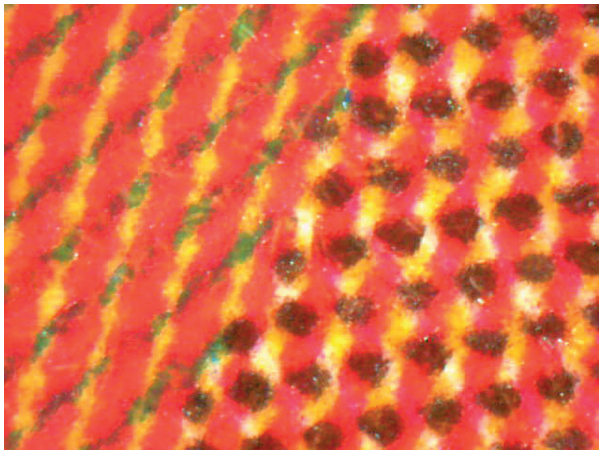
2. *Separacija i akromatska zamjena*

Printing processes are standardized, defined, and mostly treated as open systems, ruling ISO recommendations for particular printing (output) system, such as described in ISO 12647: Process control for the production and half tone color separation, proof and production prints. Input RGB images are suitable for WEB and similar purposes, but for printing system they must be converted to subtractive mode. As described in (2) for NIR separation suitable and dedicated workflow is performed suitable for dedicated purposes (2). After series of investigations workflow is set as conversion from RGB to CMY, as the first step (4). That step is important for the visual stage of reproduction, of course, in accordance with input profiles. (). Output profile and high tuning follow the interchange process. This step allows forming of the twin pairs, called "twins" (5), meaning visual (V) expression situation achieved with CMY and/or CMYK coverages, that gain the same visual output independently what mode in concrete situation is used, but strictly dedicated for secondary image purpose, with respect to Z response (6) (7). Image 3 presents a dual gray twin situation achieved by CMY and pure K, as a maximum replacement rate. As mentioned above, the first step is CMY image, in conjunction with twins principle, we have the situation that, due to secondary image from pixel to pixel, we could change from cmy to cmyk situation statement. Application program mode, of course, stays persistent. There could be some discrepancy in unifying such "dual" situation, and some lapse from "scholar" graphic arts reproduction principles, but this is treated in dual twins system mode of CMYKIR module. All variances attain some impact in overall functioning of the system, as a profile trait. Achromatic reduction as a principle is known and widely used in graphic arts reproduction processes, applied in various application ways as UCR, CCR, PCR, combined UCA etc.
Often, in programming reproduction process, basic trendlines (enforced reproduction curves displaying various reproduction functions) are presented as achromatic CMY, respectively CMYK values. As reproduced, we can treat that prints or patches as gray or neutral colors. According to standards, these colors should be colorimetrical neutral. Furthermore TAC (total area coverage) is also defined by standards, so achromatic interchange is often used. According to CMYKIR technology, twin color principles, such kind of black interchange is a useful.

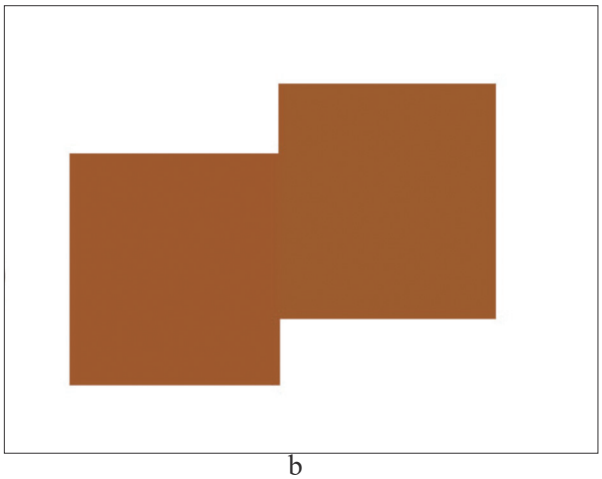
3. Separation setting and black printer channel

3. *Podešavanje separacije i kanal crne boje*

Application support (of image manipulation and aligning) in the black interchange offers "high or middle or low" rate, not a fixed amount as in alder systems. This makes possible K rate changes from one picture element to another. Such system



a



b

Figure 1 *Microphotograph of CMY (left) and CMYK (right) (a), brown twin pair with the same visual output (b)*

Slika 1 *Mikrosnimka CMY [lijevo] i CMYK [desno] [a], smeđi par blizanaca istog vizuelnog doživljaja [b],*

was used in early hidden image examples, or with large same-hue or lightness areas. For multicolor, high changing color values this was not particularly suitable.
Let us consider some theoretical (scholastic) example, C-M-Y and K values in coverage of a high density gray tone:

90	90	90	0	CMY high density value, no K
0	0	0	90	K maximal possible reduction

This situation is theoretical, while gray balance, TAC, screen behavior and other parameters are not counted. Maximal TAC could be 90C+90M+90Y (=270) or if added black also 360 coverage, 400 as solid). If consider only CMY to interchange, maximal possible rate would be 90K. Such situation is not recommended, while (according to additive law, paper rheology etc.) new interchanged density (or lightness) would not correspond to starting position. Appreciated printing materials and equipment suppliers sometimes suggest possible or reasonable rates, if not, printing plants have to make their own tests, charts and principles. From situation mentioned above, various interchange rates can be calculated and applied, from pure C+M+Y to K. As stated above, first possible situation is pure
C-M-Y coverage combination, no black.

90	90	90	0	no reduction rate
72	72	72	18	0.2 reduction rate
54	54	54	36	0.4 reduction rate (optimal)
36	36	36	54	0.6 reduction rate
18	18	18	72	0.8 reduction rate
0	0	0	90	1 (maximum possible) reduction rate

any other rate is possible between 0 and 1.
Here is an example of three twin patches, Fig 2, with various K content. It is understandable that more K coverage will gain higher secondary image contrast, but the question is what the optimal rate would be (8)
For gray scale used while establishing the system and applied as a basic reduction rate groundwork, after fine tuning differences were acceptable low. Colorimetric evaluation should be lower than DE 1.5. Figures 3 and 4 present twin gray pairs and

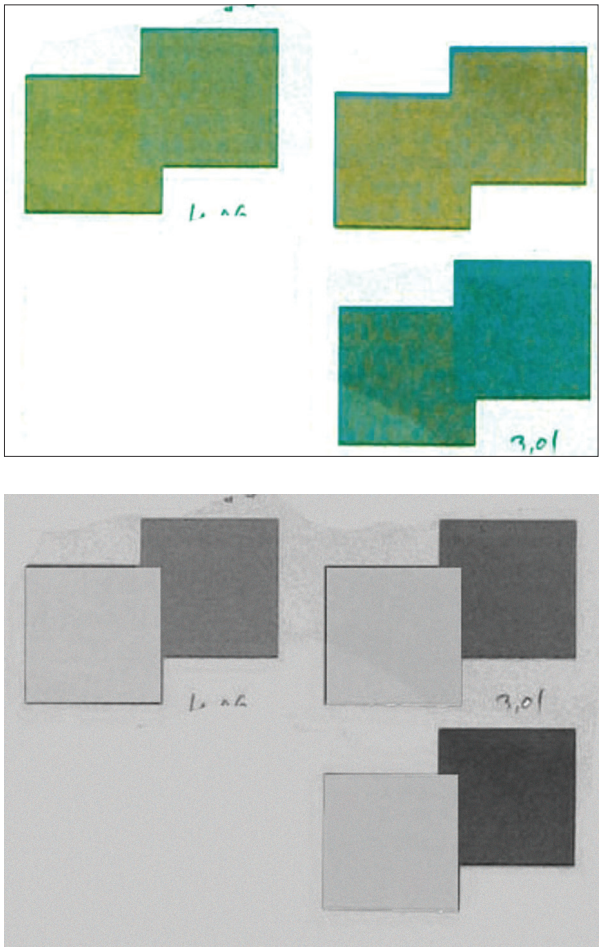


Figure 2 *Three patches in twin mode (20, 40, 60 âK)*
Slika 2 *Tri uzorka u dvojnom modu blizanaca [20, 40, 60 âK*

lightness adjustment. Evident situation is shown where CMY combination coverage twin optically equals K twin. (9)

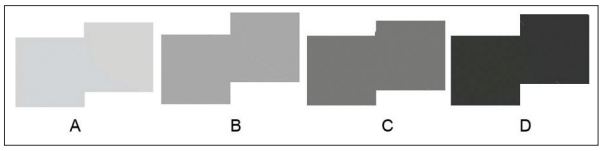
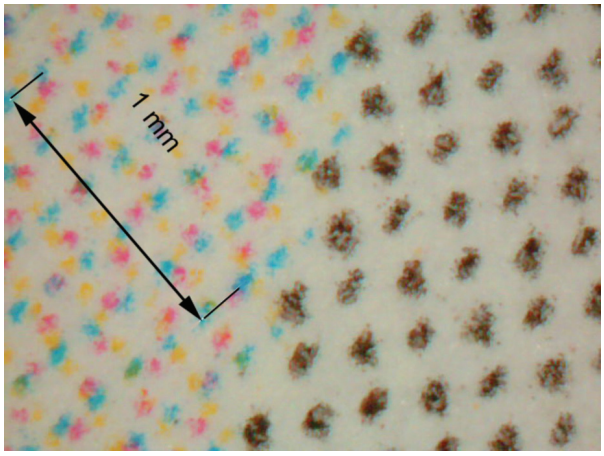


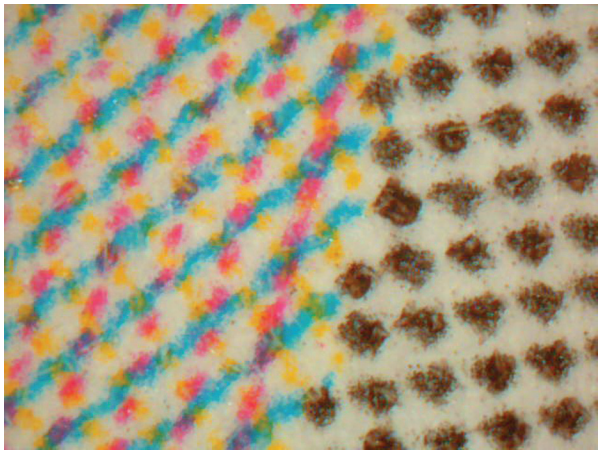
Figure 3 *Tested twin pairs*
Slika 3 *Testirani parovi blizanaca*

Coverage values of gray twin patches are presented C-M-Y-K, (for K: 20, 40, 60, 80 interchange)

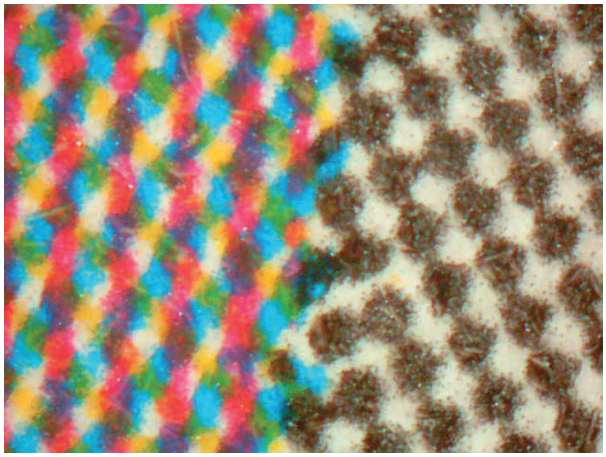
A:	20	12	12	0	0	0	0	20
B:	39	28	28	0	0	0	0	40
C:	60	49	48	0	0	0	0	60
D:	86	78	81	0	0	0	0	80



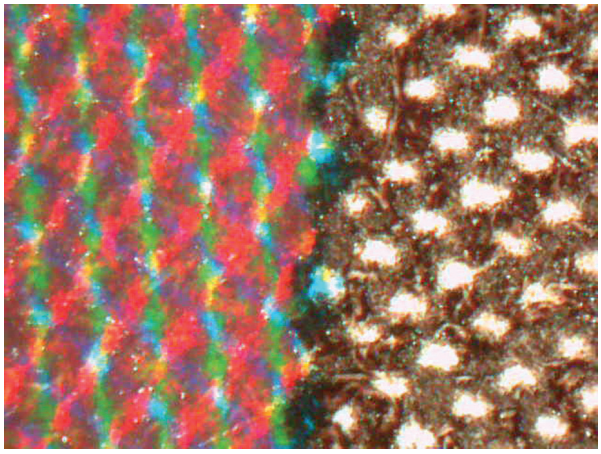
20 K interchange
20 K izmjene



40 K interchange
40 K izmjene



60 K interchange
60 K izmjene



80 K interchange
80 K izmjene

Figure 4 *Photomicrograph of gray twin pairs standard screening, 60 lin/ruling (20 K, 40K, 60K, 80K interchange)*

Slika 4 *Mikrosnimka neutralnih parova blizanaca, standardno rastriranje 60 lin/cm [20, 40, 60 K izmjene]*

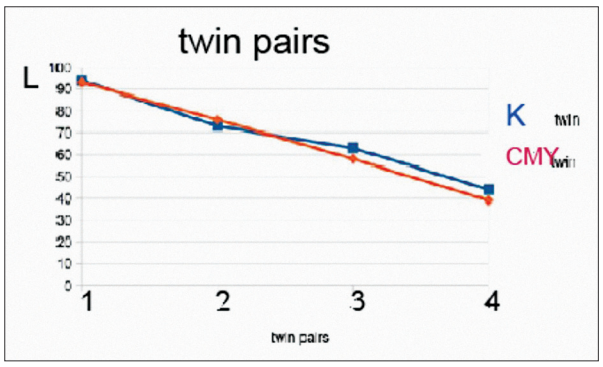


Figure 5 *Lightness adjustment-lapping (covering)*

Slika 5 *Podešavanje svjetline, usaglašavanje pokrivenosti*

Now, some more questions are opened: to find a suitable reduction rate that should smoothly fit performing twin pairs, allow fine tuning, and are acceptable for instrumental recognition in NIR domain. Basic primary C,M,Y,K and secondary CM, YM and CY absorption curves are presented in listed work (10). Investigations do not cover only "standard" colors, they already are extended to specific sources, such as natural colors (11). Experimental trials proved that in most situations colors and substrates reduction rate of 40 percent is optimal, in visual, they appear the same while reflection curves are very close, but also, in Z domain according to absorption, spectrophotometric rate should be 0,1 or more, Fig. 6; visual and photomicrograph in Fig 1: Twin brown patches (Fig .1 and Fig. 6) have following C-M-Y-K coverage values (applied for dedicated swap profile)

A: 0-58-80-40
B: 39-74-99- 0

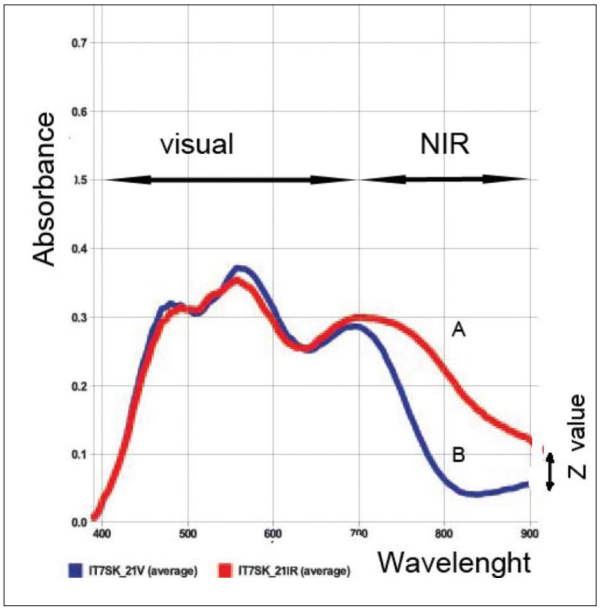


Figure 6 *Spectrophotometric curves of two brown twin pares in V and Z domain, from Fig 1.*

Slika 6 *Spektrofotometarske krivulje dva smeđa para u V I Z području, od slike 1*

In B twin pair Y component coverage practically reached solid (coverage), so further correction cannot be performed, and DE value cannot be lowered
DE76for selected pair: =4, what is already acceptable. However, in most cases achieved colorimetric differences are lower.
Input image localizes, with its hues and intensity, the properties positioning of secondary image, depending is it open air image, artwork, generated situation, line-work, or else. On the other side, output system properties implicate some parameters that should be incorporated in dual image file (profile).
Each image expresses some specific properties. Open air image, artwork, sketch and actually any substrate are capable for double image implementation. Specificities of any combination of origin, substrate, dyes-colorants and printing process/conditions have to be taken into consideration. Standard color management did not cover all demands for V and Z customization, so for twins, fine tuning dedicated module based on regression analysis is established (12). One of the numerous parameters that has to be considered, with respect to the realization process (printing) is appliance of screening system, specially

Figure 7 *Open air picture*

Slika 7 *Snimka u prirodi*

Figure 8 *Segment of the painted artwork (courtesy N. Ziljak)*

Slika 8 *Detalj umjetničke slike (courtesy N. Ziljak)*

if some custom shapes and conditions are applied. Dot gain as a reproduction factor, and real screening reproduction range are not circumvent factors in NIR double image achieving, Fig. 11.

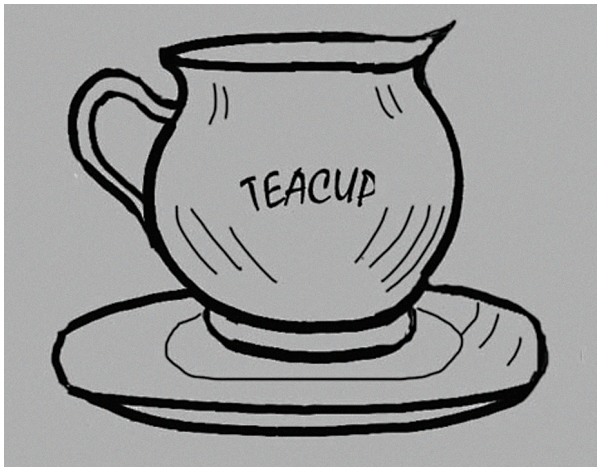


Figure 9 *Line-work example (low and high intensity only)*
Slika 9 *Crtež [primjer samo dva tona, svjetlog i tamnog],*

Figure 10 *Canvas as a printing substrate (low and high intensity only) (courtesy Infrareddesign Team)*
Slika 10 *Tkanina kao tiskarska podloga [dozvolom Infraredesign Team]*

In the presented example gain is measured at coverage 0,5. Some other specifications control more trendline points, particularly if gain is high and is not equable. Highlight and shadow area of trendline have to be examined also, if screening/reproduction system is unable to reproduce in that, or any other areas.

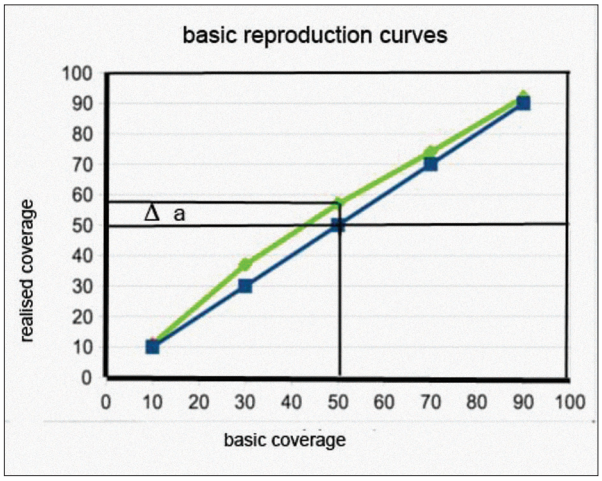


Figure 11 *Example of dot gain trendline*
Slika 11 *Primjer krivulje prirasta elemenata*

4. Conclusions

4. *Zaključak*

Dual image, visual and near infra red creating, is program aided process, depending on numerous factors according to input image, output substrate, inks, and a variety of technical and technological factors and influences, example on leather substrate (10). Various investigators are also trying to elaborate the principles of hiding image information, utilizing variant approaches (13) Achromatic interchange applied within NIR separation technology is highly depending on carbon black yield for secondary hidden image. For the whole time a balance between visual and NIR settings is present, while input RGB into CMY and CMY+K combinations and interactions are present. Adjusting dual values includes dedicated profiles and very exact rendering by recalculation of twins. Visual output regardless CMY or CMYK must be the visually and colorimetrical. Dynamic or fixed K reduction ratio is possible, and depends on variety of factors, while fixed factor of 0,4 renders good results. Dedicated profile includes variety of factors, while twin pairs setting has to be very precise. Dual image system is an open space that can be practiced in numerous fields, it also opens space for investigations, development, designing and any kind of progress.

Figure 12 *Shoe in visual (left), and NIR instrumentally detected image showing hidden information (right) (courtesy Infrareddesign Team)*

Slika 12 *Primjer cipele u vizuelnom [lijevo], I NIR području instrumentalno određena, s prikazom skrivenih informacija [desno], [dozvolom Infrareddesign team]*

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Znanstveni članak

AUTORI · *AUTHORS*

Ana Agić - nepromjenjena biografija nalazi se u časopisu Polytechnic & Design Vol. 1, No. 1, 2013.

Ivana Žiljak Stanimirović - nepromjenjena biografija nalazi se u časopisu Polytechnic & Design Vol. 2, No. 1, 2014.

Darko Agić - nepromjenjena biografija nalazi se u časopisu Polytechnic & Design Vol. 1, No. 1, 2013.

Korespondencija:
darkoagic@yahoo.com