

AUGMENTED EXPERIENCE – NEAR INFRARED SPECTRUM ADVANCED VISION EXPANDING

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Summary

By means of double image, further visual information is added. Visual experience is instrumentally widened, and secondary image is placed in near infrared (NIR) domain. Without instrumental support secondary image is unreachable to the observer, moreover it is secured against forgery. Principle of visual and instrumentally managed images presenting is based on spectral absorption/reflection properties of process inks and carbon black, on separation graphic arts reproduction procedures in visual and NIR domain. Differences in standard separation RGB to CMYK conversions, and particular CMYKIR separation are described.

Key words: double image, Z-domain, broadened image experience, CMYKIR

1. Introduction

Existence of dual image is the result of reflection systems of materials used in visual and NIR part of the spectrum [1] [2]. Visual image, the image originated by bare eye observing, is the result of standard reproduction procedures. Regardless if the image that is intended to be in visual is the result of open air imaging of an object, is it scanned or generated, the file will be in RGB stage mode. Of course, visual image dues to the subject of RGB preferences of ICC profiles, as well as viewing ones. For printing purposes autotypic process is used. This system implies subtractive color/inks mixing, accompanied with suitable screening model of halftoning printing elements. Principally, besides subtractive model in graphic arts procedures, it is possible to use extended systems of nonstandard colors/inks, but in such case mixing of colors is dedicated [3]. In such situations often is necessarily to expand reproduction procedures to non-process colors/inks, define additional program channels and perform additional printing forms. This can be also useful when applying nonstandard materials, or advanced autotypic methods [4] [5].

Graphic arts specificity is usage of black printer (channel) at standard footing, meaning black color/ink is fourth in reproduction process. Black ink allows a variety of specificities, some of them describe improvement of print quality and visual sensation of the reproduction, but also allows a possibility of chromatic inks partial changing by cheaper black ink. In such substitution situation a degree of possible achromatic interchange can be discussed. At the same time a possibility of creating variety of colors with the same visual response, but containing various or different coverage combinations of chromatic (CMY) colors, and usually (carbon) black.

2. Achromatic interchange

Accepted premise is that basic chromatic process inks in some complex (tertiary) ink combination can proportionally be substituted with black. Standard graphic arts achromatic interchange methods are implicated through procedures such as UCR (under-color removal), CCR (complementary color removal), PCR (polychromatic color removal). Achromatic reduction is rendered as percentage of possible substitution of chromatic inks coverage with black. Theoretically, interchange gamut rate is between 0% and probable uttermost rate. Fig.1 demonstrates CMY combination, entire proportional possible interchange, and CMY+K combination with approximately 50% medium rate.

Modern image correction and manipulation graphic apps usually accept achromatic reduction modules. Adjusting black trendlines and TVI (tone value increase) adjustment, TAC (total area coverage) options according ICC regulations, but reduction rate is gradual from "none" to "light", "medium", "high" to

“maximum”. Such gradual manner does not admit such accurate tuning, and is rather not flexible at most processed images. Such replacing procedures support most current applications at RGB to CMYK separations.

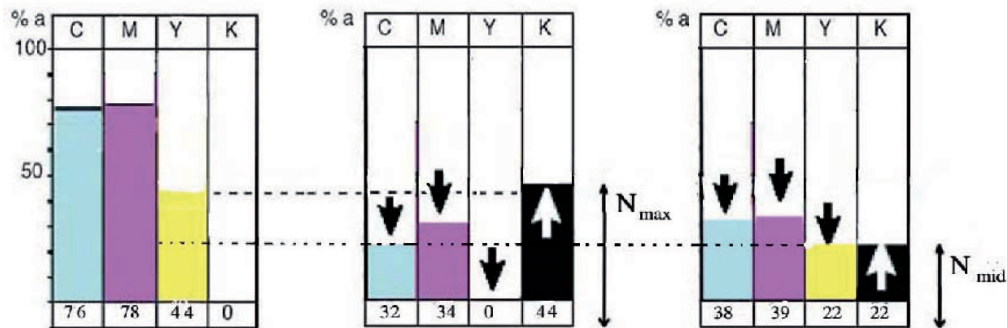


Fig. 1: Achromatic reduction example: no reduction, maximum reduction $\hat{a}Y = 0$, and medium reduction rate approximately 50% with $\hat{a}K = 22$

Problems arise at multicolor images with variety of hues and tones, where each image picture element can obtain different achromatic rate. At most images in visual range that is not a significant problem. For hidden Z image that situations appears not to be convenient, while K coverage in such situations vary from one element to another, Fig.2.

In such situations secondary image has to be placed according to visual image areas where interchange is possible.

Varieties in interchange assets can cause variations in coloristic attributes of some picture elements. From secondary image aspect, interchange discrepancies (K coverage yield) at image visualization could not be equable. Such and similar situations can route to dedicated halftone elements development, that could reduce visual transition between twins. For secondary image position setting Z barrier at 1000 nm, is requested to coordinate areas of suitable-satisfying achromatic interchange, owing to variety of investigations are performed [6] [7].

At NIR-Z, namely CMYKIR [14] technology K interchange is treated as achromatic replacement. In order to achieve optimal interchange result, interpolation system X0 – X40 reduction rate is set [15]. Series of investigations proved that optimal common achromatic rate of 40% K coverage as a balance between achromatic rate and instrumental recognition of secondary image. Fig. 3 presents CMYKIR technology achromatic interchange principle, where black ink [K] coverage is linear defined for all picture elements, and is deducted by coverage for some picture element color, according to graphic arts achromatic principles. Situation when possible

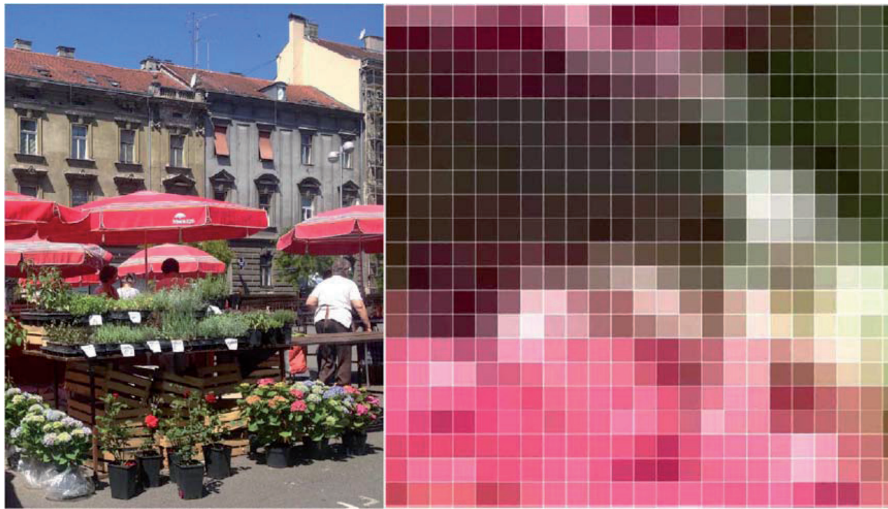


Fig. 2: Image and a portion of picture elements, enlarged detail as CMY mode, example showing that any particular area is not suitable for reduction

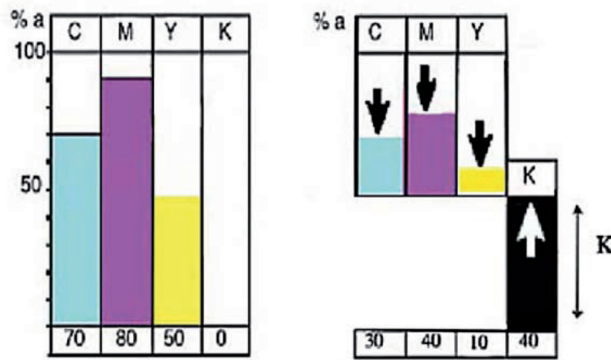


Fig. 3: example of fixed achromatic interchange

fixed achromatic interchange is lower from predicted 40%, that can happen at open air or in nature recorded images, Fig. 4. On such places secondary image programming is aggravated, while needed interpolation rate is not obtained, and secondary image will not be correct. In generated graphics (images) case, dedicated colors are set for twins purposes until $\hat{a}K = 0.4$

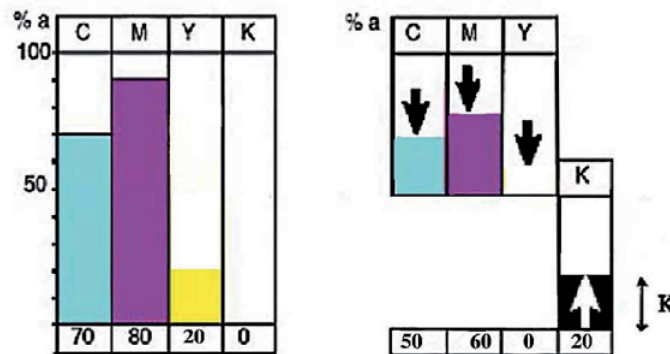


Fig. 4: interchange example when possible $\hat{a}K$ is lower than 0.4

3. Visual and NIR selection, dual pairs

Primary selection occurs in visual domain where optically RGB file is assigned. It has to be noted that RGB optical separation arrangement gets its specificities, meaning some reflectance/absorbance deflections in visual, but also in expanded area. RGB record can be visualized on screen, but for printing purposes subtractive colors (inks) arrangement has to be practiced. At that moment from RGB file a CMY or CMYK mode is formed, whether is designated as twin colors or twins [8] [9]. Twin colors visually are the same (mutually colorimetric ΔE as small as possible). When on (some) reproduction area is secondary image elements absence, the first CMY twin is reproduced. If there are secondary image elements, CMYK twin is placed. Interchange and possible modulations are performed with a dedicated programming developed CMYKIR module [10].

Already stated, first selection is generating RGB visual arrangement. Transition to subtractive mode, possibility of secondary selection is opened, respectively to discriminant of the colors used. Process inks in visual according to its selective absorption properties modulate colors perception, and black is modulating their intensity. Visual part approximate above 750 nm terminates. It is followed by expanded area where reflection/adsorption splitting of process inks and black begins. There incessantly exists negative influence of optical system, which can be specified by barrier scanning. Clear reflection splitting between process inks and black is preferable. If this condition is fulfilled, final discriminant, Z image at 1000 nm will be stable and secured [11] [12]. Fig. 5 presents a twin pair spectral behavior from spectral domain from 400 to 1000 nm.

Twin pairs 1C and 2C are chosen for a generated graphics, dedicated, predicted and selected from some other colors arrangement (palette). Applied achromatic interchange is applied within the meaning of twins equalizing, so they at the same illumination source look the same, but differentiated in NIR domain. Except visual, of interest is the part approximately from 750-850 nm, and particularly Z domain. Spectral and barrier investigations are performed with forensic facility Projectina450 (www.projectina.ch). For visual part spectral curves are near and interlace, what indicates their visual unifying. Transient area is good disjointed, what is precondition for a quality Z image. It is important to note that CMY defined twin renders lower absorption (higher reflection), and IR twins with K component express higher absorption. There the secondary selection, NIR selection takes place, what is responsible for a quality Z image. In Z domain, with that twin pairs the situation is unambiguously defined, where "visual" twins express very close spectral curves, and IR (Z) twins express also very close spectral curves [13].

Twin pair designated as C1, coverages \hat{a}_K CMY+K

V: 77 78 45 0

IR 50 50 0 40

Twin pair designated as 2C, coverages \hat{a}_K CMY+K

V: 45 45 98 0

IR 7 13 82 40

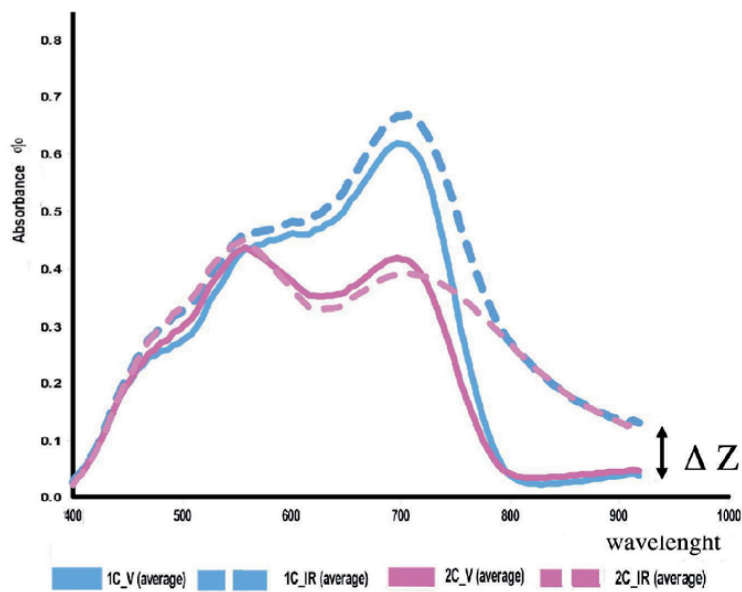


Fig. 5: twin pairs 1C and 2C visual and 1C and 2V IR (analysis made by forensic facility Projectina, Ultra Electronics Forensic Company, courtesy dr. J. Žiljak)

It is obvious that carbon black content ($\hat{\kappa}=0.4$) at composite coverages roots and express spectral characteristic of carbon black, respectively the situation that in observed area its absorbance is higher than that from only process inks. In Z domain it is obvious that spectral characteristics of V and IR twin are unattached. Their apartness is obvious, so the Z image should be instrumentally easily referred. Such arrangement of spectral curves as well as displayed difference fulfills conditions. Switching to some other printing conditions (profile), coverages recalculation, re-imaging or similar action will not produce a good recognized and stable secured image.

4. Conclusions

Parameters adjustment is crucial for secondary image quality. Equalization of visual perception in visual, and distancing themselves in extended and expanded domain (Z) ensures stability of Z image. Achromatic reduction principle embedded in image processing, correction and manipulation apps, appears not to be a quality option for CMYKIR reproduction. Achromatic interchange with fixed carbon black exchange ratio and unifying V and Z properties to be more quality option. Unfortunately, for variety of dyes and materials that can be used spectral data are not known, so they have to be defined. According to a huge range of implementation and usage possibilities, that is further encouragement to technologist, designers, artists and all other interested to improve, develop and widen the area of CMYKIR technology.

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