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BLISKA INFRACRVENA SPEKTROSKOPIJA U TISKARSKOJ TEHNOLOGIJI

NEAR INFRARED SPEKTROSKOPY IN PRINT TEHNOLOGY

Jana Žiljak Gršić

Tehničko veleučilište u Zagrebu, Zagreb, Hrvatska

Sažetak

U radu su dati spektrogrami apsorpcije svjetla za procesna bojila digitalnog tiska. Metoda INFRAREDESIGN® zasnovana je na "blizancima" boja. Jednakost boja podrazumijeva prostor spektra svjetlosti koju vide naše oči. IRD omogućava proširenje na svjetlost u bliskom infracrvenom području koju promatramo sa Z kamerom. S njom detektiramo numeričku vrijednost Z [2] koja se manifestira kao snaga apsorpcije svjetla na 1000 nm. Dizajn sa dvostrukim V i NIR grafikama uvodi novu veličinu ΔZ koja mjeri različitost apsorpcije dva bojila na 1000 nm. Jednakost i nejednakost bojila u dva spektralna područja; u vizualnom i bliskom infracrvenom, prikazuje se veličinama ΔE i ΔZ te spektrogramima apsorpcije svjetla mješavina bojila i njihovih pojedinačnim procesnih CMYK komponenatama.

Ključne riječi: *INFRAREDESIGN, VZ separacija, bliska infracrvena specktoskopija, hidden image, ZRGB kamera, blizanci boja*

Abstract

This paper provides spectrograms of the light absorption for the process digital color printers. The INFRAREDESIGN® method is based on "twin" colors. Colour equality implies the space of the spectrum of light seen by the naked eye. The IRD expands to the light in the near infrared area which is observed with an infrared camera. The numerical value Z, which is manifested as the absorption force of light at 1000 nm, is detected by an infrared camera. The design with double V and NIR graphics introduces a new size of ΔZ that measures the absorption difference of two dyes at 1000 nm. Colour equality and inequality in two spectral domains is shown with a spectrogram.

Keywords: *INFRAREDESIGN, VZ separation, near infrared spectroscopy, hidden image, ZRGB camera, twin colours*

1. Numerical description of colours in visual and the first part (Z) of near infrared spectrum

1. *Numerički opis boja u vizualnom i prvom dijelu (Z1) bliskom infracrvenom spektru*

In literature colors are described numerically in several ways: RGB, CMYK, HSB, L*a*b. For each of the specified variables is assigned a special numerical size. Computer image processing applications determine RGB colors in the steps of 256, as a numeric range of 8 bits or a record with two hexadecimal characters. CMYK colors are demonstrated by colour coverage on paper. The coverage is expressed in percentage units when defined in a Photoshop program, e.g. the precision of a particular color is determined by; or as eight, four, two or one bit per color component. And the grey image has several recording modes.

The definition of vector color in PostScript ranges from zero to one for both RGB and CMYK color definition. HSB and L * a * b colour displays are defined in their typical circular and cylindrical view: colour tone, brightness and color angle. This colour information is standardized.

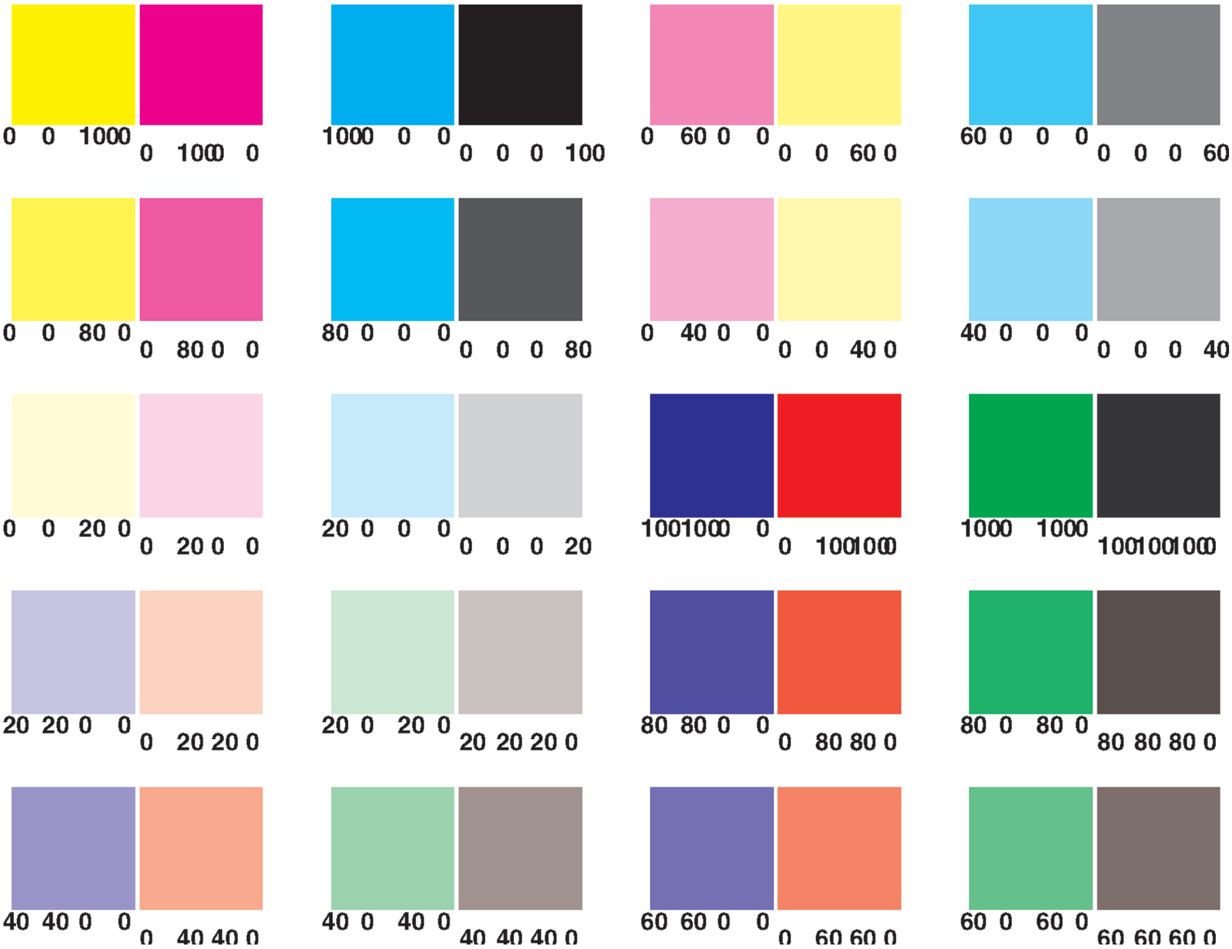

Figure 1 *Colours made from CMYK colours*

Slika 1 *Boje sastavljene od CMYK boja u koracima po 20% pokrivenost*

They do not include the quality of the material on which the dye will be applied, such as the important qualities of mutual transparency and colour penetration in paper. No attention is given to the light falling on the printed surface, which means that it does not take into account the reflection and the absorption of light. The ultimate color experience is left to the naked eye.

The digital printing for this work is carried out using a conventional toner on the OKI-ES5431. Each of the colours: cyan, magenta, yellow, green, red, blue and black are printed in the C steps coverage with the distance of 20%.

The tags are: M, Y, G, R, B and K. There are two types of grey dyes. The first, grey colour (black K) emerged as the part of a black colour with the print on a white paper. The other grey (black S) colour is created by an equal amount of mixture of cyan, magenta and yellow. In this paper, this grey colour is marked with S.

The green colour is programmed in equal shares of yellow and cyan. The red colour is printed with equal amounts of magenta and yellow. Blue is the mixture of magenta and cyan.

2. Visual and near infrared spectroscopy

2. *Near infrared spectroskopija*

This article provides a graphical presentation of dyes, inks and toners as their absorption of light from 400 to 1000 nm. The "VZ design area" is divided into three sub-areas: V (visually 400 to 700 nm), Z1 (transition 700-800 nm) and Z2 (800-1000 nm) as the first part of the near infrared spectrum. The spectroscopy is made for printing colors which gives the more precise description of colors where the absorption of light depends on the wave length of light. The color is measured from the print by forensic instrument - Projektina 4000.

Yellow, magenta and cyan dyes have peak absorption at 460, 560 and 700 nm respectively. Green colour has two peaks exactly at the places of their components C and Y. Blue has a peak in the same place as cyan, but has a "raised knee" at 600 nm, due to the super-position of cyan and magenta. Red color has a peak in the same location as magenta (650 nm). An additional knee appears at 460nm due to the equal share of yellow coverage.

All the mentioned (six) dyes do not have a positive light quality absorption above 800 nm. Blue and cyan colors extend their positive absorption qualities beyond 700 nm into the Z1 transition area.

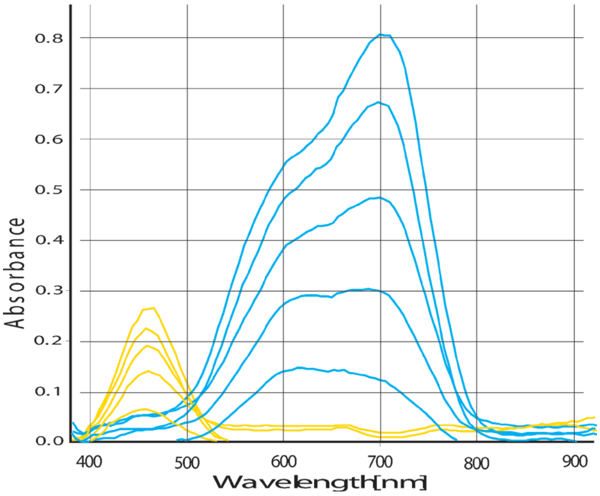

Figure 2 *Chart Y, C*

Slika 2 *Grafikon Y, C*

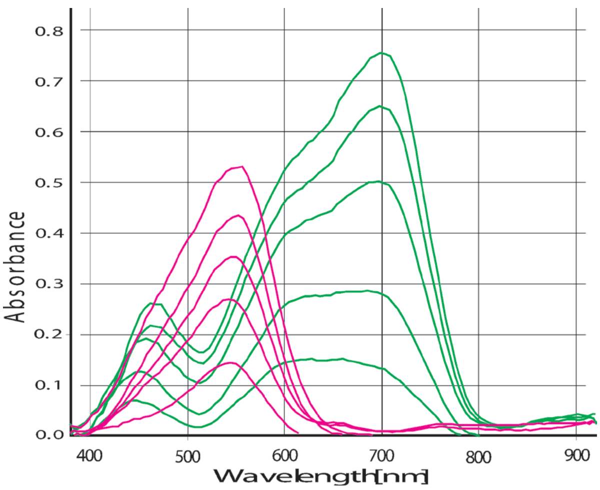

Figure 3 *Chart M, G*

Slika 3 *Grafikon M, G*

Since S dye consists of C + Y + M dye, this colour does not absorb light above 800 nm. The eye then experiences colour S as black. On the contrary, black toner, K black, called "Carbon black" absorbs light beyond 800 nm.

The focus of the entire experimental VZ design is to mix all colors with each other. A theory called INFRAREDESIGN has been developed since there are two black S and K colors that are the same to the naked eye but differently absorb light above 800 nm.

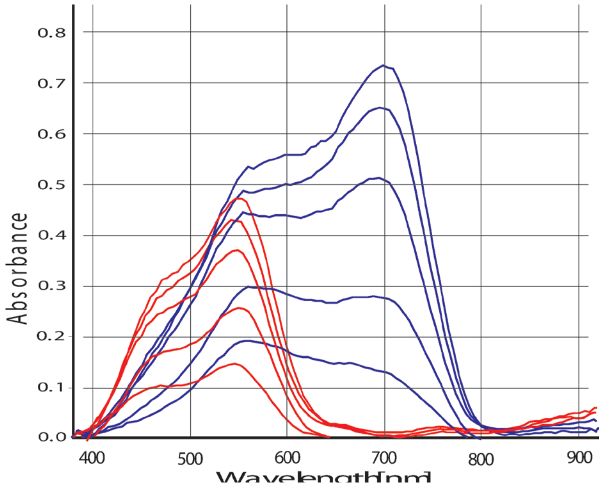

Figure 4 *Chart R, B*

Slika 4 *Grafikon R, B*

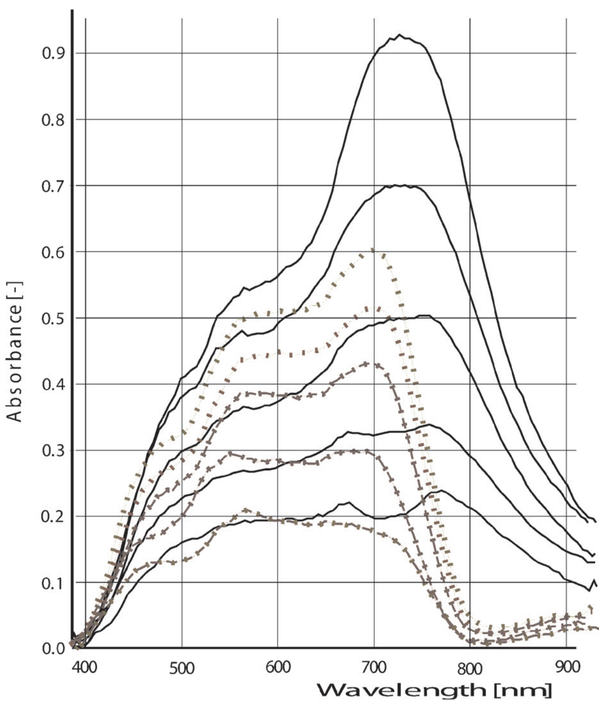

Figure 5 *Chart S, K*

Slika 5 *Grafikon S, K*

It can be said that the feature of printing dyes is strictly separated on V dyes and Z dyes, or on CMY and K dyes, which is the basis of algorithms for VZ computer graphics. While this colour mixing process is ideal for VZ design with conventional printing technologies, the process does not apply to the painting of the belle art. This is due to the many colorants for paints that have their own, different qualities of absorption of the NIR light.

3. Twin colours and dyes in the V and Z spectrum

3. *Blizanci boja u V i Z spektru*

Each color tone is executed in two components of processed colours, including digitized printing: cyan, magenta, yellow and black. The first colour component, named V (visually) has no positive qualities of absorption of the NIR radiation. The second colour (the same tone as the first dye) has a positive response to the NIR radiation. In this paper, the second colour is called the Z colorant, and in this case a camera distinguishes the V and Z dyes [2]. A variable ΔZ is introduced that measures the difference in the absorption of two colour dyes of the same tones at 900 nm in the NIR area. Both colorants have the same spectrograms in the visual spectrum (400 to 700 nm).

For the purpose of this paper, the spectrograms of brown colorant (Figure 6) are shown in the range of 400 to 900 nm. The NIR light area is divided into two parts: Z1 and Z2. The IRD technology with VZ separation is applied onto transparent material for the printing of the large quantities of labels [4]. Although, the two images are transparent, collision-free, colour settings have been achieved with regression of maths VZ models for a wide range of colours.

In colorimetric, there is a measurement size ΔE as a measure of the equality of two colors produced by different printing techniques and colour combinations in particular with combination with carbon black [5]. ΔE only applies to the V range of light. The VZ technology introduces a measure of ΔZ which measures the colour difference and equality of Z2, or shorter; "in the Z spectrum".

It has been developed about hundred of colour settings in computer programs connected to colorants and the materials to be coloreud in actual printing industry. The real experience has proved that there is no definite solution. For, even little deviation is reflected as "unhidden - visible image". The aim towards the achieving "invisible graphics" is smiting [6].

The experimental design about determination of colour equality is a long term process because the colour composition depends on four process colours and two modes of mixing the dye. Which direction should be taken as reinforcement in order to achieve equality ΔE with given ΔZ, and perhaps with gradual decreasing of the amount of each component? The graphic presentation of each component in the colour mixture is a good direction which will satisfy both ΔE and ΔZ in fewer iteration of printing experiments. In IRD plan of determining the twins, it is important to determine the concrete Z size. Most experiments are directed towards the value of K by 40%. IRD is a variant of GCR. Special variant of GCR with given K, or a variant with high precision of ΔE but with given ΔZ differences. The difference ΔE is visually tested. Simple task: picture Z must neither appear nor be seen with the naked eye.

Brown colours with different process dyes are derived in the iterative printing test on the OKI printer. Colour Z is set with parameters: C=0, M=40, Y=60, K=40. Solutions for the V-twin dyes are displayed in three colours: V1, V2, V3. The differences are:
ΔE1= 3,8; ΔE2= 2,8; ΔE3= 4,2.

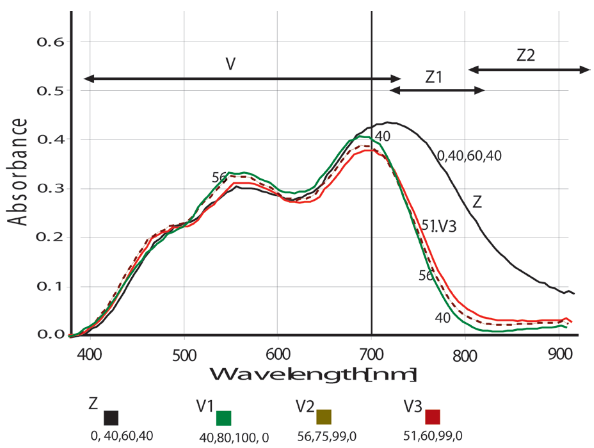

Figure 6 *The spectrogram of brown twin colour*
Slika 6 *Grafikon spektra smeđih blizanaca boja*

Enhanced results are achieved by doing experiments in the following press iterations. Spectrographic curves direct to the increase and the decrease of the individual process of CMY components. The three-step results stress the need to increase the cyan and reduce the yellow and the magenta. The value of ΔE does not give or suggest the next CMY composition change. In practice, VZ reproductions are the given RGB values and the transition to the CMY dyes is called the X0 state of the coverage of a single pixel. Item Z is also given as a grey picture which equals to NIR observation by Z camera in near infrared spectrum. The result of the VZ separation is CMYK40IR or shorter X40.

4. Conclusion

4. *Zaključak*

INFRAREDESIGN [1] is a new innovative technological achievement in the press that enables the process of hiding images, creating double images at the same place and creating an "invisible image". Spectrograms of process colorants are the basis for studying the area of light absorption in the V and Z-spectrum. Values ΔE and ΔZ are merely simple numerical values that do not distinguish the composition of process components in the default colour tone. Minimization of ΔE with the default value Z is the iterative experimental printing. The spectrographic representation of the colouring components is first performed for each printing technique, colour type, and material to be printed on, and spectrogram of common mixtures. The aim is to improve the experimental design, identify the most problematic process component and thus reduce the amount of iterations in determining the twins of VZ colours and dyes. The greater number of successful VZ colour twin form a data set in the VZ colour separation base for calculating parameters of regression equation dependence X40 on X0. This is the way to achieve a high-quality VZ print reproduction of colourful images with the default Z image that is invisible to the naked eye.

5. References

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AUTHORS · *AUTORI*

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Korespodencija

jziljak@tvz.hr