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HIDDEN INFORMATION WITH INFRAREDESIGN

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Abstract: *The article gives an algorithm for near infrared region (NIR) that contains hidden information derived as a vignette in the security printing. The motif is implementation of line solutions for graphics that are designed with colors in the visual spectrum (VS) but with the double property: one picture response in the NIR and the other is seen in the VS (400-700 nm). The algorithm is based on Bezier method with symmetrical development and planned visibility using the specific properties of dyes, their absorption of light in the near infrared spectrum. The goal is to show type that is hidden from the human visual area and is presented in three conditions: completely invisible, transition state, and instrumentally visible under the 1000 nm. Relations and parameters are given for three different color tones, which are also procedures for the development of double images in the security printing.*
Key words: *near infrared graphics, Infrared design, hiden information*

1. INTRODUCTION

Security graphics are designed with linear elements as a traditional form of anti-duplication process for protection. Scanners are not recording spot color, but its equivalent in the RGB system, which will be translated in the CMYK system of reproduction. Printing difficulties in maintaining the register of polychrome printing are at the same time detector in identifying forgery that came along with the process colors. Special spot colors for banknotes and secured documents cover ultraviolet (UV: 200-400 nm) and near infrared spectrum of light (NIR: 700-1200 nm). UV spot colors are either invisible or visible in all hues of HSB crossing from one state into some other default state in the visible (VL) space from 400 to 700 nm. Infrared area is invisible to our eyes. “Infrared color" is a color that has its own HSB stage in VL but it can be recognized by the instruments in the NIR. Recent works on the NIR coloring provided procedures of defining NIR spot colors with the mixing of process CMYK colors. With this system double image (Vila; Ferrer & Garcia, 2007) management was achieved, with the goal of concealing two images on the same printing surfaces. One image is visible in the VL and the other in the NIR wavelengths. Two independent information are planned in two different stages so that scanning cannot read both images. Instrumental recording gets only one image. To connect the two heterogeneous visual images we need software that respects the theory of merging images intended for mutual hiding of information using graphic techniques.

2. ALGORITHM OF VIGNETTES

Bezier curve is defined by four points. In the continuity Bezier line is extended with three points. Postscript definition of these three points searches for six parameters at the top of the stack. The last two data: XD and YD are the coordinates of the first Bezier curve tension as the relative distance from the start line. The starting point of Bezier curve was implemented before the implementation of the Beziers' series for which data variables XM and YM are reserved. Since Bezier curve, in these experiments, is symmetrical, the only information needed is length of the semi-period wavy line, which is given by the size of XP. Based on the draft of wave progress in Fig. 1, a command is created named /val with two Bezier curves that will be repeated N times.

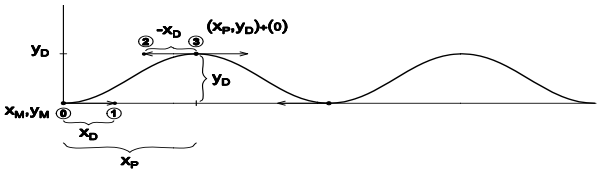

Fig. 1. /val: waves with Bezier points

Command for the N waves is given as:
/val {N {XM XD add YM XM XP add XD sub YM YD add XM XP add YM YD add curveto XM XP add XD add YM YD add XM 2 XP mul add XD sub YM XM 2 XP mul add YM curveto /XM XM 2 XP mul add def} repeat} def
The same variable "/val" is used as a linear graphic and also as a object of surface with corrugated borders.

3. EXPERIMENTS AND DESIGN OF VIGNETTES FOR NEAR INFRARED SPECTRUM

Computer graphic is derived by algorithm for tri-color spot printing. All colors are blended on the principle of infrared colors (Yousaf&Lazzouni, 1995), (Mccann, 1998) with the same tone in the visual spectrum. Color setting values are respected for the real spot color with which the security vignettes will be printed. Three different groups of values for three spot colors, and the same color tone (HUE) are given in the Tab. 1. This table also gives values that describe the command "val". These positions are: first, the invisible colors of NIR light, second; maximum response in the NIR and the values of half intensity appearance in the NIR.

No. exp.	Line 1 : XM, YM, YV, XD, XP, YD, N	Line 2: XM, YM, YV, XD, XP, YD, N	Line 3: XM, YM, YV, XD, XP, YD, N
1	40 230 40 39 30 18 20	40 235 23 18 40 15 15	40 220 60 6 15 23 40
2	25 230 40 -20 31 18 8	25 235 23 18 40 15 6	28 220 60 56 31 23 8
3	25 230 40 -20 31 18 8	25 235 23 60 40 15 6	28 220 60 -56 31 23 8

Tab. 1. Groups of values for the three spot colors

Spot colors are described through the CMYKIR process values because that exact system is not in the known examples that could be found on the market. Figure 2 represents two vignettes shown in the VL, and in two more illuminations in the NIR: 700 and 1000 nm.

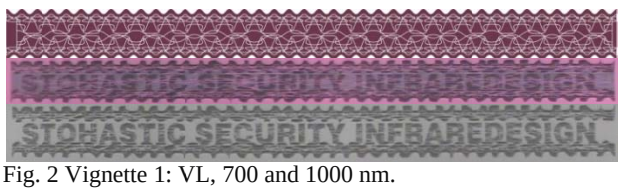

Fig. 2 Vignette 1: VL, 700 and 1000 nm.

Colors are listed with the VL RGB values: Lab, HSB (Chen&all , 2008).

K is the default value of carbon black. The values of the first experiment were:

$$V=\begin{bmatrix} \mathrm{R} & H^0 & \mathrm{L} \\ \mathrm{G} & \mathrm{S}\% & \mathrm{a} \\ \mathrm{B} & \mathrm{B}\% & \mathrm{b} \end{bmatrix}; X=\begin{bmatrix} C \\ M \\ Y \end{bmatrix}; \quad X=X_0-E^*\begin{bmatrix} K \\ K^2 \end{bmatrix};$$

$$V_1=\begin{bmatrix} 108 & 336 & 32 \\ 55 & 49 & 33 \\ 77 & 42 & 1 \end{bmatrix}; \; X_0^{Xeikon}=\begin{bmatrix} 53 \\ 85 \\ 43 \end{bmatrix};$$

$$\mathrm{E}^{\mathrm{Xeikon}}=\begin{bmatrix} 0.14233 & 0.00953 \\ 0.16256 & 0.0005 \\ 0.11428 & 0.00763 \end{bmatrix};$$

Z value for the color of the first experiment is as follows: 63% of the intensity of response at 1000 nm (NIR).

This is used to measure appearance of the hidden power of graphics. In illuminations with 1000 nm, the first color is not visible anymore and what is left is the distinct reflection of a third color that carries major hidden information.

Second experiment (Fig 3.) observes the tone of color with minimal blue component. Its value is described in the V system as follows:

$V_2=\begin{bmatrix} 117 & 50 & 65 \\ 151 & 87 & 5 \\ 23 & 69 & 72 \end{bmatrix}$; value of Z response at 1000 nm is 41%:

The color of third experiment has values:

$$V_3=\begin{bmatrix} 54 & 186 & 41 \\ 108 & 53 & -29 \\ 114 & 45 & -13 \end{bmatrix}$$

value of Z response at 1000 nm is 50%:

The third experiment (Fig 4.) shows a freer definition of Bezier curve tension. In its development shapes of "eight" are obtained. The same is applied to a form of graphic where objects are filled up and on white protecting lines as well.

Three levels of spot colors in the NIR is another proof that it's possible to manage a wide range of reflection and absorption of light in a continuous area that includes the VL an NIR.

White lines in our examples were deliberately designed as an obstacle in identifying the possible printing errors. These lines will act as a visual disorder due to the imperfect determination of spot printing colors, which should be equal in the visual spectrum. The lines are designed with the algorithm "/val" but with unsystematic parameters, regarding the tricolor spot lines intended for hiding information. Increasing of the protective effect was done using lines in the NIR colors. These lines intersect the main hidden information. The entire project of graphics ensures that the text information is still legible enough.

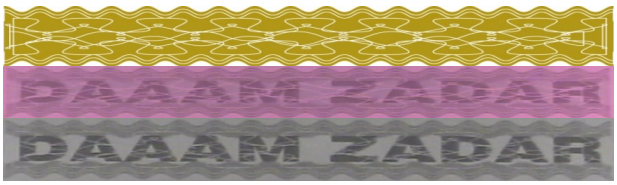

Fig. 3. Vignette 2: VL, 700 and 1000 nm

4. DISCUSSION

On the market there are no spot colors that are paired or in three or more implementations with the same VL features. This is also advantageous for individual solving of the security printing. Multilayered infrared print in all stages of preparation is prepared in the printing company that produces secured print. In no case the infrared color is bought from the printing ink manufacturer. Three people are responsible for successful implementation of vignettes on the banknotes and secured documents: designer for tone color, the person that mixes paint and pressman that will make corrections prior to mass

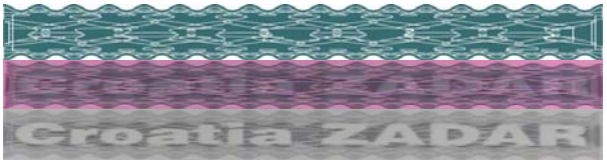

Fig. 4. Vignette 3: VL, 700 and 1000 nm

reproduction. They create their own ‘code’ of the spot color with the same group of HSB values and with planned response in the NIR.

Vignette is a procedure performed as a computer graphics algorithm that provides high-precision graphics that are each mutually planned. This paper presents the development of graphics using Bezier curve, but what is also suggested is the use of various functions arising as original language. Even more complicated results would be obtained if the mixed PostScript commands (Pap,& all , 2010) are used which implies periodicity of totally different primitive trigonometric relations. Our experiments were directed to add planned infrared response to the graphical form. One of the results is a suggestion to graphic designers of secured print, that the increase in NIR color tones to four or five is a difficult task for printing and maintaining the registry. Because the task of such security printing implies that there is no overlapping of colors, and that there is no expansion or narrowing of the single spot color area. Printing techniques require high register.

5. CONCLUSION

Printing inks possess properties of responding in the infrared spectrum. Knowing these properties (Green, Holm.& Li , 2008) it's possible to create individually mixed colors with projected appearing in the NIR. The same hue can be implemented as invisible in the VL and gradually recognizable in the NIR. This paper emphasizes the recommendation that the infrared spot colors are mixed and developed by the security printing industry and not by the printing ink manufacturers. It allows the creation of the planned double information that protects each other from copying and reproduction. Proposed are three-level spot VL / NIR dyes in the same secured graphic element, with equal HSB values. The algorithm has independently defined parameters of design and is suitable for the individualized design with mathematical interpretation known only to its author.

6. REFERENCES

Chen Y.D.; & all (2008), Multi-ink color-separation algorithm improving image quality, *Journal of Imaging Science & Technology*, 52(2):NIL_71-NIL_79.

Green P.; Holm J.& Li W., (2008), Recent Developments in ICC Color Management. *Color Research&Application*, 444-448, John Wiley & Sons, Dec., ISSN 0361-2317

Mccann J.J.,; (1998) 'Color theory and color imaging systems - past, present and future', *Journal of Imaging Science &Technology*, 42, (1), 70-78

Pap, K.; & all (2010) Image Reproduction For Near Infrared Spectrum And The Infraredesign Theory, *The Journal of imaging science and technology*. 54, 1; 10502 -1-10502 -9

Vila A.; N. Ferrer & J.F. Garcia, (2007) 'Chemical composition of contemporary black printing inks based on infrared spectroscopy: Basic information for the characterization and discrimination of artistic prints', *Analytica Chimica Acta*, 591, (1), 97-105

Yousaf M.; M. Lazzouni, (1995) *"Formulation of a invisible infrared printing ink"*, Dyes & Pigments, 27(4), pp. 297-303