

SIGNIFICANCE OF INFRARED TWIN DYES IN DESIGN OF HIDDEN INFORMATION

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Abstract

New methods of visual communication have been set up through InfraRed design. Discussion on visual discovery and concealment of information in visual and infrared spectrum was carried out using twin dyes. Recipes of twin dyes are made for the desired color tones. Double visual graphics are printed whose motifs are determined by the designer. InfraRed information is associated with visual content without distorting graphics in the visual spectrum. The usage of the IR camera on the prints reveals messages hidden from the human eye. Displayed are hidden information associated to the visual content through InfraRed design. An innovative way of visual communication finds a wide area of use for protective and promotional purposes. Twin dyes open up a new space for design in the expanded visual space in the digital environment.

Key words: twin dyes, hidden information, InfraRed design, security print, visual communication

1. Introduction

The paper shows the significance of Infrared twin dyes in design of hidden information. As color is caused by the experience of different visual stimuli and the color space is defined in the light spectrum, the color space which creates the sensation of color in our eyes, is limited to the range from 400 to 700nm. Colors realized as dyes or paint matter found within this color space are named Visual (V) dyes. Colorants extending beyond the visual spectrum are named Infrared (Z) dyes. V dyes have visibility only in the visual spectrum where the Z dyes have a response both in the visual and the spectrum defined by measuring absorption of infrared light at 1000nm [1], [2], [3]. Made are sets of twin dyes where each set of two twin dyes has the same color tone and identical $L^*a^*b^*$ value, but each twin is made from different recipes, which results in different responses in the infrared spectrum [4], [5].

Defined are twin dyes through process dyes cyan, magenta, yellow and key color, for the visual and infrared spectrum and by minimizing ΔE for the digital and offset print. For each color tone I have used in the experiments made, first the recipes for twin dyes were hand mixed. By viewing each of the twin pairs under the infrared camera, the success of the recipes is proven as the V twin disappears under the camera and the Z twin stays visible at 1000nm [6], [7].

After hand mixing the twin dyes, set up are recipes for digital printing of the same color tone and their CMYK values are shown in the research. The value of the Key tone is set to 0 for the V dye and the values of K for the Z dye is set on 20 and on 40, depending of the desired darkness and visibility level of the dyes response in the infrared spectrum.

2. The connection of visible and hidden visual content

Through design using infrared twin dyes new methods of visual communication have been set up. Double image design was previously carried out with the InfraRed design method on various media such as in newspaper print [8], print on leather [9], polymer food packaging [10] and postage stamp design [11], [12]. The aim was to secure the graphics and create an extended space for information with the visual space already being flooded with so much information, which makes it hard to create a focus.



Visual V spectrum

Infrared Z spectrum

Figure 1. Shown is a detail of a photograph of nature in the V spectrum connected through infrared twin dyes with a map visible only in the Z spectrum

Experiments of double imaging with infrared twin dyes were made on maps [13], [14], [15], [16], [17], [18], [19]. The IR cartographic system makes a new area of protection. In my Doctoral Dissertation with the title Twin dyes for security printing in infrared mapping [20] proven was that Infrared cartography is an improvement in the methods of Infrared design. It introduces and extends the Infrared design theory to cartographic documents. Achieved is an innovation and improvement of design methods through infrared technology.



Visual V spectrum

Infrared Z spectrum

Figure 2. Shown is double image print on textile showing a map visible with the naked eye and a typographic message detectable only with the ZRGB camera

The reproductions shown carry two pieces of information, one visible to the naked eye, and the other with the infrared cameras at 1000nm, printed on textile [21], [22], [23]. Produced are double graphics connecting photography and maps as shown in Figure 1. and a map and a hidden poem in Figure 2. Displayed are hidden information associated to the visual content through InfraRed design. An innovative way of visual communication finds a wide area of use for protection of the originality of a work and also for promotional purposes. Made are double visual graphics whose motifs were determined by the designer.

3. Conclusion

The aim of the research was to determine the possibilities of marking graphic elements in extended visual space. Shown is the variety of motives which can be placed either in the V or Z spectrum, connected through twin dyes. InfraRed information is associated with visual content without distorting graphics in the visual spectrum. The usage of the IR camera on the prints reveals messages hidden from the human eye. I can conclude that twin dyes open up a new space for design in the expanded visual space and visual communication in the digital environment. The new task for designers is multiple layer planning. New design technology evolves which uses classic printing.

4. References

- [1] Žiljak, Vilko; Pap, Klaudio; Žiljak, Ivana // CMYKIR security graphics separation in the infrared area *Infrared Physics and Technology* Vol.52. No.2-3, ISSN 1350-4495, Elsevier B.V. DOI:10.1016/j.infrared.2009.01.001, (2009), pp 62-69
- [2] Pap, Klaudio; Žiljak, Ivana; Žiljak-Vujic, Jana // Image reproduction for near infrared spectrum and the Infraredesign theory // *Journal of Imaging Science and Technology*, vol. 54, no. 1, pp. 10502-1-10502-9 (9), (CC, SCI, SCI-Expanded) (2010)
- [3] Žiljak, Vilko; Pap, Klaudio; Žiljak Stanimirović, Ivana; Žiljak-Vujić, Jana // Managing dual color properties with the Z-parameter in the visual and NIR spectrum // *Infrared Physics & Technology*. Vol. 55, Elsevier B.V. (2012); ISSN 1350-4495, pp. 326-336
- [4] Žiljak-Stanimirović, Ivana; Žiljak-Vujić, Jana; Matas, Maja // Infrared colorants as twins for security printing of documents and securities // *International Circle of Educational Institutes for Graphic Arts: Technology and Management*, (2013), pp 28-35, Toronto, Canada
- [5] Pogarčić, Ivan; Agić, Ana; Matas, Maja // Evaluation of the colorant twins for the neutral gray spectar in Infrared Graphic procedure // *Tehnički Vjesnik* 23 (Technical Gazette), 132 (2016), 6; ISSN 1330-3651 (Print), ISSN 1848-6339 (Online), DOI: 10.17559/TV- 20150303132036, pp 1659-1664
- [6] Žiljak, Vilko; Pap, Klaudio; Žiljak-Stanimirović, Ivana // Development of a prototype for ZRGB Infraredesign device // *Technical Gazette*. 18 (2011), 2; pp 153-159
- [7] Žiljak, Vilko; Žiljak Stanimirović, Ivana; Pap, Klaudio // ZRGB aparatura za dualnu detekciju // *patent P20100451A, Hrvatski patentni glasnik*: 2, (2012), pp 367
- [8] Barišić, Mario; Pap, Klaudio; Žiljak Stanimirović, Ivana; Žiljak, Vilko // Double image design in newspaper production // *Acta Graphica*, Vol. 21 (2010), ISSN 0353-4707 (INSPEC), pp. 27-33
- [9] Žiljak, Vilko; Akalović, Jadranka; Žiljak-Vujić, Jana // Upravljanje bojilima na koži u vizualnom i infracrvenom spektru // *Tekstil*. 60 (2012), 8; pp 355-363
- [10] Friščić, Martina; Međugorac, Olivera; Tepeš, Lidija; Jurečić, Denis // Invisible information on the transparent polymer food packaging with infra v/z technology // *TTEM, Technics Technologies Education Management*, Vol 8/4 (2013); ISSN:1840-1503, e-ISSN 1986-809X, pp 1512 -1519
- [11] Matas, Maja; Rajendrakumar, Anayath; Hoić, Ana // The role and significance of a designer in postage stamp design with infrared graphics // *Tiskarstvo & dizajn* 13, (2013), Tuheljske toplice
- [12] Žiljak Stanimirović, Ivana; Žiljak Vujić, Jana; Matas, Maja // Infrared colorants as twins for security printing of documents and securities // *45th Conference of the International Circle of Educational Institutes for Graphic Arts Technology and Management (IC)*, Toronto, Canada, (2013)
- [13] Matas, Maja; Žiljak, Vilko // Black twin colors on topographics maps in digital print. // *Acta graphica*. 3-4/14 (2014) ; pp 51-56
- [14] Žiljak Vujić, Jana; Matas, Maja; Pogarčić, Matej; Žiljak Stanimirović, Ivana // Topographic Maps with Infrared Colors// *Procedia Engineering*, 25th DAAAM International Symposium on Intelligent Manufacturing and Automation, 2014 / Katalinic, Branko (ur.). Vienna : DAAAM International, (2014), pp 928-935
- [15] Ivana Žiljak Stanimirović, Maja Matas, Matej Pogarčić, Jana Žiljak Vujić // Spot Colorant Twins for Infrared security print of Topographic Maps // *46th Conference of the International Circle of Educational Institutes for Graphic Arts Technology and Management (IC)*, Greece, (2014)
- [16] Matas, Maja. // Bojila blizanci infrared kartografije // *Međunarodni dan boja 21. ožujka 2015, tema Boja u okruženju. / Grancarić, Ana Marija ; Glogar Martinia Ira ; Parac-Osterman, Đurđica (ur.). Zagreb : Hrvatska udruga za boje, (2015)*

- [17] Matas, Maja; Politis, Anastasios; Žiljak, Vilko; Pap, Klaudio // Simulation of spot colorants for cartographic printing in the visual and infrared security CMYKIR system // Tiskarstvo & dizajn 2015. / Žiljak Vujić, Jana (ur.). Zagreb, 4, (2015)
- [18] Matas, Maja; Žiljak Stanimirović, Ivana; Politis, Anastasios; Pap, Klaudio // Infrared spot twin inks for the protection of cartographic print // International Circular of Graphic Education and Research, No. 8, (2015), The International Circle of Educational Institutes for Graphic Arts: Technology and Management, ISSN online: 1868-0879, print: 1868-0712, pp 37- 43
- [19] Matas, Maja; Stanić Loknar, Nikolina // Blizanci bojila kartografskog sustava za vizualni i infracrveni spektar // Međunarodni dan boja 21. ožujka 2016, tema Boja u znanosti i umjetnosti / Grancarić, Ana Marija ; Glogar Martinia Ira ; Parac-Osterman, Đurđica (ur.). Zagreb : Hrvatska udruga za boje, (2016)
- [20] Matas, Maja; // Twin dyes for security printing in infrared mapping // Doktorska disertacija, Sveučilište u Zagrebu, Grafički fakultet (2017) <http://eprints.grf.unizg.hr/id/eprint/2781>
- [21] Žiljak Stanimirović, Ivana; Žiljak Vujić, Jana; Stanić Loknar, Nikolina // Marking of the camouflage uniform for visual and near infrared spectrum // Technics Technologies Education Management, Vol. 8, No3 (2013)
- [22] Hoić, Ana; Žiljak Vujić, Jana; Matas, Maja // Inovativno korištenje InfraRed dizajna na tekstilu u promotivno-izložbene svrhe // Međunarodna konferencija tiskarstva, dizajna i grafičkih komunikacija Blaž Baromić, Senj, (2016)
- [23] Matas, Maja; Žiljak Vujić, Jana; Hoić, Ana // Hidden information on textile design for the visual and infrared spectrum // Polythentic & Design, Vol4, No3, (2016), DOI: 10.19279/TVZ.PD.2016-4-3-13