Infrared spot twin inks for the protection of cartographic print

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Introduced are spot twin inks with infrared non visible colors for the cartography system which provide protection of the printed information. Inks used for such documents are used specific for each element in double layers of the visible (V) and invisible (Z) twin system. Dark blue twins mark names of water areas, greens mark green vegetation surfaces and blacks mark build objects, roads and area names. In the paper three typical spot inks are multiplied with their ink twin of equal color tone, but with a different response in the infrared region. The goal is to select the information. Introduced is the usage of infrared spot inks mixed according to the offset printer. The printers create recipes for visible and invisible inks according to the Infraredesign theory, for the cartographic print. Three of the cartographic spot ink twins are used for the introduction of new forms of protection for maps and plans with cartographic information. Each ink is in the prepress in his own layer. Twin inks ensure clear information in the infrared spectrum, other inks used in the print lose information in the IR range. The Z - infrared value of the twin inks is set on 1000nm. The Z value of the V inks is zero. Set is a new way of creating security colorants, while respecting given official guidelines. Proposed is the change of ink composition for the system that determinates cartographic colorants, in order to protect information on the documents. The importance of cartographic data is the protection of the author's work in all processes of the prepress and press. The documents authentication is possible with the usage of the ZRGB camera in providing accurate information. The proof of the forensic state of such record is stated in eight decade with blockades between 700 and 1000nm.

1. Introduction

Cartographic information are printed with spot inks which are mixed prior to printing. "Twin inks" [3] is a term for two inks that have delta E less than 3 in the visible spectrum, and significantly different absorption value in NIR area. Inks are used specific for each element in double layers of the visible (V) and invisible (Z) twin system. Introduced are procedures for hidden information within the cartographic system [5], [6] using ink twins. In this paper the blue, green and black inks are set in the double state. The visual layers are doubled with their twin layers with a response in the infrared spectrum. The hidden information is only seen instrumentally at 1000 nm and undetactable with the naked eye.

Figure 1 shows fifteen decades of the electromagnetic spectrum of sunlight. Viewing of the phenomenon "dual graphics" is located in the eighth decade. In that decade, the human visual area is located which begins

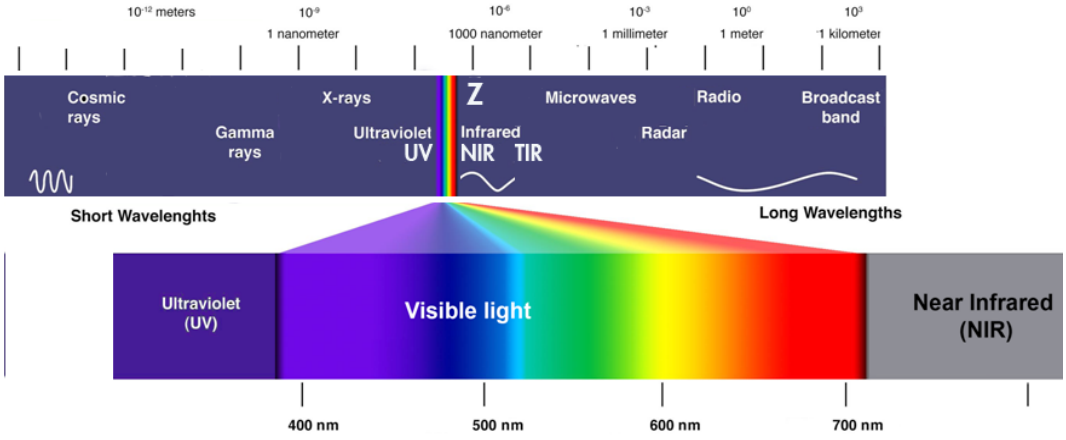

Figure 1: RGB color area within the solar spectrum

with 400 nm, and allows us to experience the RGB colors. 700 nm to 800 nm is the transition area. After that begins the near infrared. This area between 800 and 1000 nm we call Z spectrum and is invisible to the naked human eye. The eighth decade ends in point Z at 1000 nm [8].

2. The map and respective layers

Figure 2 map shows a part of the Croatian city Osijek. It hold all map elements – hights, build objects, river and water areas, green areas and boarders of the green areas. The maps is made of six combined visual V layers and three infrared Z layer. The Z layer holds the black ink with dual properties, visible in the visual and infrared spectrum.

The visual state of the map with infrared inks is exactly the same as the visual state of the map without the IRD intervention. With the inrared extention there is no interferance with the visual of the topographic map.

The Color green represents forests and meadows. The situation in the real world is changing, so some parts of the forest are converted to arable fields, new settlements, new roads. The state (in terms of the IRD, for example) of the current situation and of the situation twenty years ago is displayed in the same imprint using green twin inks. The new state is solved with V ink twin. The old state of the green areas is observed in the infrared spectrum. On the figure of the "green layer" Z layer (marked in red) is added, which will also be printed in green, but with the Z green ink that strongly absorbs the infrared spectrum. The dark green layer marks the

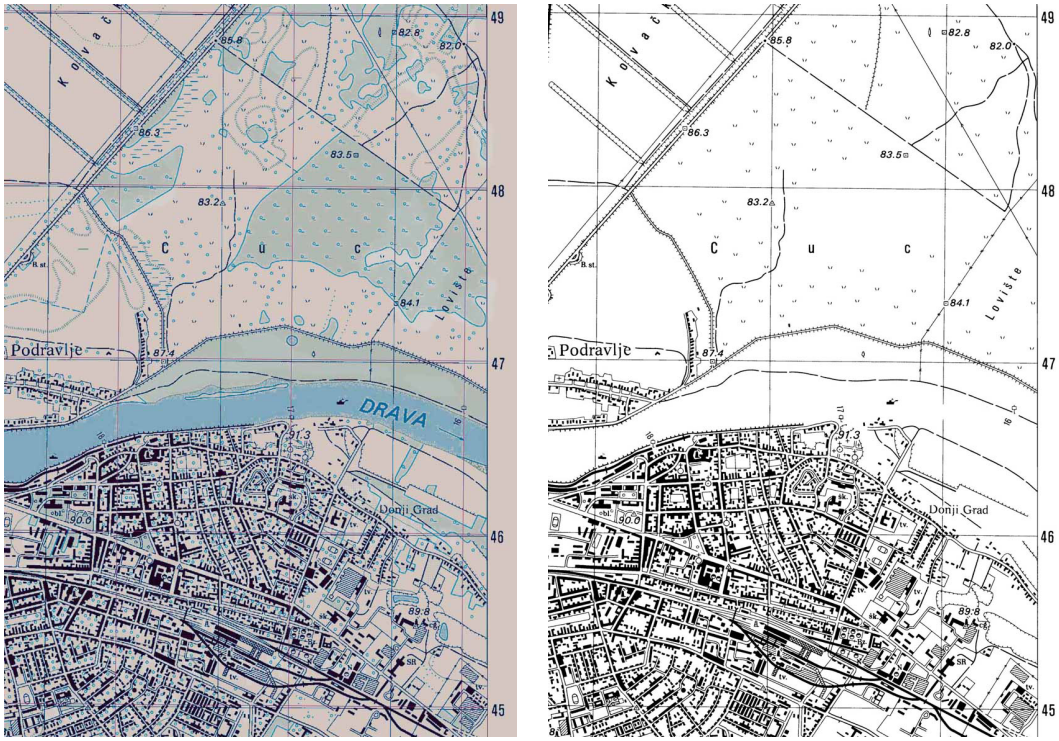

Figure 2: Left: Map of the Croatian city Osijek, Right: The black layer marks built objects, paths and area names. The state of the layer is the same (black) as in the print

Figure 3: Two green layers, show green vegetation areas and boarders of the green areas with trees

Figure 4: Figure 6: The brown layer marks hights, terrain elevation

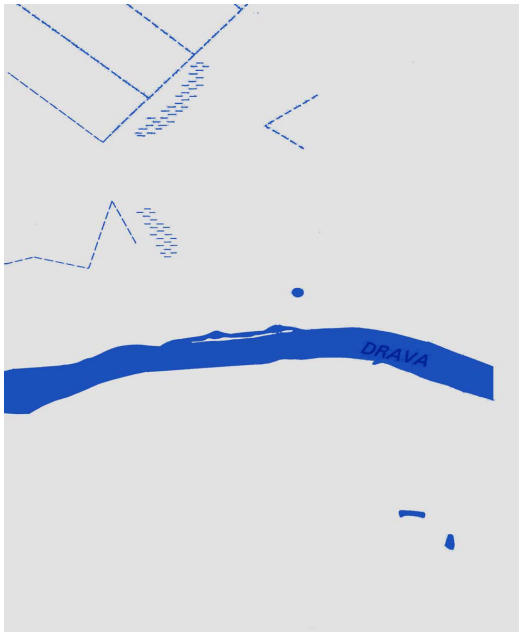

Figure 5: The blue layer, marks river Drava and all of the the water channels on the map

boarders of the vegetation areas marked with the light green on the map.
The Color green represents forests and meadows. The situation in the real world is changing, so some parts of the forest are converted to arable fields, new settlements, new roads. The state (in terms of the IRD, for example) of the current situation and of the situation twenty years ago is displayed in the same imprint using green twin inks. The new state is solved with V ink twin. The old state of the green areas is observed in the infrared spectrum. On the figure of the "green layer" Z layer (marked in red) is added, which will also be printed in green, but with the Z green ink that strongly absorbs the infrared spectrum. The dark green layer marks the boarders of the vegetation areas marked with the light green on the map.

The hight of the terrain rarely undergoes change. Yet for all the layers it is necessary to make twin inks since the hidden Z image is not dependant on the image planed for our eyes.

3. Spectrum of three twin inks: dark-brown-black, blue, green

In an article spectrometers of three color are published, with their twin inks for the offset print on cartographic paper. The twins are set with the same color - RGB values and the effort that their spectrums do not differ much. The criteria of accepting twin inks, their equality in visual spektrum, is measured by the size of the delta E which is less than three. The recipe is performed by iteratively mixing the inks until we reach such a criteria in the visual spectrum. We introduced spectroscopy because twin inks must have their differences outside the human sight in an area that is known with infrared cameras [7]. The goal is to have the same color (V - visual) and different responses of absorbtion of the NIR light in the instrumental establishing of set peculiarities. Thus, we have expanded the meaning of the GCR method, which applies only to selected parts of the reproduction. We can mix inks in several different ways. Instead of the black ink other industrial inks can be used which have strong absorbti properties of the near-infrared spectrum. Many "ultraviolet inks" (area less than 400 nm) from the range of protective inks are of such property, that apsorb infrared light very strong [4]. Such a combination can significantly expand the topic of twins and security graphics since the double vision extends from the ultraviolet, through the visual to the infracrvenon spectrum. The IR camera views only the NIR range and determinates the state on those points of the solar spectrum which have built-in filters [1].

The first ink is dark, near to black. It is conducted in two recipes. In the article we give the recipe through process inks; cyan, magenta, yellow and carbon black, although in real print there can be other recipes which secure the printing house against forgery (since we publish here numerical data)

RGB (0 – 255) 8 bits 2^8 -	72, 54, 54
V twin; C, M, Y, K %	80, 80, 80, 0
Z twin: C, M, Y, K %	72, 76, 66, 40

Table 1: dark color: (Color Setting SWOP coated)

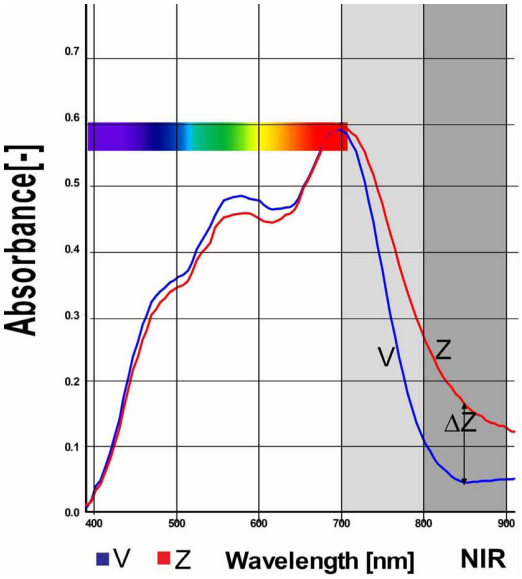

Figure 6: Spectrograf of dark, black color

The absorption of light is given in Figure 3. In the range from 400 to 900 nm carried out on the forensic device Projektina [2]. In the visual spectrum, line graphs coincide satisfactorily thus the goal of equalizing them is achieved. The values of light absorption after 700 nm differ. Line graph of V twin inks (which do not respond to the IR camera) reduce steeper than the line graph with the Z twin inks. The biggest difference in the V and Z twin inks in the NIR spectrum is achieved at 850 nm for the cartographic paper and the ink recipe inks in Table 1. We observe that with such a filter on the Projek-

tina device to get "the instrumental visual image" of the reproduction in the NIR spectrum. In the cartographic layer we separated the information on V and Z data ie. two layers, two printing form.

In this paper we provide the recipe for green twins in Table 2. Using the raster method it is possible to have darker and lighter surfaces of the vegetation for different types of forests and orchards made in the same

RGB (0 – 255) 8 bits 2^8 -	0, 126, 48 (V) 0, 115, 57 (Z)
V twin; C, M, Y, K %	52, 30, 93, 0
Z twin: C, M, Y, K %	30, 8, 70, 40

Table 2: green twins

layer for information control, avoiding that one type of vegetation information goes into another.

Twin inks have light shifts which means that even more work should be done on their visual equalization. However, the print shows good arrangement and the measurement of Delta E is less than 2,00. Printing is done with spot inks which are mixed from „Cromos - Hr" whose absorption properties of light in the visual spectrum are not equal to the SWOP inks. Research on the properties of the twin V and Z inks is always difficult when we want the theory and practice to match perfect equalizing colors. Experience from working in two spectral areas, according to the INFRAREDESIGN theory [4], has many more refining, since we have no information about the spectral sizes of the inks with which we are mixing and produce twins spot inks for the cartographic V/Z print.

Figure 7 is about the spectral light absorption in the range from 400 to 900 nm, measured after the print, shows acceptable equality in the visual spectrum and different sizes in the near infrared spectrum. As in the dark colors (Figure 1) the biggest differences between the V and Z inks are at 850 nm.

The third color with two twins is blue. The color shows water areas. Certain changes in the riverbed and coast finishing are shown through two blue inks. They differ in the infrared spectrum. In Table 3 the values of the recipe for the blue inks are given. The visual size of

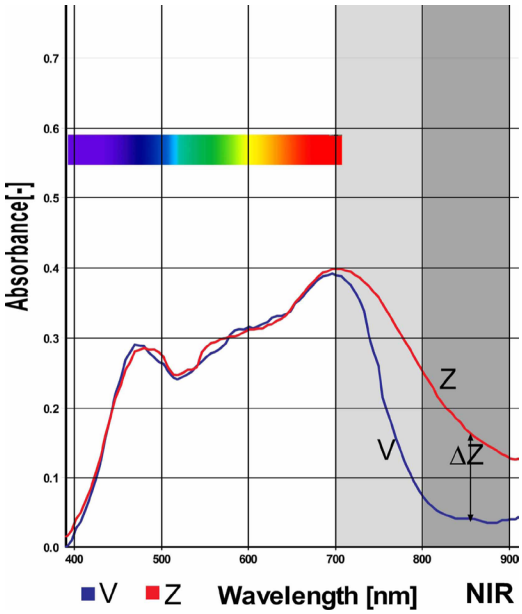

Figure 7: spectrum of green inks

RGB (0 – 255) 8 bits 2^8 -	0, 99, 142
V twin; C, M, Y, K %	99, 48, 40, 0
Z twin: C, M, Y, K %	92, 25, 0, 40

Table 3: blue inks

Inks V and Z have different values in the near infrared spectrum. In the visual spectrum they don't have a perfect match and the value of Delta E (2.90) has reached the limit of acceptance. It is the peripheral area of the IRD practice because of the desire to minimize the yellow component with the default black ink. Such is the case with green twins where minimized the magenta component. The values in Tables 1, 2, and 3 are controlled with digital printing as a base for carrying out the real mixing of spot colors.

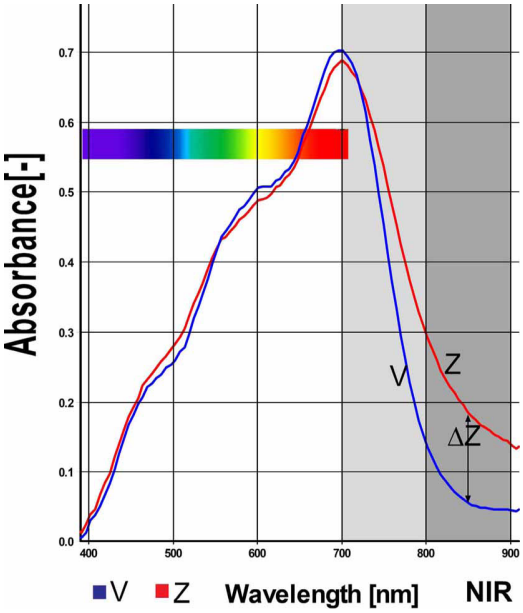

Figure 8: Spektrograph of blue inks

4. Amendment planand the crecion of new information for the NIR spectrum

All layers are subjects to acceptance and taking over values from the Z picture. Therefore they have two conditions. Where there is a a black surface on the Z picture, the print will be done according to the Z twin. The CMYKIR separation also takes into consideration the gray transitional tones [9].

The graphic id displayed with the desired information about changes in the green, blue and dark layers. The production of printing forms iscontrolled with the SPOTIR separation algorithm in order to create the Zx reproduction. The Z image has an integraded text which is used to mark the IC conference, venue and name of the institution where this visual/infrared reproduction is made. The Z image is seperated into as many new print forms as there are layers on the topographic map.

The separation result and final print is shown in Figure 9. All gray «islands» above the text respresent changes in layers of blue and green inks. The reproduction contains the topographic map with a commemorative text hidden from viewing with the naked eye. The printed variant of this study can be obtained from the authors or at the conference itself.

Figure 9: Planned „second" image which enters in the preperation for making plates for the spot print

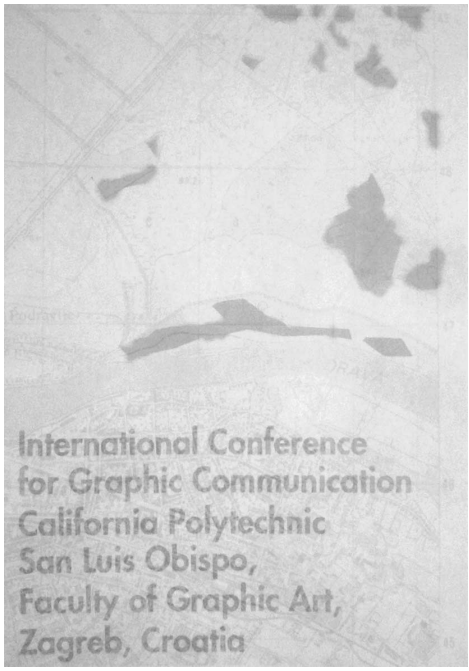

Figure 10: Zx picture after the print, visible with the Z camera at 100 nm

5. Conclusion

Typical application of spot colors lies in cartography. These are not "colorful inks" but every color is associated with a purpose, seamlessly connected with the content. Maps are painted with four, five inks with clearly defined standardized R, G, B values. Blue for the description of water areas and watercourses; green is used to indicate the forest, meadow and orchards. The IRD process provides expanded information stacking for those "reserved" colors. The green color is carried out in several ways using the extended properties of light absorption in the infrared spectrum. The cartography suggests the meaning of changes over time. The state of topographic maps years ago, today, and the plan for tomorrow, for example. Tinting information according to different absorption characteristics in the Z range. Adding "invisible" information in the form of text, drawings, vocational character. In cartography we are introducing the active relationship towards surveillance cameras with infrared filters.

Cartography becomes unique with IRD graphics. Each ink is carried out in several different variants depending on the content due to the Z range. There are no existing scanner procedures, procedures for recording, dividing of two images in the Z state with the aim of IRD reproduction. This protects the printer, publisher, designer, the transport, storage, commerce. Each new edition of cartographic products has a new hidden Z information, and without the prejudice to the question of maintaining maps in the visual experience. The Printer only work from their own interests, for example.

We look at the inks through the spectral analysis gaining information about the ink matter. The spectral analysis gained with the IRD practice new meaning in the printing practices of reproduction and design. INFRAREDESIGN iz Z labeling; quietly, discreetly, with a certain level of secrecy. It is the combination of the coloring technology, printing and the need to secure graphic reproductions. In simple terms: "The new graphic technology in the development of cartographic products."

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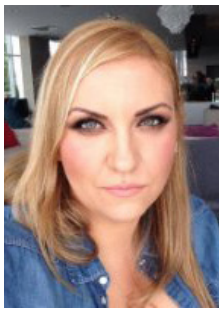

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