

Information about the absorption of light in the near infrared spectrum for colorants used for the reproduction of works of art

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Abstract

The paper presents the application of near-infrared spectroscopy in the determination of twin colorants in two light spectra. The properties of materials used in publishing and book production for hiding as well as displaying dual text and images have been examined. Black colorants are presented in different mixtures of process components: cyan, magenta, yellow and black. For twins of colors and colorants, compositions are determined in order to highlight their duality of light absorption at 1000 nanometers. Different colors are paired with equal values of the absorption of NIR radiation. They are a set of colorants which give a controlled response in the invisible spectrum and show information for NIR cameras around us. In this article innovative methods of dual VZ design in books are published.

Key words: NIR spectroscopy, infrared print, security graphics, twins of colors, colorant analysis

1. Introduction

The INFRAREDESIGN® (IRD) theory has opened up the space for a wide application of dual security print, as well as for a new approach to studying and learning about the properties of materials used in printing [1]. Algorithms have been developed which help achieve hidden information that is visible with a ZRGB camera [2]. The idea started with projects by faculty of the University of Zagreb, Faculty of Graphic Arts with the goal of expanding the methods of security printing [3]. The IRD duality of colorants has been accepted by many authors in order to introduce new precision into graphic arts IT and new ways of describing colors and colorants [4]. The application has found its place in the protection of numismatic material [5]. Significant changes have been suggested and executed in new hidden informational solutions on military apparel [6]. The textile industry has obtained new procedures in design by putting on textiles multiple pieces of information which are observed separately in two light spectra [7]. We have studied many materials and colorants for different printing techniques. The same research is concerned with the developing of new recipes for mixing colorants [8]. INFRARED Art is achieved on various media such as leather, silk and wood. Until painting pottery with a hidden image [9].

Connecting conventional teachings on colors with the teaching on the properties of colorants in the NIR spectrum is important for the hidden image on documents printed using commonly known techniques [10]. A detailed analysis of process colorants is given in the papers presenting spectrograms of process colorants for digital print [11].

A great area for the study of colorants is the visual arts [12]. A new kind of "infrared painting" has emerged and entered in galleries and art museums [13]. Paintings carry a dual creation which is presented as a video transformation of information from visual to near-infrared state [14]. Our papers are directed towards the production of art catalogues and monographs in the form of luxurious books. The goal is for the reproduction to offer expanded information on the artistic creation, to respond in two spectra, similarly to the way original works of art are observed with dual cameras because they were created as a visual and hidden image – hidden from observation with the naked eye. Extensive research has been conducted in order to determine the components of twin colorants for offset printing.

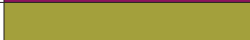




2. Spectroscopy of colorants for monograph printing

The twin colorants have been assigned the abbreviation V (the visual part of the light spectrum) and Z (according to the name of the gallery and the city for "infrared paintings": Zelina, Croatia). Abbreviation

Z is the value of the absorption of radiation at 1000 nm (in the first part of the near infrared spectrum – NIR). Both colorants have equal colors, which is manifested in the experience of the colors as seen with the naked eye. Colorant Z absorbs NIR light. Colorant V does not absorb NIR radiation.

The paper contains graphs of light absorption for twin colorants in two spectra: the visual spectrum (400 to 700 nm) and the first part of the near infrared spectrum. Green, light (yellow) and blue colorants have been executed, each according to two recipes (table 1).

Table 1

No:	V: C, M, Y, K	Z: C, M, Y, K	color	RGB
T90	50, 90, 40, 0	23, 67, 7, 40		140, 21, 92
T62	38, 32, 83, 0	10, 3, 49, 40		163, 160, 60
T61	82, 58, 34, 0,	64, 22, 0, 40		64, 91, 128
T27	35, 70, 84, 0,	0, 44, 52, 40		168, 92, 44
T72	29, 27, 62, 0,	2, 2, 28, 40		183, 175, 55
T30	66, 46, 99, 0,	36, 3, 60, 40		92, 119, 20

The assumption is that the printing is performed on white paper. Equal tests have been performed for experimental digital printing. Separations of the graphic prepress are performed according to the VZ procedure of joining and separating two images [1].

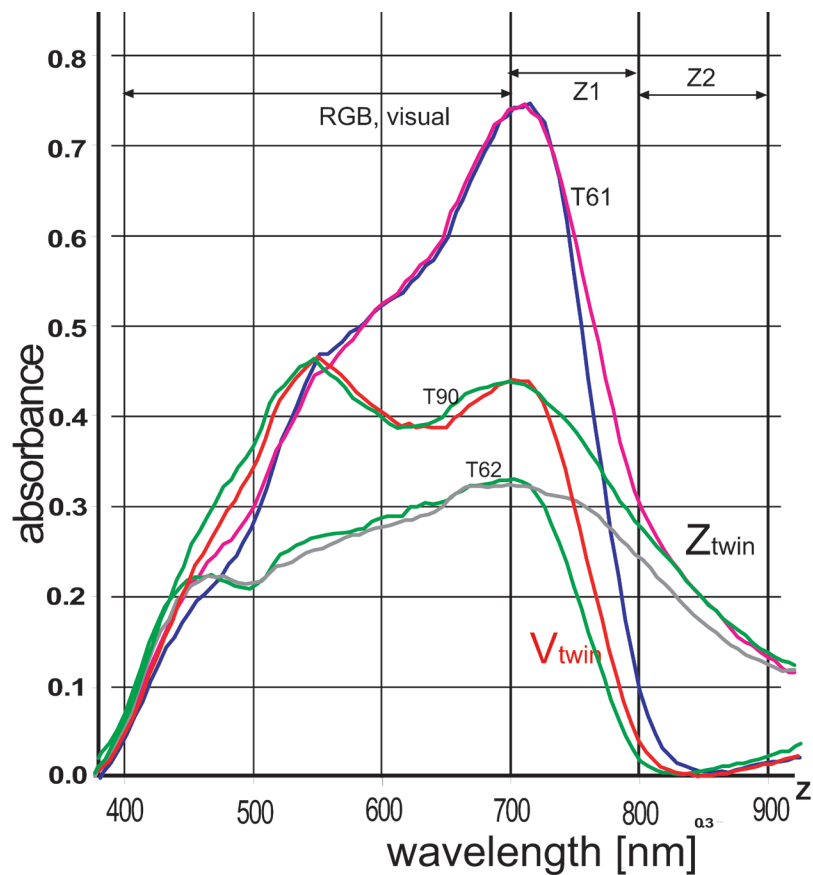


Figure 1 Absorption of twin colorants from the twin base for offset printing

In infrared printing we use gray color tones as the starting point for the development of new, saturated color tones which have two colors of equal coverage, with one component being extremely high. In the extensive measuring and work with gray tones [11] abbreviation S and K have been introduced as twin colorants, where K is the pure carbon black process colorant. Colorant S is composed only of components C, M and Y. In this work [11] the values C, M and Y are nearly equal. The hiding of the image in the gray colorant S calls for the adjustment of the relationships so that the value of ΔE between S and K is less than two. The first surprise is the large difference between values C, M and Y. What is more, for each technology (the type of print and paper to which the corresponding colorant is applied) these values are different. There is no correlation between the values of the components for different technologies of print. In this paper the focus is on twin colorants which will simulate works of art in the form of a reproduction on glossy paper with the offset technique.

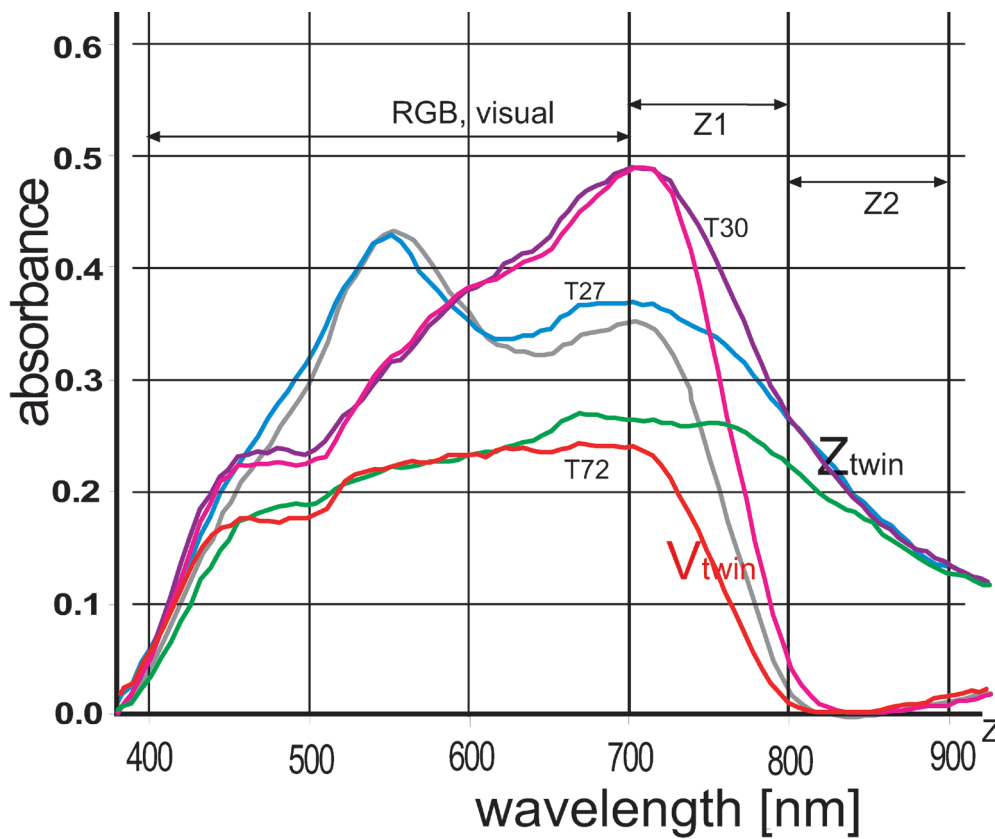


Figure 2 Absorption of twins with many bright dyes

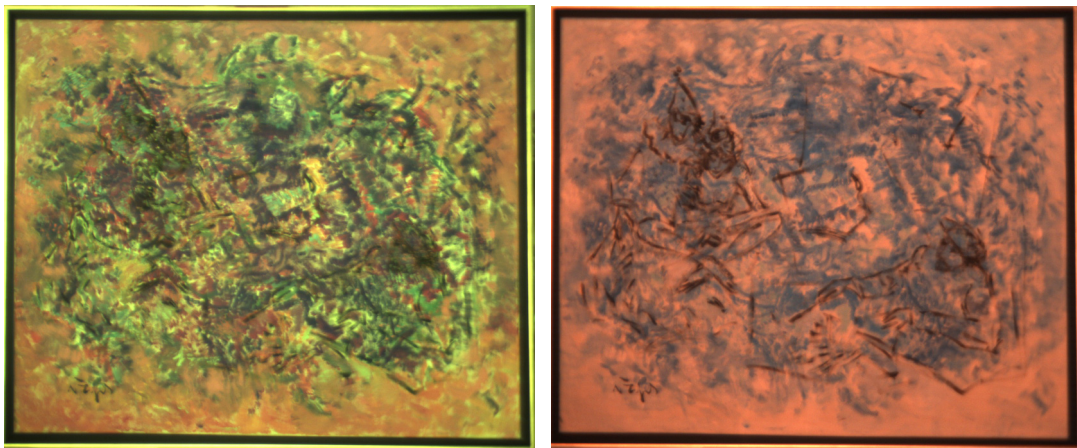
Series of experiments have been conducted for the final choice of twin colorants used in the reproduction of monographs in fine art. A set of about hundred twins adjusted for this type of print has been developed. The wealth of twin colorants has been achieved so that the reproduction can simulate a wide range of color tones

3. Information in the channels of colorants for reproduction

The piece of art (Nada Žiljak n114) was photographed with a forensic camera in 24 light blockades [15]. Blockade "N – neutral" shows the piece as it is seen with the naked eye in the range from 400 to 750 nm. In the paper blockades of light in the narrow area of 550, 610, 710 and 850 nm are shown (figure 3).



280 nm, 455 nm



515 nm, 610 nm



715 nm, 850 nm

Figure 3, Painter, Harlequin and Girl: Photographs in Six Filters

The blockade at 515 nm has rejected the yellow component. The photograph with the blockade at 850 nm gives independent information about the hidden image which will be reproduced with the carbon black colorant. This colorant absorbs NIR light. This state of reproduction is called "infrared Z image" recorded with the blockade at 1000 nm (fig 4 - animation).

The photographs in 24 series, from ultraviolet to NIR-Z state, have been arranged according to the sizes of blocked values with the intention to create an animation of the transformation of the piece of art in forensic view [16].

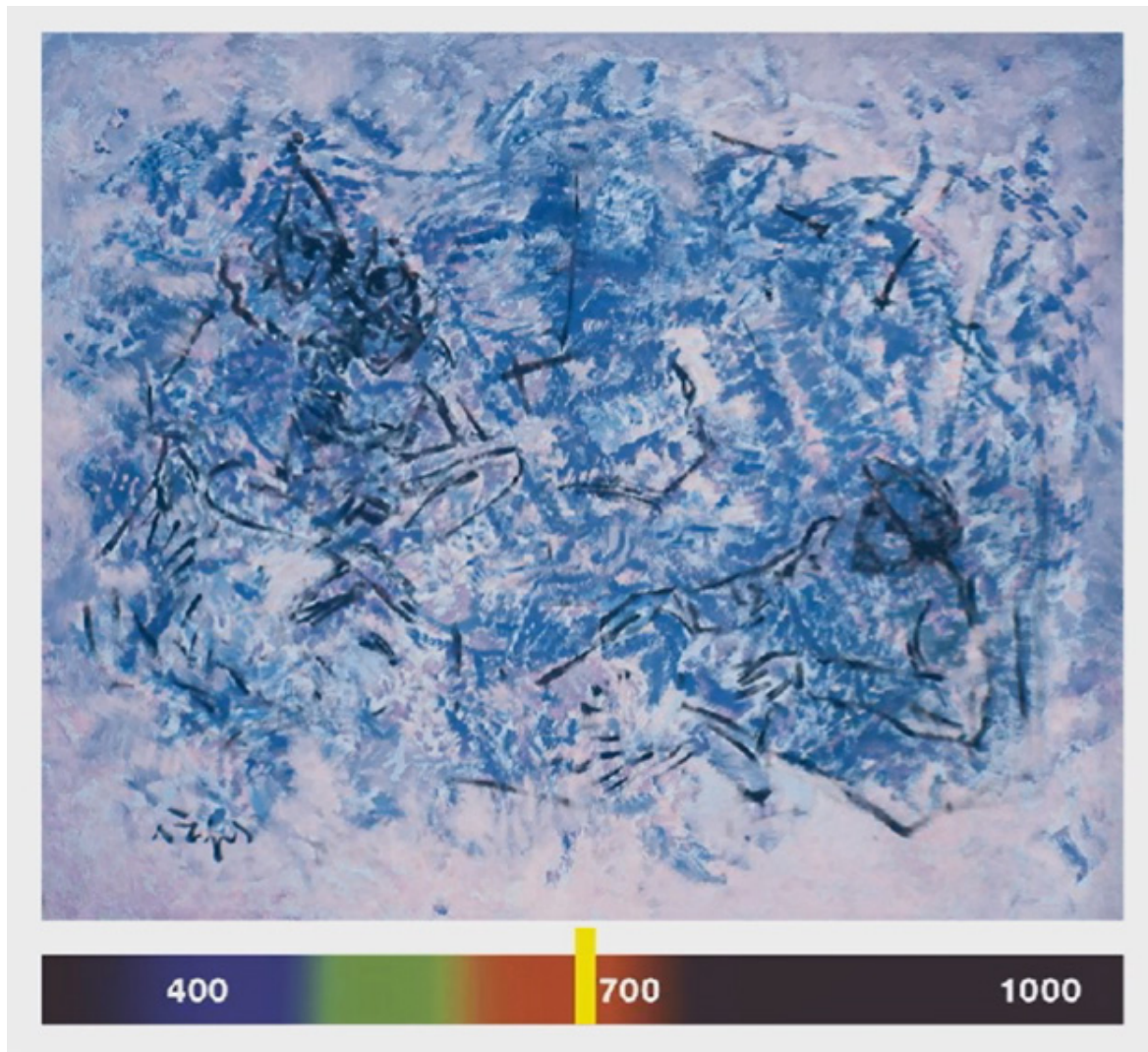


Figure 4 About 690 nm, animation [16]: www.nada.ziljak.hr/n114.mp4

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