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INFRARED BARRIER SCANNING OF CONTINUOUS COLOR DISAPPEARING ON FORGED VALUABLES

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Subject review

The article presents valuables expertise in the infrared spectrum with barrier scanning in order to prove authenticity. Suggestions are given for analyzing forgery information under the soft, intermediate and hard IR radiation. Basic characteristics of pigments are used to create a selected graphic information of color disappearing. Precise scanning was conducted by video spectral comparator with filters for visible and invisible part of the spectrum. Digital databases were created for documenting the results. The importance of IR spectrum separation in thirteen sections is highlighted in order to improve qualitative and quantitative way of information disappearing.

Keywords: *barrier scanning, forgery, infrared, valuables*

Infracrveno barijerno skeniranje kontinuiranog nestajanja boja na falsificiranim vrijednosnicama

Pregledni članak

Rad prikazuje vještačenje vrijednosnica u infracrvenom dijelu spektra barijernim skeniranjem u svrhu dokazivanja autentičnosti. Dani su prijedlozi analize falsificiranih podataka pod mekim, prijelaznim i tvrdim IR zračenjem. Iskorištena su vlastita svojstva boja za stvaranje izdvojenih grafičkih informacija. Provedeno je ciljano skeniranje video spektralnim komparatorom s filtrima za vidljivi i nevidljivi dio spektra. Kreirana je digitalna baza podataka za dokumentiranje rezultata. Istaknuta je važnost razdvajanja IR spektra na trinaest dijelova za unapređenje kvalitativnog i kvantitativnog određivanja gubljenja informacija.

Ključne riječi: *barijerno skeniranje, falsifikati, infracrveno, vrijednosnice*

1 Introduction
Uvod

Valuables authenticating should be conducted on several levels, due to the expansion of different ways of making forgeries. It is necessary to check the invisible part of the spectrum, ultraviolet and infrared. Testing must be done through instrument, as a disadvantage of human sense of vision. Infrared scanning can be carried out only in darkness with forensic devices that translate a dark image into a visible area. Analyses carried out in this work are documented on video spectral comparator with software specifically designed for the security documents analysis. New methods of non destructive valuables analyses are presented in order to preserve evidence. Barrier scanning in the infrared part of the spectrum gives a systematic presentation of color disappearing depending on the pigment characteristics.

In original valuables production, special attention is paid to a detail designed by specially mixing inks for the purpose of programmed responses at different wavelengths [2]. The UV colors can be purchased on the open market, so the analysis is increasingly turning to the verification of information in the field of IR [3]. The second level of valuables verification (with special instruments) has been so far oriented to a maximum degree to using devices with the UV lamps of 365 nm. There are visible changes in the educational and instrumental orientation. During the procurement of new equipment, taking into account the advice of the central bank, the equipment with the possibility of further verification in IR radiation of 830 nm is being purchased. Valuables, especially new editions banknotes, are designed specifically with the details which have a response right in that part of the spectrum [4]. These details are reflected in black, while the rest of the valuables have no traces of printing inks. Design of valuables with the target response in the IR spectrum has opened the way for researches of inks disappearing on forgery in the space invisible to our eyes.

Researches of ink response in the infrared spectrum prove that each color has its way of disappearance [5]. Knowing the basic properties of colors, it is possible to analyze their behavior in a strictly defined space inside wavelength from 570 to 1000 nm. Visual analysis shows a shift in the gray scale, which varies depending on the composition of the used pigments. In this article the use is discussed of IR radiation for the determination of forgery parts in valuables with the tendency of handwritten print, such as wills, promissory notes, checks, etc. Forgeries are based on genuine documents with removed, added or reconstructed parts in order to deceive the public. Comparison of the ink properties under the invisible part of the spectrum clearly indicates the use of different inks. Barrier setting on forensic device allows the analyses of the response to a specific part of the visible and invisible spectrum. With barrier IR scanning expertise is divided into thirteen phases. In accordance with previous studies, none of the tints of different composition gives the same response in all parts of the spectrum. There are a lot of colors that look the same in daylight, but in the invisible part of the spectrum have different responses. It is necessary to analyze forgeries with a professional tool in thirteen independent phases, hence the possibility that the differences are noticeable only in a specific segment of the spectrum.

2 Design of test samples
Dizajniranje testnih uzoraka

The experimental work was carried out on sixty selected different ballpoint pens which are manufactured all over the world. The only requirement was to write in blue ink. Test samples were designed by rearranging, adding or hiding the original information. Nine ballpoint pens have been selected for examples in this article. Their RGB values are listed in Tab. 1. Maintaining the similar blue tone is planned only for the visible part of the spectrum. Scanning with barrier IR filters gives different results of continuous disappearing. Testing samples are named for the experiment as line sample, number sample and text sample. Samples are designed on white Double A 80 g/m^2 premium paper.

Line sample consists of nine horizontal lines. Each line is written by hand with different ballpoint pens and marked with numbers from 1 to 9. Number sample contains a numeric string "3385" written with ballpoint pen number 5. The second digit "3" has been modified by ballpoint pen number 3 into digit "8". At the end the digit "0" is added with ballpoint pen no. 8. Text sample consists of the text "PETRA" written by hand with ballpoint pen number 5. The text is hidden by ballpoint pen number 3 with horizontal, vertical and diagonal lines.

3
Experimental part
Eksperimentalni dio

Instrumental analysis was performed on the video spectral comparator Docucenter expert with the software PIA 6000. Central part of the system is IR digital camera with high IR sensibility, 1,4 or 5 megapixel resolution (selectable), spectral range 350 - 1000 nm, pettier cooled for long exposure and predefined camera parameters for individual selection of light. All experiments were preserved and stored in a specially designed database. Analysis of samples on daylight was conducted under light conditions WHITE, excitation DOCU, emission BG38, focus 33, iris 8,0 and with 100 % intensity. Infrared analyses were carried out with 2×50 Watt IR-light source, illumination homogeneous, adjustable. Conditions were light IR, excitation DOCU, iris 4,0, focus 34 and 100 % intensity. Wavelength filtering was carried out with barriers at positions of 570 to 1000 nm. By changing of emission IR spectrum is divided in thirteen segments. Under the conditions of 570, 590, 610, 630 and 645 nm the changes are reflected in soft infrared spectrum. Intermediate infrared spectrum covers an area of conditions 665, 695 and 715 nm. Hard-infrared radiation is reflected under the terms of 735, 780, 830, 850 and 1000 nm. Experiments were conducted under these optical conditions without considering the eventual ink, coating and substrate interactions.

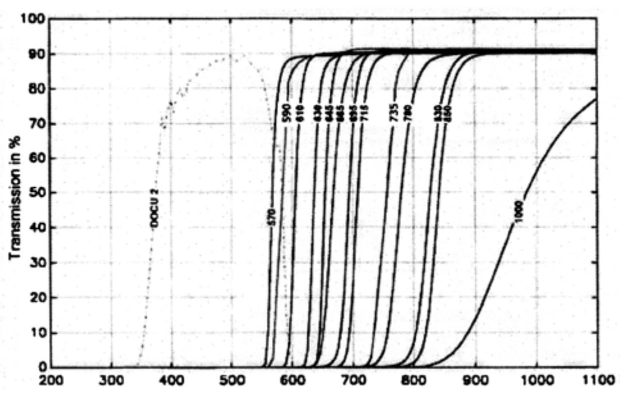

Figure 1 *Barrier filters used in experiments*
Slika 1. *Barijere filtara korištenih u eksperimentalnom radu*

3.1
Transformation of falsificated information
Transformacija falsificiranih informacija

Original protected valuables, e.g. bank notes, are designed to respond under conditions of 830 nm. The devices for authenticity control in financial institutions are based on these wavelengths [7]. Research has proven that inks disappearing at specific wavelengths are different for each color. The disappearance of the tint wavelengths of 570 to 1000 nm is seen in grayscale. Some colors can give the same response in daylight and provide varying degrees of extinction in the infrared light. It is experimentally proved that barrier scanning gives values that can show own way of pigment disappearing for each ink.

Common methods of documents falsification consist in adding the digits in front of or behind the original numerical sequence. The figures which are added in front are usually from 1 to 9; while behind the original numbers the zeros are usually added. Adding or redrawing only one digit makes graphological testing difficult. Barrier infrared scanning can demonstrate a different way of losing the color of ink which was originally used and the ink which was used for making the forgery.

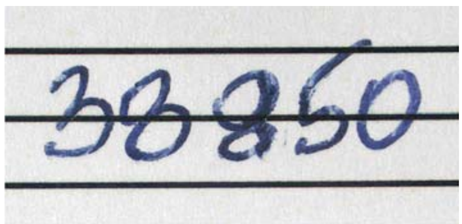

Figure 2 *Digital scan of forgery information in daylight*
Slika 2. *Digitalni zapis falsificirane informacije na dnevnom svjetlu*

Numbers' falsification depends on print mode, which allows subsequent processing. It is almost always possible to remodel number 3 to 8. The number 1 can usually be changed into 4 or 7. In daylight that rewriting can easily be mistaken. It is necessary to take into account that counterfeiters tend to mislead the public only to the extent necessary to change the ownership of valuables. For example on bank notes, very common examples are forgeries which are often drawn, torn or liquid sealed in order to focus attention to damage instead of the forgery. On checks or promissory notes similar deception can be seen in the idea of adding a new digit next to the original digit which is accentuated.

Accentuating can occur for many reasons. The most common problem is ink at the beginning of writing. In a number of samples the third digit is deliberately written with a partial repetition of the print. Ballpoint pen no. 5 is used. The second digit is originally written as number "3" and subsequently modified by a ballpoint pen no. 3 in the digit "8". The last digit "0" is added with ballpoint pen no. 8.

Barrier scanning analysis provides an insight into the supplemental information. Inks no. 3 and 8 start to disappear at a wavelength of 630 nm. At 665 nm the difference between the two inks on the second digit is clearly visible. Management of space invisible to our eyes clearly indicates forgery. The process takes place in the dark. The images are translated in the viewable area and displayed on the video spectral comparator. Pigments of ballpoint pen no. 3 are almost completely lost under the barrier of 715 nm. Original digit "3" is clearly visible. The added digit "0" is still visible, although noticeably has less intensity. Move of barriers to the wavelength of 1000 nm leads to a complete disappearance of tint and blending with the background. Which segment of the infrared spectrum will provide evidence of falsification depends on the properties of the used paints and pigments. In the present experiment the maximum response is under filter of 715 nm. Digital recording of Figures 3 - D is evidence of falsification with two different inks.

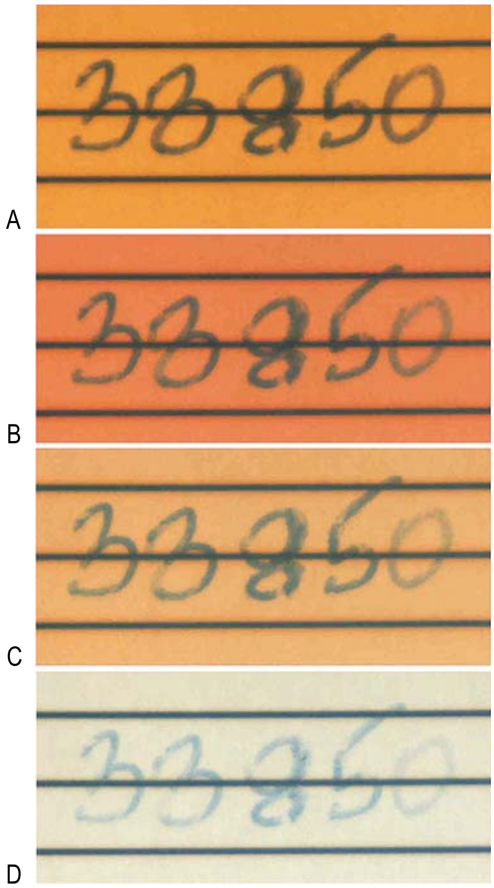

Figure 3 *Transformation of forgery information under filters of 570 nm (A), 630 nm (B), 665 nm (C), 715 nm (D)*
Slika 3. *Transformacija falsificirane informacije pod filtrima od 570 nm (A), 630 nm (B), 665 nm (C), 715 nm (D)*

3.2 Barrier scanning of inks absorption in the infrared spectrum
Barijerno skeniranje apsorpcije boje u infracrvenom spektru

A discussion was conducted about readability of hidden messages. The text "PETRA" is written with ballpoint pen no. 5 and crossed with ballpoint pen no. 3 horizontally, vertically and diagonally. In daylight it is difficult to perceive the presence of the text beneath the stains. The text is not readable under visual spectrum.

Under the wavelength of 610 nm the processes of two different responses start. The text is instantly removed from the dense structure lines. Until the barriers of 645 nm the response of both inks is reduced. After 715 nm the ink of ballpoint pen no. 3 completely disappeared. The response of the text "PETRA" is possible to be tracked until the barrier of 780 nm. Further movement of the barrier is not required.

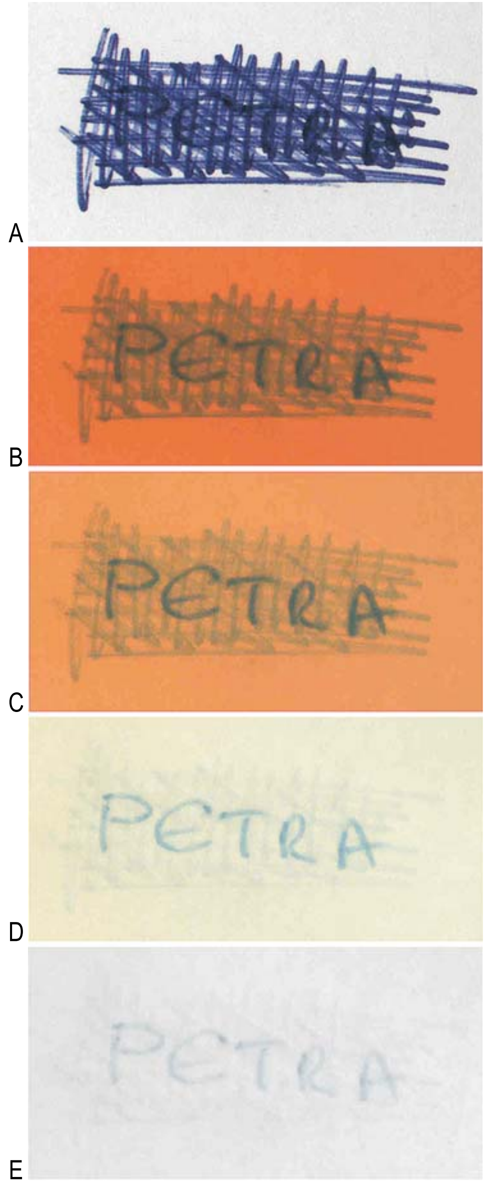

Figure 4 *Respond of hiden text under visual spectrum (A) and barriers of 610 nm (B), 645 nm (C), 715 nm (D) i 780 nm (E)*
Slika 4. *Odaziv skrivenog teksta pod dnevnim svjetlom (A) i barijerama od 610 nm (B), 645 nm (C), 715 nm (D) i 780 nm (E)*

The properties of the used dyes and pigments completely disappear.

4 Results and discussion
Rezultati i diskusija

Barrier scanning of invisible spectrum can certainly prove that falsification on valuables is possible. Digital recording shows the segment of infrared spectrum in which the separation of ink with different pigment characteristics begins. Visual and instrumental analysis that follows shows experiments carried out on nine lines of hand writing with nine ballpoint pens by different manufacturers. It is almost impossible to find a ballpoint pen from different manufacturer with the same properties of the ink. In daylight the lines look almost identical, with minor differences in color and thickness. Daylight scanning is made with 380 nm cut on and cut off 570 nm, 190 nm with BW.

Setting the barriers to 570 nm gives a visual change that

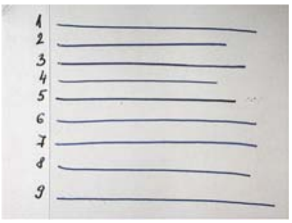

Figure 5 *Digital scan of line sample prepared for visual spectrum*
Slika 5. *Digitalni zapis linijskog uzorka pripremljenog za vidljivi dio spektra*

is not visible to our eyes. HSB and Lab values indicate a shift in the minimum values for different ballpoint pens. At 590 nm losing of lines no. 3 and 7 starts. That continues under separation of 610 nm. The disappearance of line no. 2 becomes visible. The process is continuously carried out by fading under condition of 630 nm and 645 nm. The biggest changes are reflected in line no. 3. Other lines show no visible deviation in our eyes.

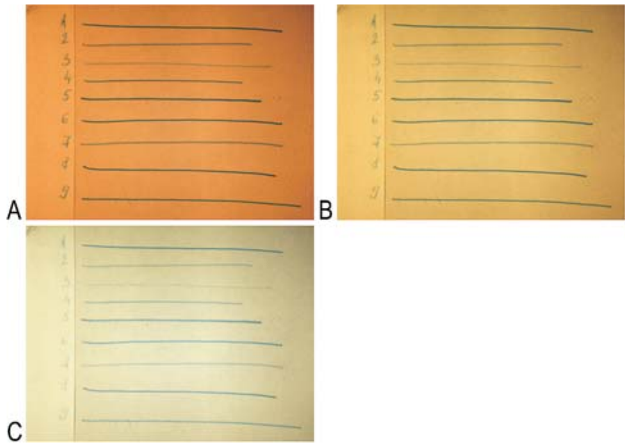

Figure 7 *Continuous ink disappearing; 665 nm (A), 695 nm (B), 715 nm (C)*
Slika 7*. Kontinuirano gubljenje boja; 665 nm (A), 695 nm (B), 715 nm (C)*

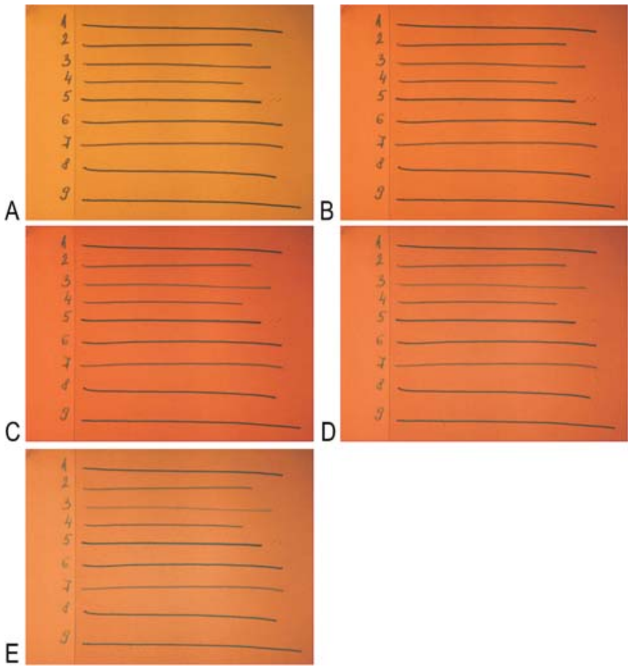

Figure 6 *Continuous ink disappearing; 570 nm (A), 590 nm (B), 610 nm (C), 630 nm (D), 645 nm (E)*
Slika 6. *Kontinuirano gubljenje boja; 570 nm (A), 590 nm (B), 610 nm (C), 630 nm (D), 645 nm (E)*

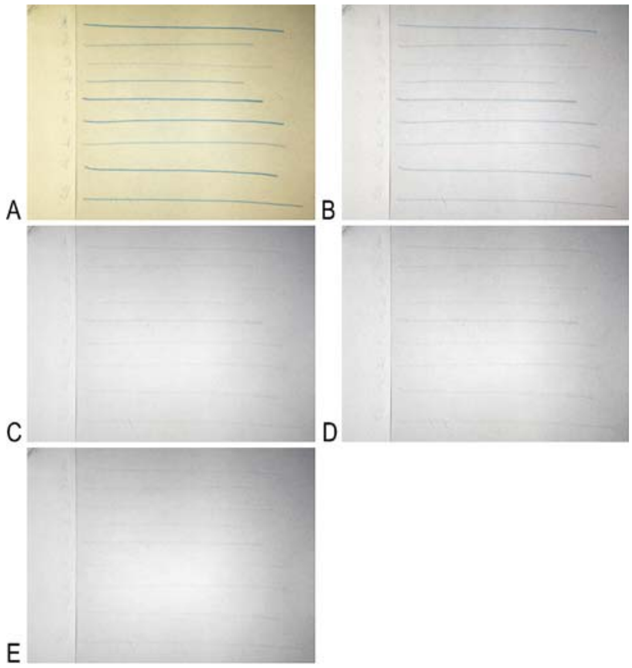

Figure 8 *Continuous ink disappearing; 735 nm (A), 780 nm (B), 830 nm (C), 850 nm(D), 1000 nm(E)*
Slika 8*. Kontinuirano gubljenje boja; 735 nm (A), 780 nm (B), 830 nm (C), 850 nm(D), 1000 nm(E)*

Table 1 *Daylight and infrared barrier scanning for 9 line samples depending on wavelengths*
Tablica 1. *Barijerno skeniranje pod dnevnim i infracrvenim svjetlom za 9 linijskih uzoraka u ovisnosti o valnoj duljini*

Ballpoint pen no.	**WHITE**	**IR 570**	**IR 630**	**IR 665**	**IR 715**	**IR 780**	**IR 850**
1							
2							
3							
4							
5							
6							
7							
8							
9							

The biggest changes are evident in the intermediate IR wavelengths of 665 nm, 695 nm and 715 nm. Under the wavelength of 715 nm line no. 3 is hardly visible. Barrier at 665 nm causes decay of lines. no. 4 and no. 9.

Barrier scanning on 735 nm provided clear evidence of different responses between inks used for line sample. Own color and pigment properties define their different response in the area of near infrared radiation. In a further analysis the lines are increasingly blended with the background. Line no. 3 completely disappears. Line no. 5 shows the maximum

***Table 2** RGB values for 9 line samples depending on wavelengths*
***Tablica 2.** RGB vrijednosti za 9 linijskih uzoraka u ovisnosti o valnoj duljini*

Ballpoint pen no.	WHITE			IR 570			IR 630			IR 665			IR 715			IR 780			IR 850		
	R	G	B	R	G	B	R	G	B	R	G	B	R	G	B	R	G	B	R	G	B
1	39	48	81	72	60	36	68	65	48	82	83	65	116	141	135	162	170	173	170	172	171
2	37	42	72	93	68	46	104	80	54	123	110	75	156	172	143	178	179	181	178	178	178
2	46	47	78	105	77	38	133	89	60	170	129	85	192	199	158	199	199	199	199	199	199
4	38	38	72	82	71	49	113	86	59	134	119	86	181	191	166	187	192	198	204	204	204
5	49	54	74	78	67	471	85	76	59	101	106	84	143	171	159	187	197	206	204	204	204
6	43	54	86	79	72	44	91	79	63	106	110	93	150	180	172	202	208	222	223	223	223
7	59	62	107	97	76	47	116	91	60	139	127	89	187	201	175	208	216	218	217	223	219
8	42	50	86	77	66	44	82	76	54	133	117	91	145	171	162	191	198	208	215	215	215
9	38	47	90	74	68	42	80	72	59	98	98	86	148	174	161	186	189	194	199	197	198

***Table 3** HSB and Lab values for ballpoint pen no. 1*
***Tablica 3.** Prikaz HSB i Lab vrijednosti za kemijsku olovku br. 1*

Ballpoint pen no. 1; *x*=334, *y*=048 pixel						
	HSB values			Lab values		
	H / º	*S* / %	*B* / %	*L**	*a**	*b**
WHITE	227	52	32	20	4	-22
IR 570	40	50	28	26	3	17
IR 590	37	36	26	25	2	11
IR 610	35	29	25	25	2	8
IR 630	51	29	27	27	-1	11
IR 645	33	15	28	29	1	4
IR 665	63	22	33	35	-3	10
IR 695	101	15	43	45	-7	7
IR 715	166	18	55	57	-10	0
IR 735	180	12	55	57	-6	-2
IR 780	196	6	68	69	-2	-3
IR 830	0	0	67	70	0	0
IR 850	60	1	67	70	-1	0
IR 1000	0	0	66	69	0	0

***Table 4** HSB and Lab values for ballpoint pen no. 2*
***Tablica 4.** Prikaz HSB i Lab vrijednosti za kemijsku olovku br. 2*

Ballpoint pen no. 2; *x*=306, *y*=084 pixel						
	HSB values			Lab values		
	H / º	*S* / %	*B* / %	*L**	*a**	*b**
WHITE	231	49	28	18	5	-20
IR 570	28	51	36	31	9	18
IR 590	34	56	34	29	7	20
IR 610	22	45	36	31	10	14
IR 630	31	48	41	36	8	19
IR 645	32	48	47	41	8	22
IR 665	44	39	48	47	1	22
IR 695	63	28	55	57	-6	21
IR 715	93	17	67	68	-10	13
IR 735	81	13	67	69	-6	11
IR 780	220	2	71	73	0	-1
IR 830	0	0	71	74	0	0
IR 850	0	0	70	73	0	0
IR 1000	0	0	70	73	0	0

***Table 5** HSB and Lab values for ballpoint pen no. 3*
***Tablica 5.** Prikaz HSB i Lab vrijednosti za kemijsku olovku br. 3*

Ballpoint pen no. 3; *x*=284, *y*=123 pixel						
	HSB values			Lab values		
	H / º	*S* / %	*B* / %	*L**	*a**	*b**
WHITE	238	41	31	20	6	-19
IR 570	35	64	41	35	9	28
IR 590	30	58	42	35	11	24
IR 610	26	57	47	38	14	24
IR 630	24	55	52	42	16	24
IR 645	33	55	55	47	11	29
IR 665	31	50	67	57	12	30
IR 695	45	43	71	67	1	33
IR 715	70	21	78	79	-8	20
IR 735	73	18	79	80	-8	18
IR 780	0	0	78	80	0	0
IR 830	0	0	78	81	0	1
IR 850	0	0	78	80	0	0
IR 1000	0	0	76	78	0	0

***Table 6** HSB and Lab values for ballpoint pen no. 4*
***Tablica 6.** Prikaz HSB i Lab vrijednosti za kemijsku olovku br. 4*

Ballpoint pen no. 4; *x*=286, *y*=160 pixel						
	HSB values			Lab values		
	H / º	*S* / %	*B* / %	*L**	*a**	*b**
WHITE	240	47	28	17	8	-22
IR 570	40	40	32	31	2	15
IR 590	24	60	45	36	16	24
IR 610	27	58	42	34	13	22
IR 630	30	48	44	39	9	20
IR 645	48	26	36	37	0	12
IR 665	41	36	53	51	2	20
IR 695	80	20	55	56	-9	13
IR 715	84	13	75	76	-7	11
IR 735	124	8	72	73	-7	5
IR 780	213	6	78	77	-1	-4
IR 830	0	0	81	83	0	0
IR 850	0	0	80	82	0	0
IR 1000	0	0	80	82	0	0

***Table 7** HSB and Lab values for ballpoint pen no. 5*
***Tablica 7.** Prikaz HSB i Lab vrijednosti za kemijsku olovku br. 5*

Ballpoint pen no. 5; *x*=287, *y*= 198 pixel						
	HSB values			Lab values		
	H / º	*S* / %	*B* / %	*L**	*a**	*b**
WHITE	228	34	29	23	2	-13
IR 570	39	40	31	29	2	14
IR 590	26	42	32	28	7	13
IR 610	26	38	33	30	6	12
IR 630	39	31	33	33	2	12
IR 645	40	33	40	39	2	14
IR 665	74	21	42	44	-5	12
IR 695	102	20	51	53	-11	12
IR 715	154	16	67	68	-12	3
IR 735	155	15	68	69	-11	3
IR 780	208	9	81	79	-2	-6
IR 830	0	0	82	83	0	0
IR 850	0	0	80	82	0	0
IR 1000	0	0	83	85	0	0

***Table 8** HSB and Lab values for ballpoint pen no. 6*
***Tablica 8.** Prikaz HSB i Lab vrijednosti za kemijsku olovku br. 6*

Ballpoint pen no. 6; *x*=378, *y*=242 pixel						
	HSB values			Lab values		
	H / º	*S* / %	*B* / %	*L**	*a**	*b**
WHITE	225	50	34	23	3	-21
IR 570	48	44	31	31	0	18
IR 590	23	56	45	36	15	22
IR 610	34	34	33	31	3	12
IR 630	34	31	36	34	3	11
IR 645	39	28	43	42	2	13
IR 665	74	15	43	46	-4	9
IR 695	114	14	54	56	-9	8
IR 715	164	17	71	71	-12	1
IR 735	187	17	73	72	-9	-5
IR 780	222	9	87	83	0	-8
IR 830	60	1	87	88	0	1
IR 850	0	0	87	89	0	0
IR 1000	0	0	89	91	0	0

***Table 9** HSB snd Lab values for ballpoint pen no. 7*
***Tablica 9.** Prikaz HSB i Lab vrijednosti za kemijsku olovku br. 7*

Ballpoint pen no. 7; *x*=224, *y*=289 pixel						
	HSB values			Lab values		
	H / º	*S* / %	*B* / %	*L**	*a**	*b**
WHITE	236	45	42	28	9	-27
IR 570	35	52	38	34	6	21
IR 590	30	48	40	35	8	18
IR 610	33	53	41	36	8	22
IR 630	33	48	45	41	7	22
IR 645	33	43	51	46	7	21
IR 665	46	36	55	54	0	22
IR 695	59	28	63	65	-5	23
IR 715	92	13	79	79	-8	11
IR 735	103	11	77	78	-8	9
IR 780	192	5	85	86	-3	-2
IR 830	0	0	88	89	0	0
IR 850	140	3	87	88	-3	1
IR 1000	330	1	90	91	1	0

***Table 10** HSB and Lab values for ballpoint pen no. 8*
***Tablica 10.** Prikaz HSB i Lab vrijednosti za kemijsku olovku br. 8*

Ballpoint pen no. 8; *x*=363, *y*=347 pixel						
	HSB values			Lab values		
	H / º	*S* / %	*B* / %	*L**	*a**	*b**
WHITE	229	51	34	21	5	-23
IR 570	40	43	30	29	2	15
IR 590	29	42	31	28	6	13
IR 610	29	39	31	29	5	12
IR 630	47	34	32	32	0	14
IR 645	30	31	41	39	5	12
IR 665	37	32	52	50	3	17
IR 695	116	12	51	53	-8	6
IR 715	159	15	67	68	-11	1
IR 735	155	14	73	73	-11	2
IR 780	215	8	82	80	-1	-6
IR 830	0	0	84	86	0	0
IR 850	0	0	84	86	0	0
IR 1000	0	0	85	87	0	0

***Table 11** HSB and Lab values for ballpoint pen no. 9*
***Tablica 11.** Prikaz HSB i Lab vrijednosti za kemijsku olovku br. 9*

Ballpoint pen no. 9; *x*=345, *y*=408 pixel						
	HSB values			Lab values		
	H / º	*S* / %	*B* / %	*L**	*a**	*b**
WHITE	230	58	35	20	7	-28
IR 570	33	56	39	34	8	22
IR 590	27	38	30	27	6	11
IR 610	42	33	27	27	1	11
IR 630	37	26	31	31	2	9
IR 645	52	25	34	36	-1	12
IR 665	60	12	38	41	-2	7
IR 695	93	17	51	53	-8	10
IR 715	150	15	68	69	-11	4
IR 735	159	15	67	68	-11	1
IR 780	217	4	76	76	0	-3
IR 830	48	3	78	80	0	2
IR 850	330	1	78	80	1	0
IR 1000	26	3	79	80	1	2

response.

RGB values are given of used ballpoint pens in daylight and under six infrared barriers. That clearly manifests a different response depending on the attributes of the different ballpoint pen pigments. None of the inks responds equally in all parts of the spectrum.

HSB and Lab values for all nine used ballpoint pens were measured in daylight and in all thirteen parts of infrared spectrum. A specific response is presented as a basic aspect of the analysis of counterfeit securities with barrier IR scanning.

The response under near infrared light depends on the ink components, substrates and printing techniques. Changing one of these segments would give different results. In described experiments only inks were changed, while the substrate and coating remained the same.

5 Conclusion
Zaključak

The own characteristics of ink and pigments reflect different behavior in the near-infrared part of the spectrum. Great freedom in mixing colors gives unlimited number of ink which in daylight looks identical. In that aspect we can recognize the difficulties in analyzing the forgery valuables. By visual analysis it is not possible to identify differences in the composition of different ballpoint pen inks. Analysis in the invisible part of the spectrum is necessary to identify the way of losing tint. Barrier infrared scanning with video spectral comparator provides information about the behavior of ink in thirteen segments. Filtering by selection of wavelengths from 570 to 1000 nm reveals the hidden information. Some colors respond identically to certain wavelengths and then the disappearance of color components occurs. Each component of ink reacts unequally under near-infrared spectrum, and it causes different disappearance. Managing the visible - invisible spectrum gives an overview of hidden information. Separation in the near IR radiation is documented in digital records. Comparison of information in precisely programmed data bases provides indisputable indicators about falsificated valuables.

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