Consideration of screen and image resolution

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CONSIDERATION OF SCREEN AND IMAGE RESOLUTION

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Subject review

The paper analyses a narrower segment of older and newer kinds of screens, CRT displays with a cathode ray tubes, TFT liquid crystal displays with a thin-film transistor and plasma displays. A screen pixel, which is common to all of them, has also been examined. The terms of screen and image resolution have been explained. The term "normal", connected with image resolution, has also been considered.

Key words: *image resolution, screen, screen pixel, screen resolution*

Razmatranja o ekranskoj i slikovnoj razlučivosti

Pregledni članak

U radu se komparira jedan uži segment starijih i novijih vrsta ekrana, ekrana s katodnim cijevima, TFT ekrana s tekućim kristalom te plazma ekrana. Razmatra se i ono što im je zajedničko, ekranski piksel. Detaljno se objašnjavaju pojmovi ekranske razlučivosti i slikovne razlučivosti. Ukazuje se na korištenje pojma "normal" vezano uz slikovnu razlučivost.

Ključne riječi: *ekran, ekranski piksel, ekranska razlučivost, slikovna razlučivost*

1
Introduction
Uvod

Screen and image resolution are the two terms which there is seemingly nothing more to say about. But is it really so? Who uses these terms, where can they be found, except in cartographic articles, and are they always used properly?

Whereas some answers to these questions are obvious, some will be given hereafter.

2
Screens and screen pixels
Ekrani i ekranski pikseli

Newer kinds of screens are slowly displacing the older ones. However, they can still be found in our offices, together with the older kinds of screens.

Some of these older kinds of screens are CRT displays with a cathode ray tube. TFT liquid crystal displays with a thin-film transistor and plasma displays belong to newer, more improved, and ever cheaper screens.

All these kinds of screens share one common (and smallest) part, and that is a screen pixel. A screen pixel of all these screens consists of red, green and blue primary colours of additive colour mixing [7]. A pixel of CRT displays and plasma displays consists of red, green and blue phosphorous particles, whereas a pixel of TFT liquid crystal displays consists of red, green and blue filters.

For more detailed information about these screens and their structures see [1, 2, 3].

If all these three components of screen pixels – the red, green and blue one – are illuminated uniformly and with full screen power, then we perceive white on the screen. Due to the small size of single pixel components, because of the small mutual distance and because of the observation distance, an eye does not see them as single dots, but they melt in the retina in one unique dot (screen pixel) according to the principle of additive primary colour mixing.

The shape of a screen pixel is always rectangular for TFT liquid crystal displays and plasma displays whereas the pixel shape of CRT displays depends on the kind of applied mask. If it is a tension mask, the pixel shape is rectangular, if it is a shadow mask, the pixel is mostly triangular. CRT displays with a tension mask always disposes of a rectangular pixel with constant width (a) and variable height (b) (see Tab. 1) [1].

Table 1 *The size of a screen pixel on the CRT displays with a tension mask*
Tablica 1. *Iznosi ekranskog piksela kod ekrana s katodnim cijevima s rešetkastom maskom*

CRT displays with a tension mask				
	15"		20"	
Screen resolution	*a*/mm	*b*/mm	*a*/mm	*b*/mm
640×480		0,44		0,60
800×600		0,32		0,44
1024×768	0,25	0,26	0,30	0,34
1152×864		0,22		0,26
1280×1024		0,20		0,20

The fact that the forming of an image in CRT displays with a tension mask is completely different from the forming of an image in TFT liquid crystal displays or plasma displays reflects itself on the screen pixel. The latter's screen pixel is rectangular, but with unchanging dimensions. In this connection different screen resolutions depend on the screen diagonal size. E.g. the 17"-TFT liquid crystal displays have screen resolution of 1280×1024, whereas the 20"- and 21"-TFT liquid crystal displays have screen resolution of 1600×1200 [2, 4, 5]. The sizes of screen pixels for the majority of the 17"-TFT, 20"-TFT and 21"–TFT screens can be seen in Tab. 2 [3].

Table 2 *The size of a screen pixel on the TFT liquid crystal display*
Tablica 2. *Iznosi ekranskog piksela kod TFT-ekrana s tekućim kristalom*

TFT liquid crystal displays		
Diagonal size	Screen resolution	Pixel size, mm
17"	1280×1024	0,264
20"	1600×1200	0,255
21"	1600×1200	0,270

3
Screen and image resolution
Razlučivost ekrana i slikovna razlučivost

Screen resolution or resolution of a screen is defined numerically, e.g. 800×600, 1024×768, 1280×1024 and 1600×1200, where the first number stands for the number of columns and the second one for the number of screen lines. The smaller screen resolution, the rougher the image. Screen resolution is most essential for the screen quality.

The abbreviation dpi is added to the numerical mark and it is used in informatics for image resolution. The abbreviation stands for dots per inch. One inch is British and American measure and amounts to 25,4 mm. The pixel size can always be calculated from image resolution and vice versa.

Tab. 3 presents the relationship between screen and image resolution on the CRT displays with a tension mask. The surveys on the 15"-tension mask displays reveal a screen resolution of 1024×768 with nearly a square screen pixel of about 100 dpi [1].

Tab. 4 presents the relationship between screen and image resolution on the TFT liquid crystal displays. The sizes of screen pixels, and thus the image resolution, depend on the size of screen diagonal [3].

In order to save the memory, screen presentations should be made in the image resolution of the screen itself.

Table 3 *Screen and image resolution on the CRT displays*
Tablica 3. *Ekranska razlučivost i slikovna razlučivost kod ekrana s katodnim cijevima*

	15"-tension mask display				20"-tension mask display			
screen resolution	pixel width *a*/mm	image resolution, dpi	pixel height *b*/mm	image resolution, dpi	pixel width *a*/mm	image resolution, dpi	pixel height *b*/mm	image resolution, dpi
640×480	0,25	102	0,44	58	0,30	85	0,60	42
800×600			0,32	79			0,44	58
1024×768			0,26	98			0,34	75
1152×864			0,22	115			0,26	98
1280×1024			0,20	127			0,20	127

Table 4 *Screen and image resolution on the TFT liquid crystal displays*
Tablica 4. *Ekranska razlučivost i slikovna razlučivost kod TFT-ekrana s tekućim kristalom*

TFT liquid crystal displays			
diagonal size	screen resolution	pixel size, mm	image resolution, dpi
17"	1280×1024	0,264	96,2 (96)
20"	1600×1200	0,255	99,6 (100)
21"	1600×1200	0,270	94,1 (94)

According to [6], the recommended image resolution is different for Macintosh-screens and PC-screens. For Macintosh-screens it is 72 dpi, and for PC-screens 96 dpi.

Comparing the values of image resolutions from Tab. 3 and Tab. 4, we can notice that these recommendations, though given in ancient 1996, can still be applied for PC-screens.

4
The choice of image resolution
Odabir slikovne razlučivosti

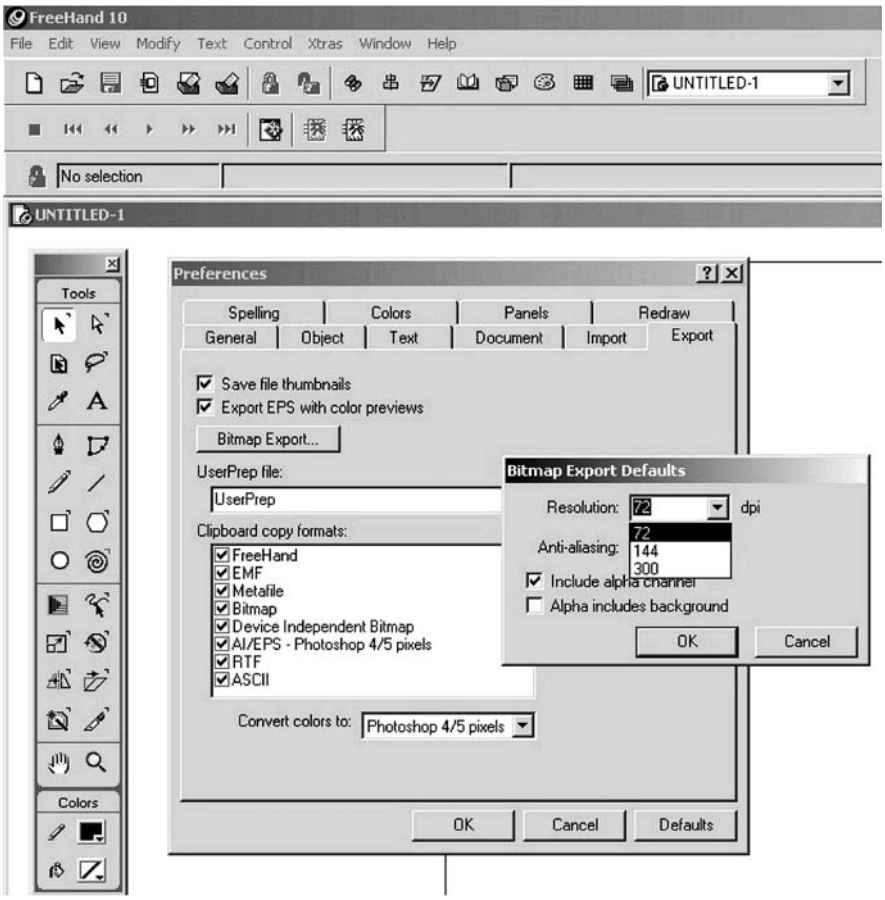

Figure 1 *Bitmap Export in FreeHand Macromedia software*
Slika 1. *Bitmap Export u softveru FreeHand Macromedia*

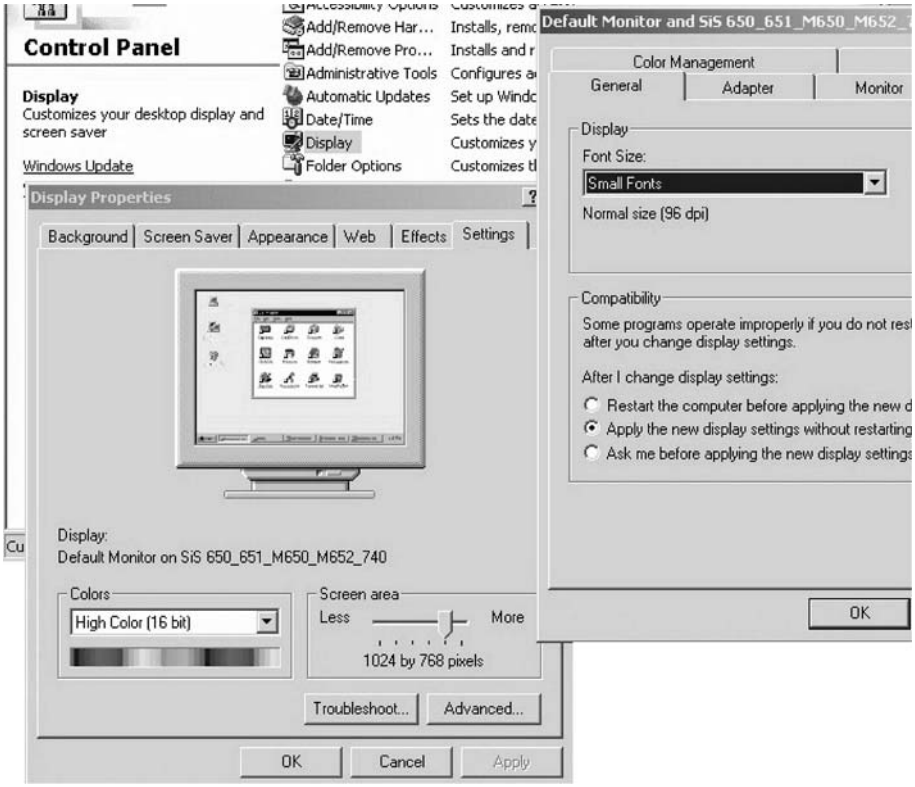

Figure 2 *"Normal size (96 dpi)" with a screen resolution of 1024×768 on 15"-screen*
Slika 2. *"Normal size (96 dpi)" pri ekranskoj razlučivosti 1024×768 na 15"-ekranu*

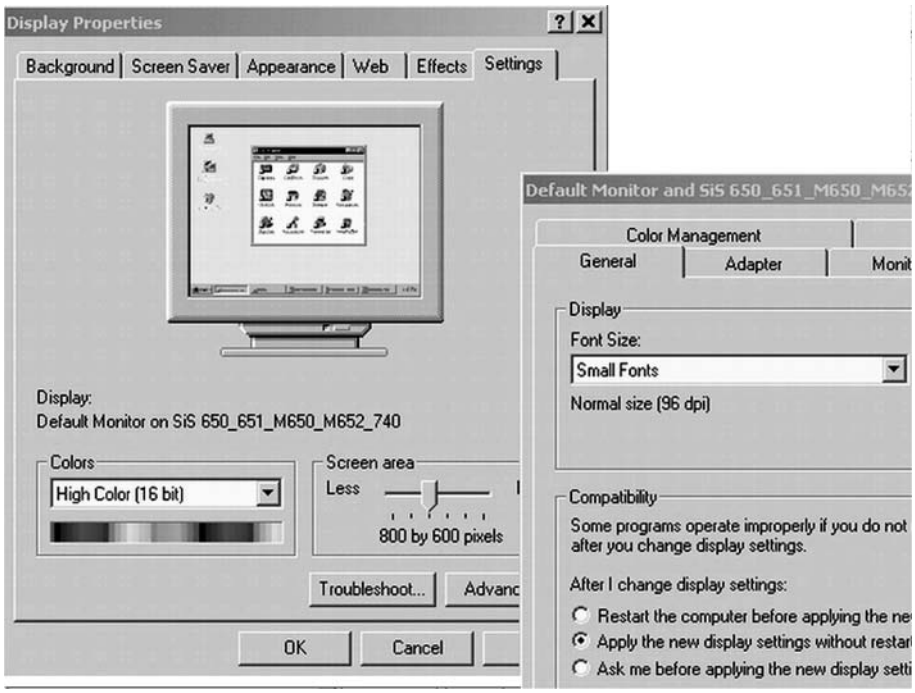

Figure 3 *"Normal size (96 dpi)" with a screen resolution of 800×600 on 15"-screen*
Slika 3. *"Normal size (96 dpi)" pri ekranskoj razlučivosti 800×600 na 15"-ekranu*

4.1
About the term "normal screen resolution"
O primjeni pojma "normal screen resolution"

The term "normal screen resolution" has probably been derived from [6] or similar recommendations. For the bitmap export, only two image resolutions – 72 dpi and 300 dpi – can be found in older versions of e.g. FreeHand-Macromedia software. The newer versions of the same software do not apply this term (Fig. 1) and neither do CorelDRAW, OCAD, Irfan etc.

The term "normal screen resolution" applies only to the numerical value of 72 dpi, whereas in Tables 3 and 4 we can notice the existence of different image resolution for different screen resolutions. Reiterating, as presented in Tables 3 and 4, different screen resolutions result with different image resolutions.

The term "normal screen resolution" can still sometimes be found in cartographic articles, though it is not right.

4.2
About the use of the term "normal size (96 dpi)"
O primjeni pojma "normal size (96 dpi)"

In the previous chapters the changing image resolution was discussed. Every user can find the term "normal size" (96 dpi) on her/his screen in the following order:
1. "My Computer"
2. "Control Panel"
3. "Display Settings" (see Fig. 2 and Fig. 3).

Curiously, on my 15"–screen with the same display setting, the term "normal size" indicates a fixed value of 96 dpi for both screen resolutions – 1024×728 and 800×600. With a screen resolution of 800×600 there is a significantly rougher image than with a screen resolution of 1024×768.

5
Conclusion
Zaključak

Different screen resolutions make different image resolutions. The graphic software, e.g. FreeHand Macromedia or CorelDRAW offer with bitmap export several different image resolutions and the user herself/himself chooses one of them. The ambivalent term "normal screen resolution" is no longer in use and so it should not be used in cartography any more.

A user of any graphic software gets, with an enlargement of 100 %, different image resolutions on different screens or different screen resolutions on the same screen. Thus, we get images of different sizes.

With the discussed term "normal size" we are talking about copying 1:1. A raster pixel in pixmap (pixel map) corresponds to one image pixel, and it should not use a fixed value of, for example, 96 dpi. The term "normal size" can be used in the case when the numerical value is not mentioned. A pixmap stores and displays a graphical image as a rectangular array of pixel colour values [8].

6
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