Analyze of Image Quality Parameters on Thermal Paper as Proposal to Extension Standard ISO/IEC 13660

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Abstract

Standard ISO13660, witch presents mainly parameters of monochrome printouts, has a few shortcomings. They are connected with lack of quality control for color printouts as well as subjective customer feelings not taken into account.

Recently technologies of digital printing have been developing very fast and because of that they are not only very varied, but what is more important they different features.

Analyzing different technologies of printing it is possible to say what kind of characteristics are common for each technology.

After theoretical analysis as well own works there were proposed extension of norm ISO13660. In the part there were presented important parameters of printouts for thermal technology.

This work deals with parameters of IQ printouts on thermal paper, especially bar code and fiscal paragon printouts. In this work there are proposed parameters and conclusions.

Introduction

The quality and velocity together with economic parameters are the most important parameters of modern printers.

Taking into account big speed of the development of digital printing technology as well as marketing considerations objective quantitative assessment is a present-day problem in typography.

Numerous research works made in scientific centers and in laboratories of printers manufacturers, international normalization works are proves for big interest in the issues of printing quality. Besides there are made research on exploitation materials such as paper and dyes.

The fundamental international document that is dealing with issue of quantitative estimation of the parameters of printouts quality and methodology of the measurements of the printouts quality parameters is ISO 13660 standard.

The standard concern basically general parameters of monochrome printouts quality. These parameters are put together in two groups: parameters of linear elements and surface parameters. Linear parameters concern mainly quality of alphanumeric writing marks. The surface parameters concern mainly graphic pictures.

The advantage of the standard is a definition of the fundamental parameters of quantitative estimation of the quality of monochromatic printouts as well as the methodology of the measurement of those parameters. Nevertheless there are also shortcomings in the standard.

The basic shortcomings of the ISO 13660 standard are: the lack of definition of quality of color printouts, the lack of relation with the subjective feelings connected with the perception of the pictures by the reader or by the observer, shortcomings in methodology of the test printouts preparations, shortcomings in the methodology of tested printers calibration, shortcomings in the methodology of the calibration of the measuring equipment that is taking part in preparing control test printouts and preparing color printouts (e.g. scanner, monitor, computer system). Very important shortcoming of the ISO 13660 standard is the lack of the parameters typical for particular technology of digital printing.

Technologies of digital printing differ between each other because they use different physics – chemical phenomena, what made them achieve specific features typical only for one technology.

Defects of the ISO 13660 standard were presented in several publications.

The results of research, which are concerning the subject of the printing quality, that are presented in these publications clearly suggest the directions of the development of the research work and international normalization works. Many publications suggest that there should be revision of an ISO 13660 standard.

This work deals with specific features of the printing on the thermal paper, difficulties in realization thermal printouts as well as perfection in maintenance in printouts quality. For example characteristic feature for this printout is near print resolution (because of the common usage of heating resisting elements that have specified geometrical dimensions), not very precisely printed first liens of the horizontal incommensurable line segments (heating elements of the linear thermal head are not sufficiently warm).

These and similar properties of thermal printouts show the need of more accurate analysis of printing process, determination of the influence of single factor on the quality of printing as well as completing the ISO 13660 standard. The supplement could be a detail part norm that concerns quality parameters of the thermal printouts.

Specific features of classic printing technology of thermal printing on thermal paper as well as their connections with the quality of printouts.

There are several characteristic features of the process of the thermal printing on the thermal paper.

During printing the linear thermal head are used. The characteristic of that technology is near print resolution. The near print resolution cause characteristic "steps" that can be seen on the slanting lines as well as on the curvilinear elements of the writing marks and pictures – Fig. 1.

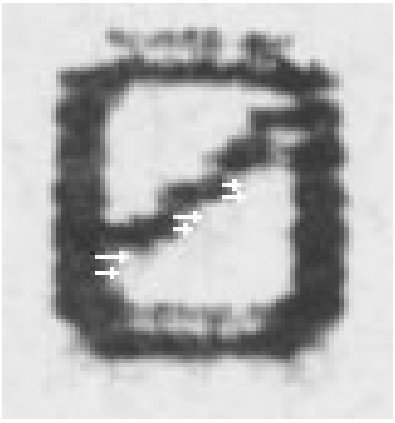

Figure 1. "Stepping" of the thermal printouts on the lines

It often happen that some printing resisting elements are damaged. In such situation there can be observed not dark perpendicular lines on the printout. Because of that on the beginning of the investigation there should be done a printout of the rectangles on the all width of the printed verse. If there occur no printed line than the printing head is damaged.

This defective work of head is one of the reasons because of which there can be observed line non-continuity.

During printing one pixel thick horizontal lines by the linear head, especially during the beginning of printing process (first horizontal line) it may happen that not all heating resisting elements are warm enough in order to make a blackening of the point. In such a situation printed line has a non-continuity, because it has points that are not dark at all or that are insufficiently dark (the blackening is smaller than the darkness border described in ISO/IEC 13660 as a 60% darkness edge threshold – R_{60}). – Fig. 2.

This phenomenon causes non-continuity on linear printouts. In order to avoid it on all investigated printouts there was applied line that was two pixels thick. The next line is usually printed by fully warm elements and because of that is a continuous line.

We made investigation of our printouts from the thermal paper. Our research proved that printing of the rectangles that have different length (printing of the horizontal line that have different length and using different number of resisting elements) cause the damage in the darkness of the rectangles. The smaller the number of heating resisting elements was heated the shorter is the length of the printed line and the darkness of the line grew – Fig. 3 and 4.

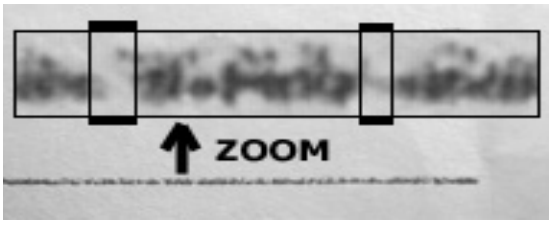

Figure 2. Line non-continuity in two pixels thick lines (printout of lines that are two pixels thick)

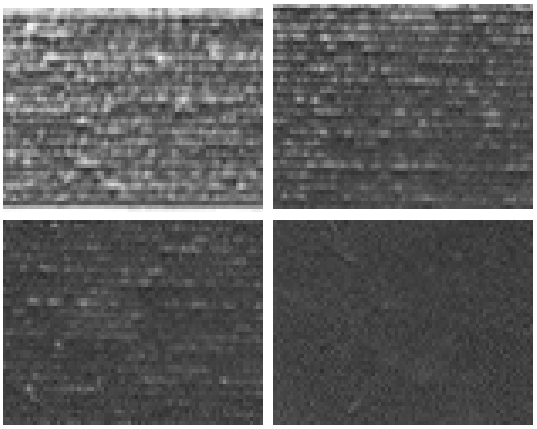

Figure 3. Darkness of the rectangles that have different width - rectangles with different length and with changing darkness

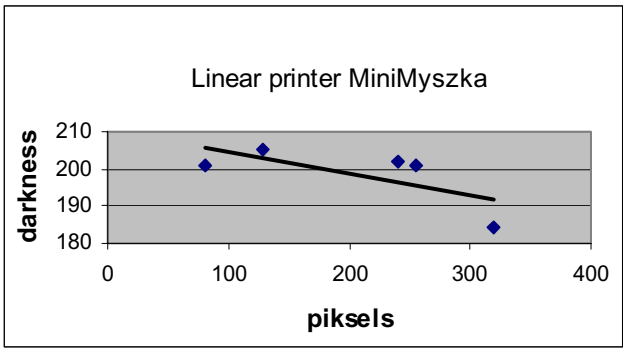

Figure 4. Dependence of the darkness parameter as a function of the length of the rectangle.

The reason for such changes in the darkness of the rectangles is a difference in the power supply to the heating resisting elements in linear thermal head. The total energy is being distributed in bigger number of the resisting elements when longer rectangles are being printed. This causes the difference in darkness of the printed elements (different values of the darkness parameter).

The printout on the thermal paper is made during continuous movement of the paper. This causes the blurriness on the edges of the printed lines or pictures. This effect can be seen beyond the edges in the direction opposite to the direction of the paper movement. For printers with linear printing head the blurriness occur on the horizontal lines in the direction perpendicular to the verse and below the verse. For the printers with moving head the blurriness occur on the vertical edges in the direction opposite of the printing head – Fig. 5.

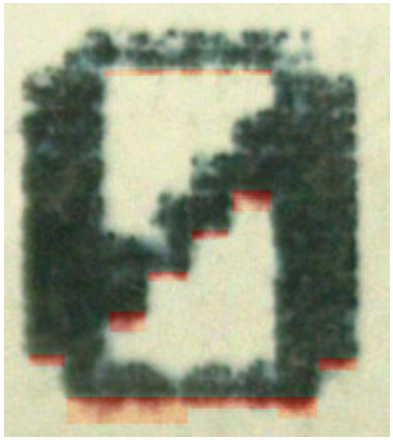

Figure 5. The blurriness of the printed pictures for the linear printing head

The blurriness of the printed pictures is a characteristic feature for the printouts on the thermal paper and is described and measured by such parameters as: blurriness and raggedness.

Thermal printouts may have different darkness of the printed points because of the different thermal properties of the printing head resisting elements. These differences are described by such parameters as: fill and mottle which are defined in ISO/IEC 13660 standard. Properties of the thermal paper have big influence on the values of the fill and mottle parameter.

In practice diversified thermal papers are being used. (The differences are in thermal properties of the papers as well as in structure of the paper. The thermal paper may have low, medium or high thermal sensitivity. The paper structure might be common, coated or multiplayer). For the investigation on the printing quality control it is recommended to use the paper that is recommended by the manufacturer of the printer. It is also possible to use one chosen paper. In our investigations one type of thermal paper was used due to limited technical possibilities.

The research on the influence of the paper parameters on the printing quality should be done in agreement with the paper manufacturers.

To sum up the parameters of the printouts quality on the thermal paper are: linear non-continuity, blurriness of the edges, stepping, darkness, mottle, and fill.

Blurriness, raggedness, fill, mottle, darkness are general parameters of the printing quality described in ISO/IEC 13660 standard. The rest of the parameters are offered and defined specially for thermal printouts on the thermal paper as characteristic parameters for that type of printing.

Give the definition of the linear non-continuity, stepping and illustrate these parameters with pictures.

The linear non-continuity is described as an interruption in the darkness of the horizontal line that is composed out of two verses of the pixels below the darkness edge threshold defined according to the ISO 13660 standard – below 60% darkness.

The stepping is defined as division of common area of stepped lines and area of theoretical slanting lines – Fig. 6.

In agreement with procedure recommended in ISO/IEC standard, for the determination of blurriness, raggedness and darkness parameters scans of control printouts were made. From obtained files values of the parameters were calculated. Results are presented in table 1.

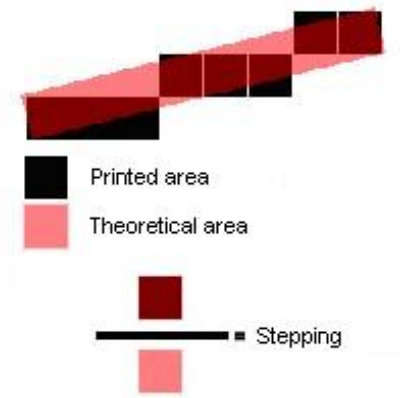

Figure 6. Definition of "stepping"

Table 1. Values of the Thermal Printouts Quality Parameters

	Width of printout [pixels]	Darkness	Raggedness [mm]				Bluriness [mm]			
			Top	Down	Left	Right	Down	Top	Left	Right
Printer (linear) MminiMyszka	320	184	0,86	0,5288	0,82	1,34	12,33	8,74	7,63	10,98
	255	200	0,91	0,62	0,45	0,54	11,02	5,16	4,77	6,04
	240	202	1,00	0,59	1,00	1,07	11,68	5,27	10,26	6,54
	128	205	0,47	0,84	0,27	0,28	7,36	5,90	2,54	2,12
	80	200	0,81	0,99	0,25	0,25	6,44	6,34	1,81	2,34
Printer(moving) Kafka SQ	255	203	0,19	0,25	0,30	1,667	2,76	3,84	3,73	23,82
	194	201	0,18	0,19	0,71	1,02	2,29	3,22	3,41	19,48
	128	200	0,24	0,22	0,32	0,77	2,31	3,60	3,18	6,10

Conclusions

There are proposed such parameters of the printouts quality, which are specific for the monochromatic thermal printouts: linear non-continuity, stepping, blurriness of the edges.

There are proposed such general parameters of the thermal printouts quality: darkness, linear non-continuity, stepping, and blurriness of the edges, mottle, and fill.

The thermal printouts made by the linear printing heads have better quality of vertical than horizontal lines.

The preparation of the part standards for the thermal printouts is advisable.

References

1. Standard ISO 13660 “Measurement of image quality attribittes for hardcopy autput- Binary monochrome text and grphic images” 2001

Biographies

Ludwik Buczynski received his PH DR degree in micromechanics from Warsaw University of Technology in 1972. Since 1963 he worked in Micromechanics and Photonics Institute of Warsaw University of Technology and since 1986 to 2003 in R&D Center Office technique PREBOT Radom Poland. He is member of IS&T. Since 1990 his main area of interest are computer peripheral’s devices and image quality investigations.

Eryk Klucinski is a student of the Warsaw University of Technology, Institute of Micromechanic and Photonic. His diploma work concern of influence of thermal print technology on image quality and standardization’s works in image quality.