GRID 2020
10 . INTERNATIONAL SYMPOSIUM
GRAPHIC ENGINEERING AND DESIGN
12-14. NOVEMBER 2020

10th JUBILEE

Influence of digitization input device on calculation of print (non)uniformity value of prints using ISO13660 method

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Introduction

There are developed various methods for print quality control, starting from densitometry until spectrophotometry. Recently, one new way has also been introduced for evaluating the print quality of lines, text, print uniformity, registration, etc. It is still underdeveloped but is undoubtedly used for print quality control. The new method is called Image Quality Analysis by some authors (Briggs and Tse, 2005), and it is based on an analysis of the acquired images (i.e., printed samples).

We adjusted the name and called it the Image Analysis Method (IAM) because it closely describes the quality control of the prints. Schematic representation of the method is presented in Figure 1. From the original to the numerical values, we need to go through a few steps. The technique can be incorporated into one device (such as QEA Personal IAS or vipFLEX), or the steps could be performed independently.

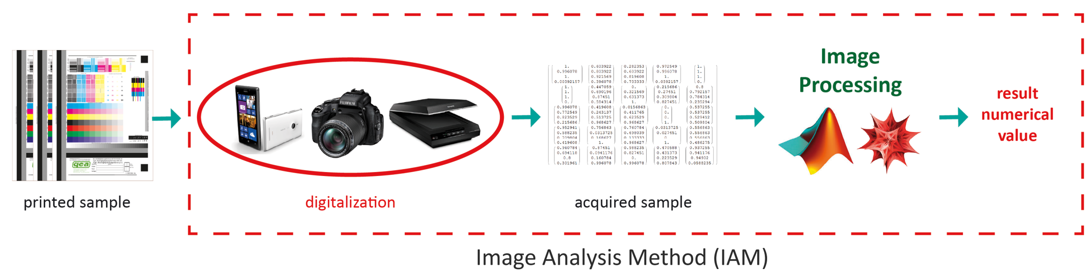

Figure 1

Schematic representation of Image Analysis Method (IAM)

Using IAM, we can evaluate print quality according to a large number of attributes. One of the most frequently used attributes is print (non)uniformity. The general physical description of this attribute is that the print nonuniformity is an unwanted variation of optical density (reflected light) from the print. There are different types of print nonuniformity. Two main groups are random and systematic nonuniformity.

In this paper, we only analyzed random nonuniformity – graininess and print mottle.

Methods

The samples for the experiment were generated using the MATLAB software and plugin Macro Uniformity Toolbox (Rawashdeh, 2006). In the mentioned sample generation plugin, it is possible to vary several parameters. For the research, it was chosen to vary the minimum size (pmin) of the blotch. On all samples, the background color is neutral gray (0.5) (Fahlcrantz, 2005; Lindberg and Fahlcrantz, 2005), and the size of digital samples is N = 2048 px.

Generated samples were printed on IQ Selection whiteboard (250 g/m2) with inkjet printing machine Epson Stylus PRO 7800. Size of the patch was 160 x 160 mm (Jurič, 2018). After print, samples need to be digitized. For this research, we used two different systems: scanner-based and camera-based system. When scanning samples, all automatic corrections were turned off for all devices. Scanner resolution was set at 600 spi. Unlike scanning, during digitization of samples with a mobile phone, it is necessary to define the conditions of digitization and device parameters to avoid variations during the experiment. These devices must be positioned and fixed during digitization, so for the purposes of the experiment, it is necessary to use the stand. The mobile phone was at a distance of 30 cm from the sample, and the D50, which simulates daylight, was chosen as the light source.

After digitization, the samples required necessary processing, which implies only two operations: cutting and rotation. Depending on the resolution of the digitization input device, the fields for later processing are of different dimensions in pixels, and constant dimensions expressed in cm. To avoid blurred edges and the appearance of vignettes, the 16 x 16 cm sample was cut to 15.5 x 15.5 cm.

Results / Discussion

Based on the obtained results of print nonuniformity (Figure 2 and 3), using the ISO method, the samples can be clearly grouped into two sets: micro (graininess) and macro (print mottle) nonuniformity. Regardless of the size of the blotch (spot), some of the samples can be grouped as graininess and some as mottling. The ISO Graininess value increases to sample V4 and then decreases slightly, while the ISO Mottling value slowly rises from the first sample and continues to grow after sample V4. A spot size of pmin = 0.95 for this sample confirms the definition of the ISO standard 13660, that in mottling the maximum spot frequency is less than 0.4 cy/mm (ISO, 2001) which corresponds to a spot size pmin of 2.5 taken for sample V5. The maximum frequency for sample V4 is: fmax = 1/pmin = 1.05 cy/mm. Therefore, it can be concluded that samples from V0 to V4 belong to the group of micro nonuniformity. The slope of the curve in sample V21, which is most pronounced when using a scanner, confirms that the sample is the same as sample V0 - uniform. By enlarging the spot size, a uniform print is obtained again.

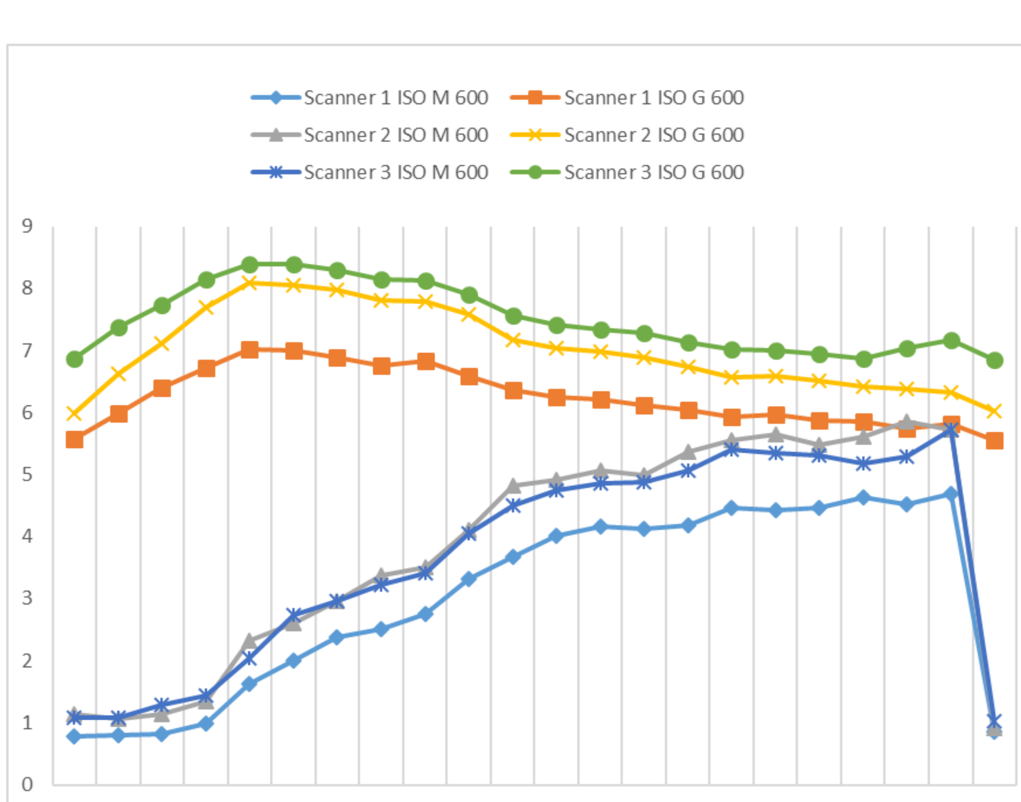

Figure 2

Results of graininess and print mottle using scanners as input device

Based on the graphs, it can be clearly seen that the values obtained using different scanners correlate well, which confirms the value of the correlation coefficient that is above 0.9. However, this is not the same case when looking at mottling values when using mobile phone as input device. The shape of the curve is drastically different, and the correlation is much weaker (0.6 - 0.8). When using a mobile phone, signal noise occurs, which directly affects the calculation of the print mottle, but does not affect the graininess value.

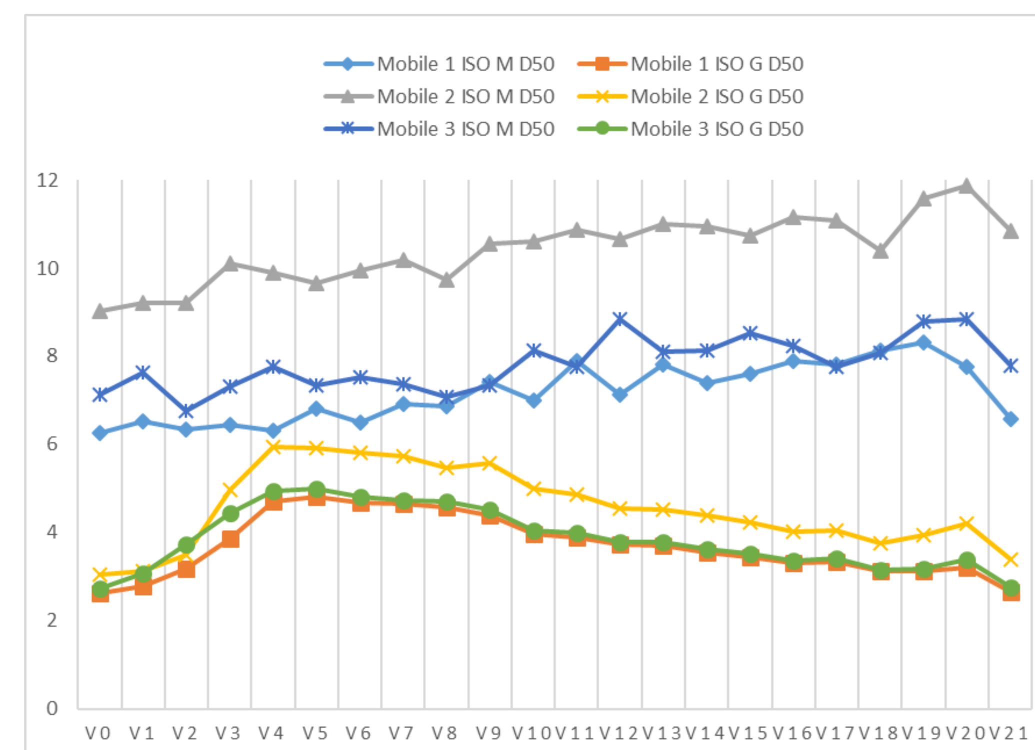

Figure 3

Results of graininess and print mottle using mobile phones as input device

Conclusion

Print quality analysis is a crucial part of the printing process and should be conducted in controlled and well-defined conditions. The ISO 13660: 2001 standard has defined new attributes for quality analysis, but is incomplete in terms of methodology. In this paper, the influence of the input device for digitization on the obtained value of print nonuniformity (mottle and graininess) is examined. Based on the results, a clear difference in mottle and graininess values can be seen when different devices are used for digitizing the same samples. The most considerable deviations from the set, initial values appear when measuring mottling when using a mobile phone. The scanner proved to be a more stable and accurate device to use.

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ACKNOWLEDGMENTS

This research (paper) has been supported by the Ministry of Education, Science and Technological Development through the project no. 451-03-68/2020-14/200156: "Innovative scientific and artistic research from the FTS (activity) domain".