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RESEARCH ARTICLE

Comparative analysis of print contrast of hybrid modulated digitally modulated screening on different grades of paper

Vandana*, **Ambrish Pandey**

Abstract

Information technology and Innovation has transformed our life; the same is true for printing. Screening technology has developed and become highly advanced during past few decades. The aim of this research is to identify the significant difference in print contrast between hybrid modulated (XM) digitally modulated (DM) screening on different grades of paper printed by sheet-fed offset printing process. Samples sheets are printed with same solid ink density to make valid comparison. Around 150 sheets are printed to achieve target solid ink density value (+ 0.05) during printing. After the density values are attained in accordance with standard SID values, next 50 sample sheets are printed, measured and evaluated.

Keywords: Print contrast, Solid ink density, Hybrid modulated screening, Digitally modulated screening.

Introduction

Screening is used to convert continuous tones images into printing dots. Printing is done by transferring these dots to the desired substrate under defined printing conditions. XM screening is also known as cross/hybrid modulated screening. It places the frequency-modulated microdots on an amplitude-modulated grid which is spaced uniformly (Hybrid Screening, AM, FM Screening, Cross Modulated Screening, Magnetic Inks, Printing Inks). XM technology is the result of developing a modern algorithm of conventional screening, which allows higher line screen printing than Amplitude Modulated Screening and a significant reduction in the process control that was associated with frequency-modulated screening (Dial, 2006). XM screening is primarily amplitude modulated screening, although frequency-modulated screening is used at tint values below 5% and above 95%. This allows smooth transition and imaging in highlight and shadow areas (Allen, 2022b). XM screening is designed to compensate for each method's deficiencies by combining the best features of AM and FM screening technologies (Allen, 2022b). These screens are also known as "transitional" screens. By adopting hybrid screening, printers can raise line screens higher than usual halftone line screens without any rigorous process control and easier to print (Hybrid Screening, AM, FM Screening, Cross Modulated Screening, Magnetic Inks, Printing Inks).

DM screening is the advanced stochastic screening since it provides ultra-smooth flat tints that are as smooth as AM conventional screening and achieves the high level of image detail long associated with FM stochastic screening. In DM screening, each and every pixel is modulated and controlled digitally considering the laser optics, plate technology, ink flow and press behavior so that dot gain is eliminated, resulting in the removal of artifacts and graininess completely (Screening Technologies- Premedia and Print Workflow Solutions-Prepress Automation, n.d.). DMS is also defined as "intelligent screening". DM screening decodes an image digitally during the rasterization process and then analyses it intelligently to determine the position of dots precisely on the plate with their proper sizes and shapes (Sherfield, n.d.). The DMS halftone dots display two crucial qualities, first, they output images with dots that are small enough to produce a print that is nearly photographic in quality and second, they are sturdy enough to be stable in a real-world production environment (Badea, 2019c).

Print contrast is the ability of the printing press to hold shadow detail (Figure 1). The print contrast is inversely

Department of Printing Technology, Guru Jambheshwar University of Science & Technology, Hissar, Haryana, India.

***Corresponding Author:** Vandana, Department of Printing Technology, Guru Jambheshwar University of Science & Technology, Hissar, Haryana, India, E-Mail: vandanaguptahsr@gmail.com

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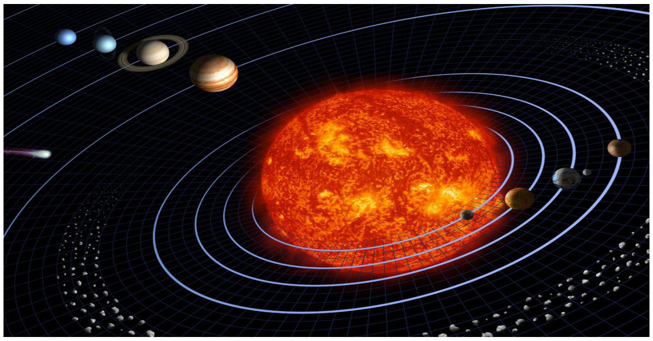


Figure 1: Print contrast

Source: https://media.nationalgeographic.org/assets/photos/000/291/29100.jpg

proportional to the dot gain. Print quality increases with the increase of contrast (CO.FO.ME.GRA., 2008). Print contrast is determined by checking the screen in the three-quarter tone. Print contrast should have higher value as much as possible. It means that the solids should have a high ink density, but the screen should still print open. When the inking is increased and the ink density of the dots rises, the contrast is increased. However, the increase in ink feed is only practicable up to a certain limit. Above that limit, the dots tend to exhibit gain, especially in three-quarter tone, to fill in.

This reduces the portion of white paper, and the contrast decreases again. If the solid density is correct, the contrast value can be used to assess various factors which influence the print result such as rolling and printing pressure, blankets and underlays, dampening, printing inks and additives. Since the contrast value, unlike the dot gain, depends to a large extent on the solid density it is not suitable as a variable for standardization. This is why in the recent past, its importance has decreased significantly (Keuter & Ryzko, 2012).

Print contrast is calculated by measuring the ink density of a solid area and the ink density in 75% tint. The print contrast is calculated by using below formula:

$$\text{Print contrast} = \frac{D_s - D_t}{D_s}$$

where D_s is the solid area density, and D_t is the tint density (CO.FO.ME.GRA., 2008).

Objectives of Study

The research objective of this experiment is to compare the print contrast at 75% patch printed by offset printing process using hybrid modulated screening and digital modulated screening techniques. An experimental approach is adopted for collecting data of cyan, magenta, yellow & black ink at 75% patch printed on different grades of paper to identify the significant difference between them (Table 1).

Materials and Methodology

This research work is based on an experiment. To conduct this research work, the master of 44.5 × 29.5 cm output is prepared by incorporating quality measuring parameters and printed in KCMY color sequence on different grades of paper on RYOBI 524HX (Sheet fed Offset) by using XM and DM screening technologies. Around 150 sheets are printed to achieve target solid ink density value (+ 0.05) during printing. After the density values are attained in accordance with standard SID values, next 50 sheets are printed for spectrophotometer analysis. To execute this research work, a particular paper type is printed with the same SID by using different screening methods (XM & DM) with variations of + 0.05 to make a valid comparison. Gloss coated and matte-coated sheets are printed at C-1.35, M-1.30, Y-1.35 & K-1.5 SID. Uncoated White and yellow sheets are printed at C-1.1, M-1.05, Y-1.1 & k-1.25 SID. LWC is printed at C-1.20, M-1.20, Y-1.25 & K-1.35 SID.

Printing substrates are selected according to the paper types defined by ISO 12647-2 for offset printing (Characterisation data. (n.d.)) GSM Margin of ± 5 is considered as per the availability of paper stock in the market. Below are the different paper grades used for research work for offset printing (Table 1).

Data Analysis

To evaluate the quality of printed sheets, a series of test elements is printed along with the image, and each element is designed to highlight a particular aspect of the printing quality parameter. Some of these test targets are evaluated by measuring instruments and others are evaluated visually. For this research work, print contrast is measured at 75% patch of cyan, magenta, yellow and black ink by using XMS and DMS with the help of spectrophotometer-X-Rite eXact™. Average values of cyan, magenta, yellow and black ink printed

Table 1: Specifications of different paper grades used for research work

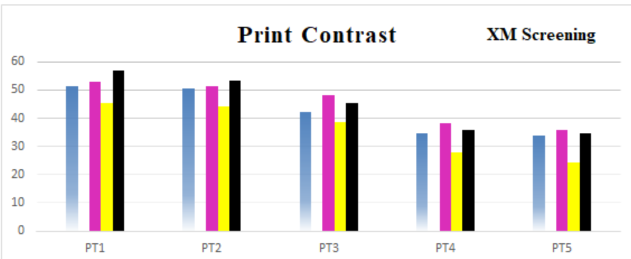
Paper Grades	*GSM*	*L*	*a*	*b*	*Company*
Paper type 1 (PT1)	120 g/m² glossy coated	95.24	0.44	-3.18	SAPPI
Paper type 2 (PT2)	120 g/m² matte coated	96.04	0.02	-1.5	SAPPI
Paper type 3 (PT3)	65 g/m² LWC web offset	94.61	1.02	-0.06	CENTURY
Paper type 4 (PT4)	120 g/m² uncoated white offset	93.89	2.09	-5.72	ITC
Paper type 5 (PT5)	120 g/m² uncoated yellowish offset	93.61	-0.73	8.32	RUCHIKA

Table 2: Average value of print contrast @ 75% patch of C, M, Y & K ink by using XMS

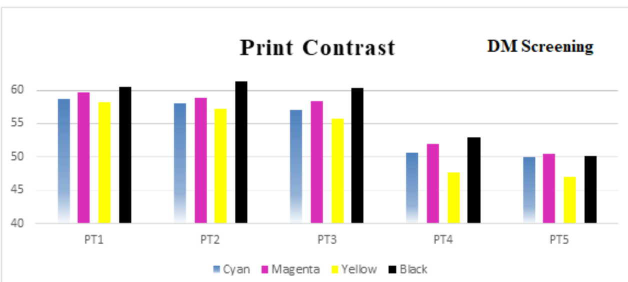
XMS	*PT1*	*PT2*	*PT3*	*PT4*	*PT5*
Cyan	51.5	50.4	42	34.8	33.9
Magenta	52.7	51.3	48.2	38.0	36.0
Yellow	45.2	44.3	38.4	28.0	24.2
Black	57.0	53.3	45.5	35.7	34.8

Table 3: Average value of print contrast @ 75% patch of C, M, Y & K ink by using DMS

DMS	*PT1*	*PT2*	*PT3*	*PT4*	*PT5*
Cyan	58.6	57.9	57	50.6	49.9
Magenta	59.6	58.8	58.3	51.8	50.4
Yellow	58.1	57.1	55.7	47.6	46.9
Black	60.3	61.2	60.3	52.9	50.2



Graph 1: Average value of Print Contrast @ 75 % patch of C, M, Y & K ink by using XMS



Graph 2: Average value of Print Contrast @ 75% patch of C, M, Y & K ink by using DMS

using hybrid and digitally modulated screening on different grades of paper are presented in Tables 2 and 3. Graphical comparison of cyan, magenta, yellow and black on different paper types by hybrid modulated Screening (Graph 1) and digitally modulated Screening (Graph 2).

Results and Discussion

Print contrast is observed as an integral component in printing to define entire tonal range for image reproduction. This indicates improved ability to reproduce an image with greater shadow details. Digitally modulated screening has more print contrast than hybrid modulated screening. It is also observed that digitally modulated screening showed high print contrast irrespective of paper types as compared to hybrid modulated screening.

It is observed that print contrast lowers down as the paper goes coarser. In all paper types (Gloss coated paper, matte-coated paper, Lightweight coated paper, Uncoated white paper and Uncoated Yellow paper), GC paper showed maximum print contrast.

Conclusion

Digitally modulated screening is more suitable than hybrid modulated screening in terms of print contrast on all paper types printed by a sheet-fed offset printing process. It is also observed that digitally modulated screening shows better shadow details irrespective of paper types. Print contrast on coated substrates results better than uncoated substrates.

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