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Analysis of Screen Frequency, Scanning Resolution and Magnification Induced Variation on Tonal Characteristics of Lithographic Offset Print

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Abstract: Graphic reproduction in digital environment involves use of scanned or computer- created originals. In scanning process, influential parameters with regard to print quality are input resolution, desired screen frequency, and magnification. In pre-press houses, rule of thumb prevails when it comes to selecting scanning resolution without considering influence of magnification and desired print quality expressed in line per inch. Such general approach gives rise to unnecessary file size and variation in tonal characteristic. Even separate in-house standards also add to the complexity of the problem. This paper aims at identifying and validating relationship between such variables and giving input scanning resolution. The paper studies printing of given image along with control element in twenty-seven trials on maplitho paper to facilitate measurement of tonal characteristic.

Index Term*:* Screen Frequency, Scanning Resolution, Tonal Characteristic Offset Printing, and Magnification

1. INTRODUCTION AND BACKGROUND

In full color graphic reproduction, commonly known as four color printing, a printer is required to achieve color, grey and tonal balance to reproduce color in lithographic offset printing. In the wake of digitization of origination department final print quality is getting decided in designing stage as the digital proofing technique using inkjet printing technologies is established. Conventional equipment like reproduction camera, contact printer and printing down frame have now been replaced by Image setter and Plate setter. These technological advancements have put more emphasize on accuracy of digitally created or captured graphic originals. Originals are captured with CCD or CMOS based digital camera and color scanner. Each CCD or CMOS unit forms one pixel of the image and such number decides effective resolution of the image. Digitally image is captured at once with scanners and digital cameras with intended resolution. This resolution expressed in DPI (dots per inches) decides reproducible grey levels and print quality measured in LPI (lines per inches). Magnification factor for reproduction is also equally responsible to define final print quality irrespective of printing technology employed. The linear relationship suggested by David C [3] in the following formula.
Scanning Resolution (DPI) = 2 X Magnification Factor (m) X Desired Print Quality (LPI)

In professional assignments scanning resolution is preferred at 300 DPI without bothering much about desirable LPI and magnification factor in question. Image size, expressed in megabyte, is the function of number of colors in image, intensity levels per color and scanning resolution or display resolutions expressed in DPI and PPI respectively. The comparative relation with regard to memory size is shown in table 1. As table 1 signifies importance attached to increasing scanning resolution which is showing increase in memory size of the image.

Table 1. Memory Size for different digital image.

No. of Colors per Pixel	Number of bits per Color	Scanning Resolution (DPI)	Memory in Megabytes
1	8	300x300	7.2
3	8	200x200	9.6
3	8	300x300	21.6
3	8	400x400	38.4

Handling and managing such huge file within the digital workflow and over the internet adds to the cost. The aforementioned formula states relationship between scanning resolution with desired LPI and magnification factor. But increase in LPI is not always a welcome step as it gives rise to dot gain in mid-tone area with all types of dot shapes. Hardware used in graphic arts industry is memory dependent and hence outputting speed and efficiency also get affected. In India the industry standard exercised for scanning is 300 DPI as magnification range is limited. Digital input devices offer resolution levels exceeding 1200DPI and hence study of effect of changing scanning resolution on print characteristics can validate the industry standard and help pre-press operator to optimize the scanning environment.

Bandyopadhaya S. [1] has overviewed use of histogram in optimizing screen ruling and screen shapes to improve image and print quality. Study was limited to study interactions between screen ruling and shapes required detailed investigation into factors of image quality. David C.J [3] presented detailed information on relationships between finite image resolution parameters- DPI, PPI, LPI, and SPI. He also covered hardware used in digital printing workflow that included scanner, image setter, computer screen display, and printers. Charles J. et al. [2] developed a camera-back OCR system capable of recognizing text from poorly scanned text documents based convolution neural network trained on large data. However this model assumed paper surface of uniform white with text of uniform shade on it and did not cover possible effect of scanned color and non-text images on text recognition. Shuzhen W. et al. [4] introduced a system with potential for application in image-based modeling and rendering, cultural heritage projects, and professional digital photography. Helmut C. [5] has summarized development of scanning technologies and shed light upon designs and constructions of different types of scanners used in full color graphic reproduction. Gregory M. [6] has elaborated factors involved in CTP scanning that finally decide print quality parameters. Hugh M. [7] presented relationships between DPI PPI and LPI in the simplest similar to that of David C.J [3]. Relationship between scanning resolution and print quality parameters was also studied by Bob T. [8] and it was mainly aimed at understanding effect of properties of materials used in graphic reproduction.

Related work discussed above have successfully established importance of resolutions of color scanner, monitor, Computer-to-Plate system, Raster Image Processor, proofing system, digital camera and underlined their importance in defining print quality in graphic reproduction and display quality on website and monitors. These experiments could suggest formula for scanning, printing resolutions, and reproducible grey levels but resulted in offering two multiplying factors- 1.5 and 2.0 to calculate scanning resolution PPI when printing resolution LPI was given [3]. Additionally the experiments did not focus on studying the effect of scanning resolution on print quality parameters- dot gain, tonal and color balance. It is normal in printing to plot a characteristics curve to analyze main effect and study interactions between printing parameters. The characteristics curve takes global performance of print into account and hence is capable of giving complete feedback of effect of parameters involved on print quality [8]. In this paper an effort is made to add two more parameter to printing resolution LPI shown by Bandyopadhaya S. [1] that is scanning resolutions PPI and magnification factor 'm' while keeping dot shape constant. This paper used characteristics curves i.e. plot of theoretical dot area % on x-axis against observed printed dot area % on y-axis for three levels of input scanning resolutions.

In the reminder of this paper the materials, parameters and experimental set-up is presented in section 2 while results and graphical representation is taken in section 3. The brief observations based on graphical representations are described in section 4. The last section discusses the conclusion and achievements of the experiment carried out. The paper, to simplify the discussion, has provided total four tables and three figures and dot area % measurements totaling 324 are shown in appendices A, B and C.

2. MATERIALS AND PARAMETERS

As lithographic offset printing is still the most preferred choice for commercial printers, it is selected as printing technology to print prepared test forme consisting grey scale and normal full color original. The table 2 and 3 show varying and constant parameters identified for the project activity. The 27 experimental trials undertaken are shown in table 4.

Table 2. Varying parameters

Parameter	Varying
Screen Frequency LPI	120, 150, 175
Scanning Resolution DPI	200, 300, 400
Magnification Factor m	0.75, 1.00, 1.25

Table 3. Constant Parameters

Parameter	Constant
Dot Shape	Elliptical
Substrate	80 GSM Map litho Paper
Ink	Micro Quickset Ink
4 - Colour Sheet Fed Offset Printing Machine Operating Condition	Press Speed, Fountain Solution Chemistry, Printing Pressure

Table 4. Experimental Set up

Screen Frequency LPI	Scanning Resolution DPI	Magnification Factor m
150	400	1.25
150	300	1.00
120	400	1.00
150	400	0.75
120	300	1.25
120	300	1.00
175	200	1.25
120	200	1.00
150	200	1.25
120	400	0.75
120	400	1.25
150	300	0.75
150	200	1.00
175	400	1.25

175	300	0.75
175	300	1.00
120	200	0.75
150	300	1.25
150	400	1.00
150	200	0.75
175	300	1.25
175	200	1.00
120	200	1.25
175	400	0.75
175	400	1.00
120	300	0.75
175	200	0.75

Screen frequencies selected (120, 150 and 175 LPI) follows the industry trend and scanning resolutions (200 DPI, 300DPI and 400 DPI) are selected on either side of industry standard of 300 DPI. Magnification range is following the ISO 'A' series paper size.

To observe more close response of varying parameters effect of digital plate making i.e. computer-to-plate making technique is used which maintains the tonal reproduction during imaging stage. Print characteristics or dot area curve is taken as a response variable to judge the performance of individual trial. The significance of scanning resolution (DPI) is decided to be judged from the graph of theoretical % dot area taken against observed % dot area in the print trial. Measurements of dot area are taken with the x-rite spectrophotometer that is capable of measuring dot area in percentage. Instrument calibration was done prior to the measurements and other measurement conditions were followed in accordance with the guideline given in the instrument manual. During printing digital pH meter was used to maintain pH of the fountain solution throughout the printing trials.

Trials are taken with 80 GSM maplitho paper with quickset inks. Nine trials for each screen frequency are accommodated on one sheet of (19 X 23) inch. Elliptical shaped half tone dots are selected as they show less dot gain and noise with increasing screen frequency.

3. RESULTS: GRAPHICAL REPRESENTATION

Percentage dot areas measured from grey scale- print control element is shown in table 5 to table 13. In each table scanning resolution is changed while keeping screen frequency and magnification-factor same. In this way all 27 trials' performance is tabulated only in nine tables. Theoretical dot area percentages are measured for ten gray scale levels and are adequately giving indication of print characteristics performance. Figures 1 to 9 represent plot of theoretical dot area (%) against observed dot area (%). Each of such eighteen plots are accommodating three curves each drawn at scanning resolution of 200, 300 and 400 DPI and keeping screen frequency and magnification unaltered in every figure. Such curves represent print characteristics performance of each experimental print trial.

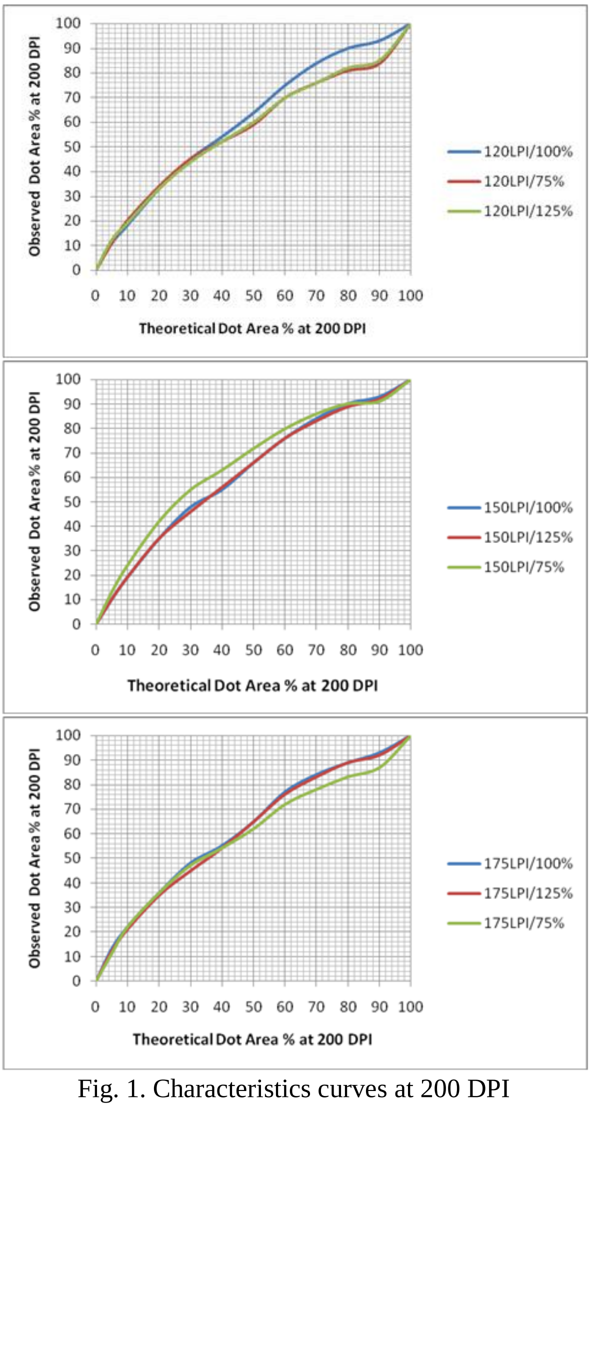

Fig. 1. Characteristics curves at 200 DPI

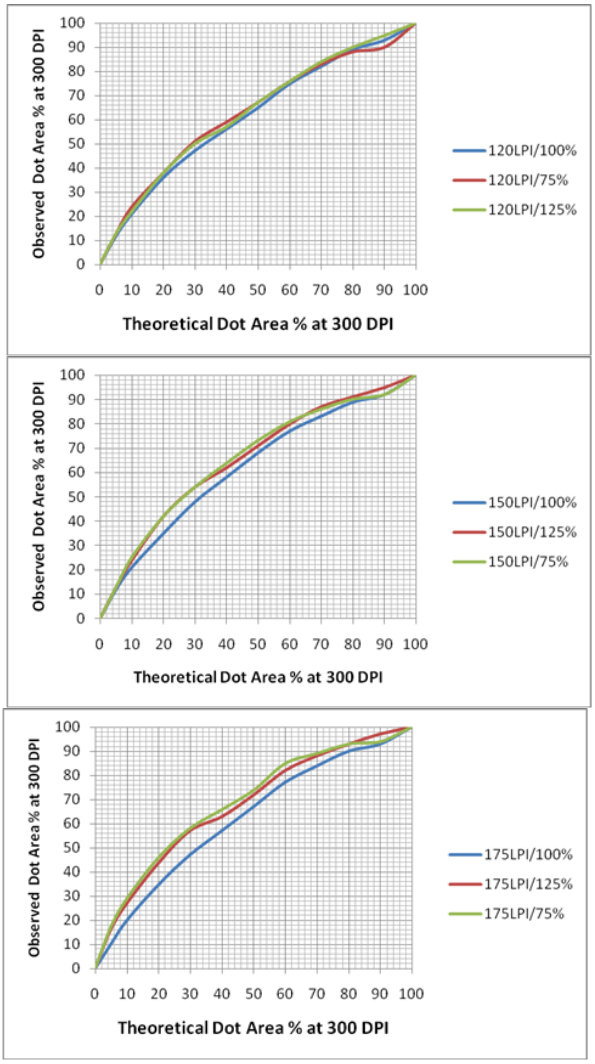

Fig. 2.Characteristics curves at 300 DPI

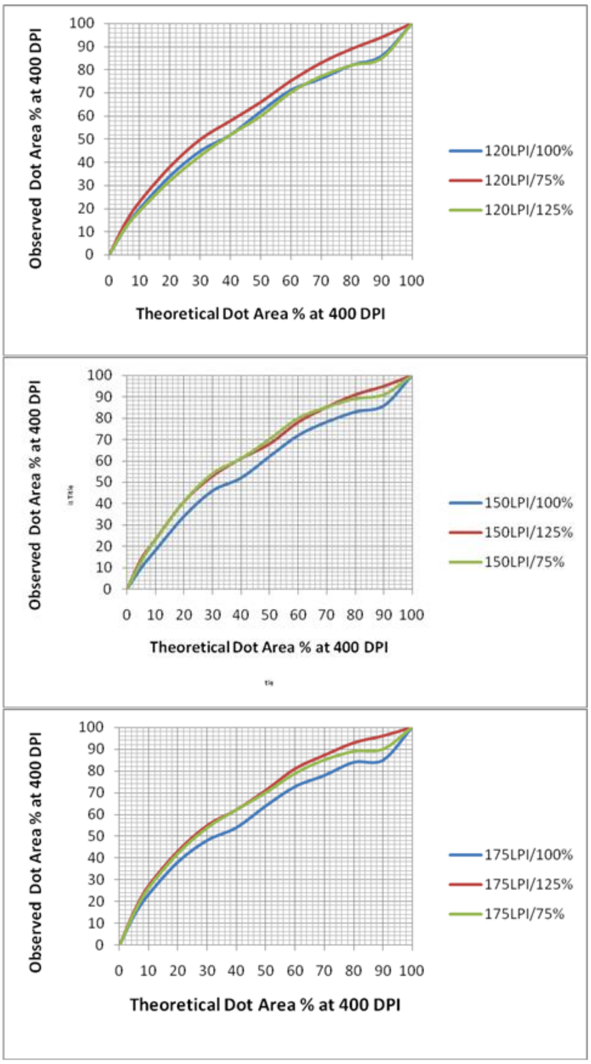

Fig. 3.Characteristics curves at 400 DPI

4. OBSERVATIONS

As LPI increases, dot gain increases. Significant dot gain occurs when reduction of the original image takes place when at the same DPI and LPI level. As DPI decreases, significant amount of dot gain occurs as compared to original DPI level. As DPI increases, not much change occurs. However, as LPI increases, we see some dot loss occurring as compared to original DPI level.

5. CONCLUSION

It is evident from the print characteristics curves that the scanning resolutions of 200, 300 and 400 DPI make no significant effect in print quality. For a given screen frequency and magnification factor, the % age dot gain decreases with increase in scanning resolution but not significantly. For full color graphic original reproduction, the scanning resolution of 400

DPI appears to be non-critical and adds only to the increase memory size in pre-press work. Further experiments to study effect of higher scanning resolutions on fine text and line work printing needs to take up with modified test forme to analyze performance of reproduced print quality. Furthermore, in full color original reproduction as number of optimum grey levels required are 257 and lithographic offset printing technology is capable of reproducing them at 200 and 300 DPI resolution, the still higher scanning resolution seems unnecessary. Another experimental model also required to study response of digital output device to changing scanning resolutions to underline the effective utility of scanning resolutions provided in input devices such as color scanner and digital camera.

REFERENCES

[1] Bandyopadhaya S. (1999): Effect of Screen Ruling and Screen Shape on Image Quality. IS&T, pp. 311–314.

[2] Charles J. Patrice Y. Paul V. James R. (2003): Text recognition of low-resolution document images. Microsoft Research, 1(2), pp. 1–11

[3] David C. (2012): Understanding resolution and the meaning of DPI, PPI, SPI, & LPI. IDEAS, pp. 1-7.

[4] Shuzhen W. Wolfgang H. (2004): The design of an inexpensive very high resolution scan camera system. EUROGRAPHICS Vol. 23, No 3

[5] Helmut K. (2001); Handbook of Print Media Technologies and Production Methods. Springer. pp. 482-485

[6] Gregory M. (2000); CTP Scanning Systems. Handbook of Optical and Laser Scanning. pp. 713-730

[7] Hugh M. (1998); Introduction to prepress. Pira International. pp. 81-88

[8] Bob T. (1998); Printing Materials: Science and Technology. Pira International. pp. 451-472

Appendix A. Dot percentage for printing at 200 DPI

200 DPI	120LPI/ 100%	120LPI/ 75%	120LPI/ 125%	150LPI/ 100%	150LPI/ 125%	150LPI/ 75%	175LPI/ 100%	175LPI/ 125%	175LPI/ 75%
0	0	0	0	0	0	0	0	0	0
5	11	11	12	10	10	13	13	12	11
10	18	20	19	19	19	24	22	21	22
20	33	34	33	35	35	42	36	35	36
30	45	45	44	48	46	55	48	45	47
40	54	52	52	55	56	63	55	54	54
50	64	59	60	66	66	72	65	65	62
60	75	70	70	76	76	80	77	76	72
70	84	76	76	84	83	86	84	83	78
80	90	81	82	90	89	90	89	89	83
90	93	84	85	93	92	91	93	92	87
100	100	100	100	100	100	100	100	100	100

Appendix B. Dot percentage for printing at 300 DPI

300 DPI	120LPI/ 100%	120LPI/ 75%	120LPI/ 125%	150LPI /100%	150LPI/ 125%	150LPI/ 75%	175LPI 100%	175LPI/ 125%	175LPI/ 75%
0	0	0	0	0	0	0	0	0	0
5	12	13	13	12	13	13	10	16	17
10	21	24	22	21	24	25	20	27	29
20	36	38	38	35	42	42	35	44	46
30	47	51	50	48	54	54	47	57	58
40	56	59	57	58	62	64	57	63	66
50	65	67	67	68	71	73	67	72	74
60	75	76	76	77	80	81	77	82	85
70	82	83	84	83	87	86	84	88	89
80	89	88	90	89	91	90	90	93	93
90	93	90	95	92	95	92	93	97	94
100	100	100	100	100	100	100	100	100	100

Appendix C. Dot percentage for printing at 400 DPI

400 DPI	120LPI/ 100%	120LPI/ 75%	120LPI/ 125%	150LPI/ 100%	150LPI/ 125%	150LPI/ 75%	175LPI/ 100%	175LPI/ 125%	175LPI/ 75%
0	0	0	0	0	0	0	0	0	0
5	11	13	11	10	14	13	13	15	14
10	20	23	19	18	23	23	23	27	26
20	34	38	32	34	41	41	38	43	42
30	45	50	43	46	53	54	48	55	54
40	52	58	52	52	61	61	54	62	62
50	62	66	60	62	68	70	64	71	70
60	71	75	70	72	78	80	73	81	79
70	76	83	77	78	85	85	78	87	85
80	82	89	82	83	91	89	84	93	89
90	86	94	85	86	95	91	85	96	90
100	100	100	100	100	100	100	100	100	100