Method of Measuring Resolution for Printer

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Abstract

One of the methods designed by author for measuring resolution printed on paper or media from printer in which the pattern is formed by dots is described in this paper. This particular method printed out a special doted pattern by the testing printer and captured the image pattern through optical microscope with the integration of CCD CAMERA to process the image captured via image processing software. Several sets of dual dots distance were calculated and analyzed to come up with the printing resolution, not by the print head or optical scan module.

This method is suitable for testing any printing resolution that forms pattern with dots. The measuring method involves of a simple pattern design: two dots are separated and isolated at a proper distance, with the drafting software or control device to design a suitable diameter of a dot and gradually increase the distance between the center of the two dots, the increased value is less than the length of the resolution, increase the total length at least more than multiple times the testing resolution. Use this same method to print out several sets of patterns with perpendicular in horizontal and vertical axis respectively and capture the pattern from the combination of appropriate microscope and CCD zoom factor. Calculating the geometric center of the distance for the two points through the image processing software and from the compile statistics of the measured distances to come to know the distance change between horizontal and vertical axis would be the length of the printer resolution.

Introduction

There are two different types of resolution for the composition of the laser printer, one is optical scan resolution and the other one is hardware (system) resolution. The inkjet printer on the other hand has the nozzle arrangement and hardware resolution. The so-called optical scan resolution refers to the actual dpi presented on the surface when scanned by the light source of the laser. Hardware resolution refers to the dpi that can be displayed by the same direction as the paper feeds into the printer. Resolution for the perpendicular directions can be increased with software programs regardless of what type of printer used. For instance, the optical scanning of a laser printer can increase on/off frequencies of laser to increase the dpi value. The inkjet printer can increase the frequencies of ink ejection while the movements of inkjet cartridge to increase the dpi value in that direction.

The resolution described in the specifications for most printers in general were merely the resolution manipulated by the software from optical scan module or nozzle arrangement of inkjet head, it did not include the effects brought by the previous described devices during the printing. For instance, the resolution performance of the laser printer would be affected by feeding motor speed when the transferring device printed onto the paper after exposure as well as the precision of the transferring device. By the same token, the cartridge of the inkjet printer moved through the transmission device and the paper feeding mechanism would also affect the resolution. Hence, due to the above reasons, this paper for the method of measurement is based on the finished printout pattern in collaborating with the image acquiring device and the image processing to proceed with the resolution measuring of the final printing results.

Experiment

This paper brings up the printing pattern to acquire the resolution, and the system architecture is as figure 1 with the following steps:

a. **Pattern design:** uses drafting software to draw two dots 400μm apart that is parallel with the paper feeding direction. These two dots are the smallest points that can be print out by the printer which are not hollow points under the observation by the microscope. At the 500μm perpendicular to the paper feeding direction (increasing distance based on the distance between the testing resolutions) is the two points of 405μm and with the same logic to draw additional two points between the distances. In the boundary of an A4 paper, draw several same patterns on equal horizontal distances at the top, middle, and low positions. Turn the same patterns 90 degrees, and draw three same patterns on equal vertical distances.

b. **Pattern printing:** print out the two patterns mentioned above from the waited resolution test printer.

c. **Capturing pattern:** fix the printed out pattern (102) on the X-Y removable stage (101), with added CCD CAMERA (640X480 pixels)(104) zoom optical lens (103) capturing the two points that are 400μm apart in one of the sets to start measuring test.

d. **Image process:** Take the captured pattern to calculate the geometric center coordinates for each point via the computer (105), after recording, calculate the geometric center distance. Move the stage to orderly measure the geometric center distances for remaining points. Measure the remaining horizontal or vertical distance of the two points. Test another printed pattern and record it down when finished.

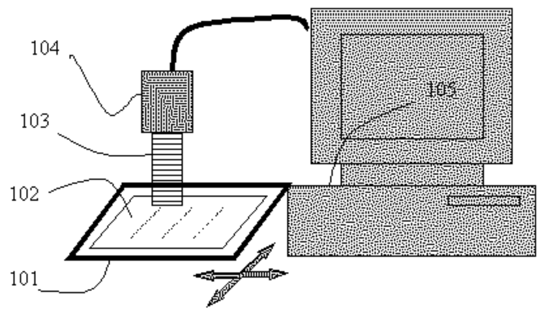

Figure 1. Test system

With the printout analysis for distance values of the measured dot patterns through the above steps, the distance value can be discovered as it increased when similar to a cycle. Take the average of this value and divided from 25400μm to get the dpi value for the resolution.

Test Equipment:

The test equipment used in the experiment were as follows:

1.	Printer	HP LJ 4050 & Fujitsu 16DV
2.	Microscope	1~20x
3.	CCD CAMERA	Mono-chrome
4.	Personal computer	Windows software
5.	X-Y Stage	20cm*30cm
6.	White light	25 Watt
7.	Image processing software	Visual basic
8.	Papers	A4 size

Precondition:

First use the drafting software to draw up several sets of pattern with proper distance apart, and then print out several of these patterns with the test printer. Select an better quality print and place it on the test stage. The edge of the paper is parallel with the edge of the stage.

Turn on the testing computer, light source, and X-Y movable stage, to adjust the movable stage position to allow the CCD to capture the pattern through the optical lens.

Test Procedure:

1. Open up the image processing software written with visual basic, move the stage to return to the origin for starting a new coordinates, then move the stage to the position where the image can be captured by CCD, acquire the designed two-point pattern.
2. Lock the captured pattern, set the pattern and the paper in gray tone threshold range to do the thresholding treatment, separate the satellite points and only keep the main dot.
3. Calculate the area of the main point and find the central coordinates.
4. Calculate the distance between the two points, and then record it down.
5. Move the stage to the next adjacent two points and repeat step 2~4, and then repeat on another set.
6. Compile the total distances for two sets of the distance between the two points to get the average and the standard deviation. Divide 25400 by the average and the standard deviation to come up with the printer resolution, see table 1 & 2.

Results and Discussion

HP LJ 4050 Variation of the Distance Between the Two Points in Horizontal and Vertical Directions

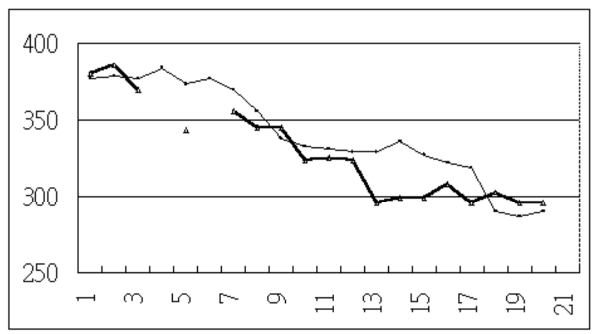

Figure 2. Vertical distance

Figure 3. Horizontal distance

Table 1. HP 4050 1200dpi Testing Results

Vertical resolution	1188
Standard deviation	±272
Horizontal resolution	1096
Standard deviation	±40
Printing resolution	(1096±40)dpi * （1188±272） dpi

Fujitsu 16DV Variation of the Distance Between the Two Points in Horizontal and Vertical Directions

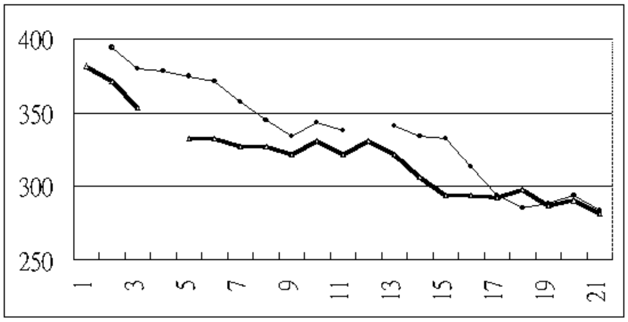

Figure 4. Vertical distance

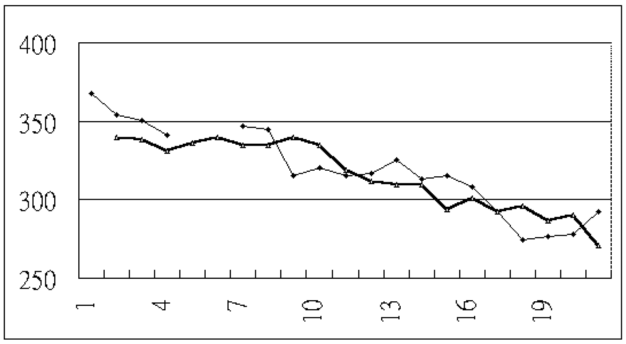

Figure 5. Horizontal distance

Table 2. Fujitsu 16DV 1200dpi testing results

Vertical resolution	1188
Standard deviation	±187
Horizontal resolution	1099
Standard deviation	±246
Printing resolution	(1099±246)dpi * （1188±187）dpi

1. From figure 2 to figure 5, the horizontal coordinates represent the pair number of two dots per set. The vertical coordinates represent the distance between the patterns. From the pattern fluctuation variation one can see the distances are descending in a step pattern from left to right.
2. From figure 2 to figure 5, the fluctuating line has a break and not continuous, which shows the difference between such dots and the average distance is greater than length of the resolution (1200dpi would be 21um, which is eliminated as a stray point). From the changes one can see the distances are descending in a step pattern from left to right.
3. From figure 2 to figure 5, from the variation of the fluctuating line one can see the distance between two steps is 42um (600dpi). There is one point exist between the two steps to increase the printer resolution to 1200dpi.
4. From figure 2 to figure 5, the distance for each step is approximately 35~45um.

Conclusions

The author uses this method to make printing test on 5 laser printers respectively. If only takes the fluctuating distance between any two-point pattern within the range of the testing resolution data, the printer resolution can be obtained through calculation. However, if the fluctuating distance between any two-point pattern is outside the range of the testing resolution, exceeded by 30%, then would recommend to label such printer as defective and deny the measuring test.

From the above testing results, we know the resolution shown on the printer's specification, besides from the hardware or optical module, it would be more appropriate to analyze the resolution from the actual printed patterns. What the end user really cares is whether the print quality lives up to what the number says in the specification. As for the manufacturer, the only thing he should be aware of is whether the engine module meets the standard demand.

References

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Biography

Chen-Hao (Howard) Liu received his M.S. degree in Opto-Electricity from the National Central University, Taiwan in 1992. He has worked in the Opto-Electric and System Laboratories, ITRI, Taiwan. He has been involved in the research in electrophotography for six years, working in the laser printer design, but also the laser cartridge and F-theta lens designs.