A Method To Perform Printhead Alignment By Means of Colorimetric Patches.

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Abstract

In order to maximize Image Quality (IQ) in inkjet printers, it is required to ensure maximum dot placement accuracy on paper. Due to print head drop directionality, mechanical tolerances, etc. there's a need to calibrate dot placement error (DPE).

This paper present a novel method to perform Automatic Printhead Alignment (APA) using color information, from combine several colors in an interference pattern instead of the current use of lightness information from color pairs interference patterns or positioning algorithms.

Introduction

Printhead Alignment it's a relevant calibration in an Inkjet Printer in order to obtain good IQ. In most of the printers this procedure is totally automatic and is based in print a pattern and analyzes it after reading the print image with an optical sensor. Usually the sensor use is a photo receiver and some color LEDs in order to be able to read all the colorants and align it using only lightness information.

Two reasons make possible new alignment methods using color information. First the current trend of increase printer colorants and printhead resolution that has increase substantially the total number of nozzles to align and second, the common presence of a spectrophotometer on the printer to obtain a high quality color calibrations.

Background

Several methods can be used to align; basically we can divide it in two blocks.

Distance from Reference

In this first method, several squares or columns, depending on the printer, are printed using each of the existing colorants. Usually the black one is used as absolute reference (Figure 1).

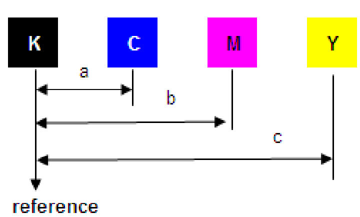

Figure 1. *Example of printed pattern using distances from Reference method to obtain color or printhead position error values.*

After alignment pattern is printed this is read using an optical sensor, and obtained data is processed in order to find the printhead misalignment.

The processing algorithm basically find the more relevant peaks for each scanned signal after apply a noise reduction filtering, and fit a Gaussian signal in order to obtain the exact position of each the peaks.

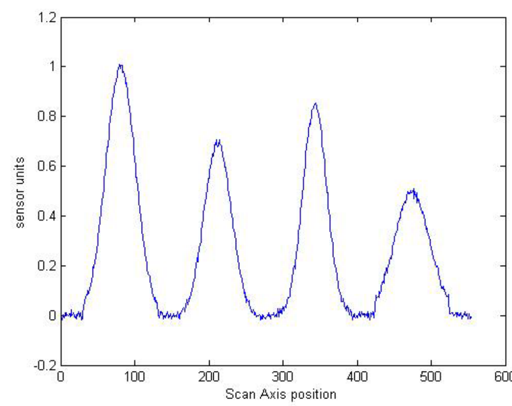

Figure 2. *Typical signal obtained with optical sensor from different color blocks..*

Correction offsets are calculated by measuring the distance of each color block to the reference color (Figure 2) and obtain the error from the difference from the expected one. This difference or error is what we call DPE.

This kind of pattern is very sensitive to sensor resolution and media deformations between printing and scanning. Distance from Reference method is used too many printers using several methods to improve the basic one increasing alignment accuracy and repeatability. Some of these methods are for example add repetitions, or print the pattern at several ink densities or firing frequencies.

Interference Patterns

With Interference Patterns we can increase the APA performance improving the weak points of the 'Distance form Reference method'.

In this case the interference pattern is form by several areas; at each area several lines of one colorant and the reference colorant are printed. At each of these areas the distance between the color and the reference is different and well know. (Figure 3).

DPE offset is calculated by measuring the ink density of each of the alignment area: in the patch that corresponds to the better alignment between the color and the reference, the ink coverage on paper is minimized, thus the ink density measured is minimum in this step.

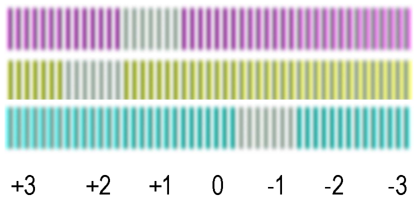

Figure 3*. Printed Interference Pattern from Magenta, Yellow and Cyan, using black ink as reference.*

Like in the previous method, we process the signal (Figure 4) after capture the signal and apply some noise reduction filters. However in this case resolution used in scan process is not very important, because we are not looking for an exact position; the information is now in the lightness of each step. Possible media deformations caused after print don't modify the light area position

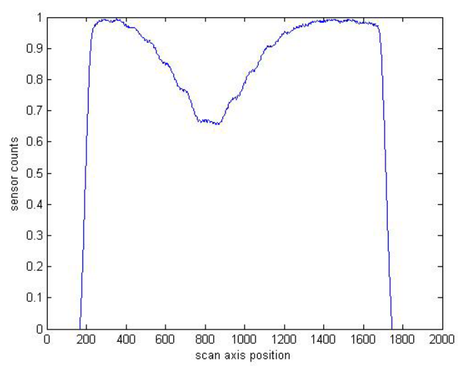

Figure 4. Typical scanned signal from an interference pattern.

Proposed Colorimetric pattern

The proposed method is very similar to the previous one. The difference is that we will try to obtain the error values, printing more than one color against the reference. For example, instead of print Cyan(C) vs Black(K) in one pattern, Magenta(M) vs Black in a second one, and Yellow(Y) vs Black in a third one, we will print C+M+Y vs K. in the same pattern(Figure 5)

In this case the offset is calculated by measuring the color coordinates of each of the alignment patterns, instead of use only the lightness information.

In the patch that corresponds to the better alignment between the color and the reference, the hue of the pattern is biased to the opposite of that color (i.e. for the most aligned Yellow pattern, this will turn to Blue).

Similarly, if we have more than 4 colors we can distribute it in several patterns, trying to print together colors with different hue. In order to obtain better performance it is recommended not to print in the same Colorimetric pattern colors with very similar spectral information as for example Cyan and Light Cyan neither Magenta and Light Magenta.

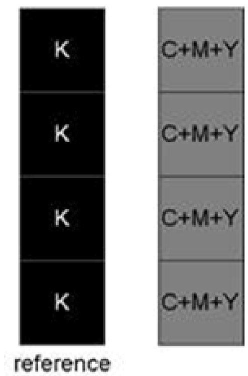

Figure 5*. Basic Interference Line, one line printed with reference color, and the target line with more than one color.*

Experimental

The concept was validated by print this pattern in the DesignJet Z3100 and capture the color measures with the embedded spectrophotometer. Different printhead alignment errors were introduced, and analyze the obtained data in order to validate our concept.

As example, if we have a K-C offset = -1 dot, K-Y offset = +2 dots and K-M offset = +1 dot, printed pattern will look like Figure 6.

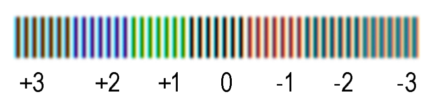

Figure 6*. Printed colorimetric Pattern.*

By measuring an average of the color at each step, and calculate the hue difference between the non neutral patterns, after filtering the data by saturation, we can identify the print obtain the 'Lab' color which pattern corresponds to the best aligned color. (Figure 7)

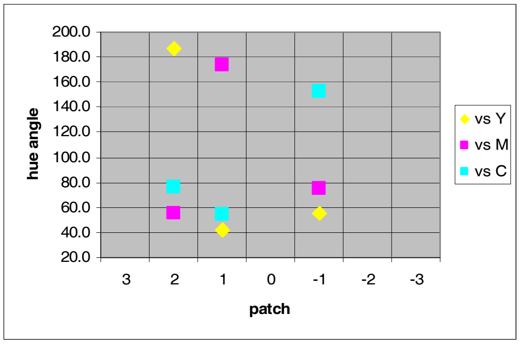

Figure 7. *Hue angle of non neutral patterns.*

In our example:

Pattern 2 is the less Y, so the Y offset is +2
Pattern 1 is the less M, so the M offset is +1
Pattern 1 is the less C, so the C offset is -1

Conclusion

Conclusion from our tests is that the explained method can be implemented in color inkjet printers successfully, reducing media waste and time and final printer cost, due to the reuse of color sensors for other calibrations.

Calibration accuracy is very similar between methods.

Author Biography

Sergi Puigardeu Aramendia holds an telecommunication degree from Polytechnic University of Catalonia (UPC, 2004). He has been working in the R&D lab in Large Format Printing in Hewlett Packard for the last 4 years in Image Quality team. His work focuses on Printer Calibrations and Image Quality measurements.

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