Improving ICC Profiles Color Management System Performance by Testing CIELAB of Duplex Paper in Color Reproduction

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Abstract: Accurate color control is very important in order to have a predictable quality of final product. A Technique is proposed for improving the color quality of digital color proof. This method investigates ICC Profile's performance by testing CIELAB (Commission Internationale de l'Eclairage L*, a* and b*) value of Duplex paper. Firstly, ICC profile with color target ECI2002CMYK is sent to offset machine, and the corresponding CIELAB and the ΔE color difference are obtained by spectrophotometer with color sensor. Secondly, the CIELAB of duplex paper are measured, and a new color target is developed to create ICC profile based on CIELAB of duplex paper. At last. For the purpose of testing the accuracy of the obtained ICC profile, these color target is sent to offset machine, and the color eror ΔE is calculated. In the experiment the average color difference of ICC profile ECI2002 CMYK is 4.78ΔE and the average color difference of ICC profile's duplex paper color is 3.15ΔE which is below the printing error threshold and 2D- color gamut visualization of ICC profile ECI2002 CMYK and duplex paper color describe that creating ICC profile with approach of CIELAB duplex paper closely follow the data of ICC profile's color ECI2002CMYK.

1 INTRODUCTION

Color consistency is very important in printing quality. The problems in color reproduction is the difference between input device and output device color model and color gamut. However, the color devices used in the workflow have different color-mixing models and color gamuts, which makes the goal of color reproduction hard to accomplished (Liu et.al, 2007). The repeatable quality of colour reproduction is a growing challenge for producers of digital printing devices as well as for paper producers. The properties of the printing substrate such as whiteness, brightness, gloss, opacity, porosity, surface roughness, etc., the colourants and the printing technology in different combinations together are all factors that influence the overall print quality. Paper properties are one of the most important factors affecting the completeness of the image transfer and image appearance (Ivana et.al, 2013)

Digital color proof on PrePress is a color reference before sending it to the offset or digital machine. The color management on PrePress uses a Color Management System (CMS) for input and output verification. CMS relationship regarding the CIE LAB color model standards. The ICC (International Color Consortium) profile is the key to achieving the CMS workflow. ICC profile color transformation begins by transforming the input device color on the CIELAB color standard model, then mapping the color gamut (collection of colors) from the input device to the output device on the CIELAB model, then transforming the color from CIELAB to the output device (Zhen Liu et.al, 2009; Jure Ahtik, 2017). The fact shows that the color of CMS application's was not consistance between original and the reproduced product, even though the printing process is in accordance with the machine calibration requirements in making color standards.

From the side of paper, making color standards uses only one type of paper, while the color standard is used to print several types of paper, such as duplex and ivory paper with different color characteristics. It is predicted that this paper color difference is one of the factors causing the difficulty of achieving print colors that match the color proofing, even though CMS has been applied. This paper proposes the design of the ICC Profile with a paper color approach that is through testing the color of printed paper LAB, using duplex paper. The Plate is printed with

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ECI2002 color target, and send it to offset machine using duplex paper; the former target is employed to get sample data; the CIELAB and density of sample data are measured. A New color target is developed to modify the ICC profile digital color proof based on CIELAB value of duplex paper. For the purpose of testing the accuracy of the obtained digital color proof, the color difference are calculated.

2 METHODOLOGY

2.1 CIELAB Color Space

Color may be described using more color systems such as XYZ, RGB, CMYK, CIELAB, which quantify in different manners the three attributes of color perception: hue, saturation and luminosity. The present paper shows the data referring to the color measurements in the CIELAB system to study the color of ICC profiles transformations.

2.2 Color Difference

For the purpose of testing the accuracy of the obtained ICC profile, color difference is used to measure the accuracy of ICC profile based on ECI2002CMYK and CIELAB duplex paper. The Color difference ΔE is calculated depends on the color model. Because the color stimulus can be represented as a point in space, the difference in color ΔE between two stimuli is calculated as the distance between the points representing these stimuli. The CIEL*a*b* and ΔEab was introduced by the International Commission on Illumination (CIE) in 1976. Given two colors in the CIEL*a*b* color space, (L_1, a_1, b_1) and (L_2, a_2, b_2), the ΔEab formula is defined as:

$$\Delta E = \sqrt{(L_1 - L_2)^2 + (a_1 - a_2)^2 + (b_1 - b_2)^2}$$

Where L_1 – the CIE L* value of reference color
a_1 – the CIE a* value of reference color
b_1 – the CIE b* value of reference color
L_2 – the CIE L* value of sample color
a_2 – the CIE a* value of sample color
b_2 – the CIE b* value of sample color.

2.3 Color Gamut

In color reproduction systems, color gamut refers to the subset of colors which can be accurately represented in a given circumstance, such as within a given color image or by a certain color device. While the gamut boundary means the outer surface of the 3D gamut, or the outer contour line of the 2D gamut. Color gamut is often described in *CIELAB* space; this is mainly because *CIELAB* color spaces are independent of devices (Bangyong Sun, et al., 2014). In this research, In order to determine the range of the reproducible color, the 2D color gamut is used to show that range color of ICC profile duplex and ICC profile standar ECI2002 CMYK.

3 RESULTS AND DISCUSSIONS

In the experiment, firstly, the color target ECI2002 CMYK which has 1485 patches for ICC profile is printed out on a 190 gsm semiglossy paper 44 inch by Epson Stylus 9700 printer, a kind of digital color proof printer, and then the spectrometer X-rite 530 is used to measure CIELAB values. Within the measured results for 216 CMY sample data, the maximal CIEL* value is 93.99 and the minimal CIEL* value is 88.81, the maximal CIEa* value is -0.56 and the minimal CIEa* value is -4.55, the maximal CIEb* value is 92.95 and the minimal CIEb* value is 5.56. Then these color target is sent to offset machine to find out the ΔE color difference, the results shows the everage error is 4.78ΔE with maximal error 6.45ΔE.

Secondly, the CIELAB value of duplex paper with 250, 270, 310, 350, 400 gsm are measured on solid color and 100% raster, and then the corresponding CIELAB value are obtained by spectrophotometer with color sensor. Between these CIELAB value, the range of colors and tones achievable by an imaging system of duplex color (the optimal value) of CIEL* is 91.30, the minimum CIEL* value is 89.10, and the maximum CIEL* value is 93.50. At last, these CIEL* values are used to modify the ICC Profile with oris color tuner before the color target is printed out. In this process, 320 patches were randomly selected and the CIELAB of the optimal, maximal, and minimal value of color target are measured used spectrophotometer. For the purpose of testing the accuracy of achievable the range color between the optimal, maximal, and minimal value, CIELAB of these value are measured. The former target is employed to compare the CIELAB optimal value and CIELAB maximal value, and CIELAB optimal value with CIELAB minimal value. If ΔE color difference more than 3.5 then back to previous process to get ΔE color difference less than 3.5. At last, The CIELAB of maximal and minimal value are used to determine the limit of CIELAB duplex paper. In this experiment, the ΔE color difference between

CIELAB optimal value and CIELAB maximal is 2.97, and CIELAB optimal value and CIELAB minimal is 2.78, and the duplex paper's color target optimal is used to create ICC profile and the comparison between CIELAB of ICC profile with color target ECI2002 CMYK and ICC profile with duplex color modified in yellow color are obtained in figure 1 to figure 3.

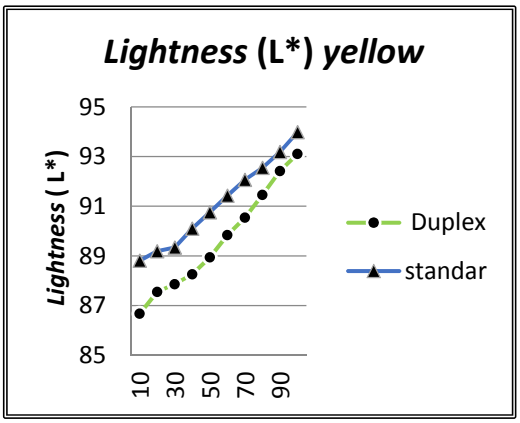

Figure 1: CIEL* of two ICC Profile

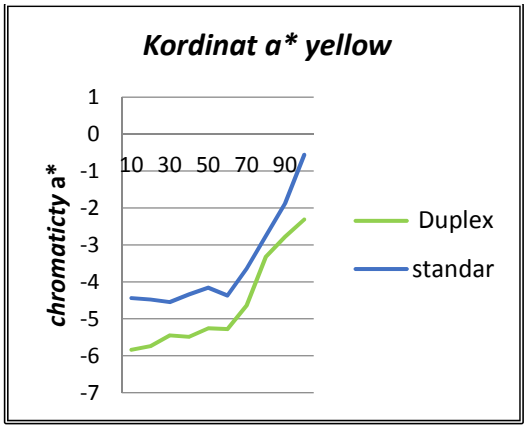

Figure 2: CIEa* of two ICC Profile

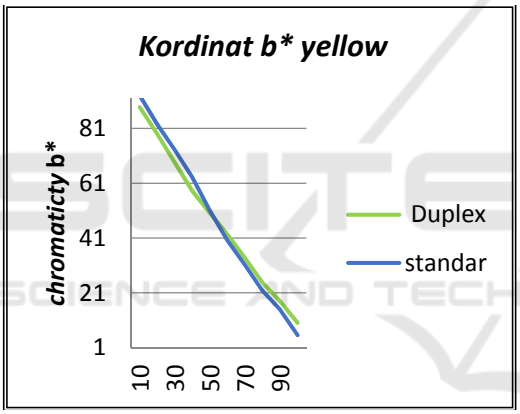

Figure 3: CIEa* of two ICC Profile

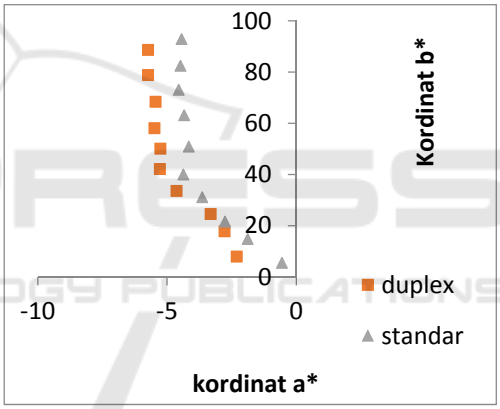

Figure 4: CIEa* and CIEb* ICC duplex and ICC standar

Figure 4 shows trend CIEa* and CIEb* of ICC profile duplex and ICC profile with ECI2002 CMYK which is duplex profile tend to a- (green) and b- (blue) and ICC profile ECI2002CMYK tend to a- (green) dan b+ (yellow).

To test the accuracy of predictable color quality of final product, ICC profile's color reference of digital color proof send to offset machine and compare the ΔE color difference between the former data of ICC profile with color target ECI2002 CMYK and ICC profile based on the color of duplex paper. For all testing color, the average error is 3.15 ΔE with the maximal error 5.25 ΔE. Because for most of the printing process, the average error threshold is 5 ΔE, the experiment results is acceptable which indicate the approach of color paper is suitable to create ICC profile. In order to determine the range of the reproducible color, the color gamut is obtained in figure 5 below.

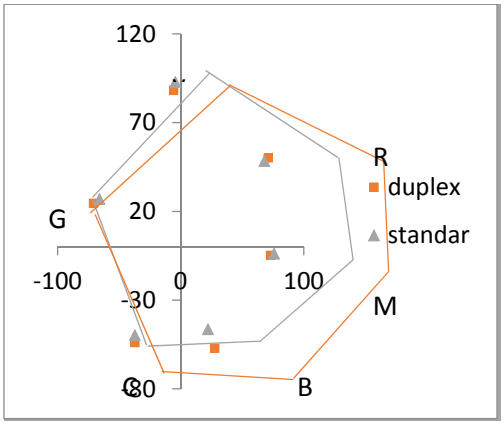

Figure 5: color gamut of ICC standar and ICC duplex

Figure 5 shows that range color of ICC profile duplex and ICC profile standar ECI2002 CMYK are different, Color gamut of duplex paper tend to a+ (red) and b- (blue), and it is follow the data of CIELAB duplex paper.

4 CONCLUSIONS

A technic of create ICC profile by applying the CIELAB of paper color has been proposed and the approach of color paper is suitable to create ICC profile. Results shows the accuracy is acceptable. To achieve the visualization and parametric description of color gamut is very significant for the accurate evaluation of color gamut performance and capabilities on color output device.

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REFERENCES

Ahtik, Jure. 2017. *Comparison of ICC and DNG Colour Profile Workflows Based on Colorimetric Accuracy*. Journal of Print and Media Technology Research.6(2017)3.pp 115-121.

Bangyong Sun, Shisheng Zhou. 2012 *Study on the 3D Interpolation Models Used in Color Conversion*. ACSIT International Journal of Engineering and Technology, Vol. 4, No. 1, February.

Bangyong Sun, et.al. 2014. *Calculating Cyan-Magenta-Yellow-Black (CMYK) Printer Gray Component Data Based On Polynomial Modelling*. Academic Journal. Vol. 9 No. 9. Pp 352-356.

Bangyong Sun, et.al. 2014. *A Color Gamut Description Algorithm for Liquid Crystal Displays din CIELAB Space*.The Scientific World Journal Volume 2014, article IC 671964.

Chuan, Zhi. Chuan, Shi Yi, and Sun Bangyong. 2016. *Research on Gamut Visualization Method of the Color Output Device***.** Journal of Display Technology Vol. 12 No. 5

CIE. 2018. CIE 15:2018. Colorimetry. Vienna: CIE. DOI: 10.25039/TR.015.2018

Durmus, Dorukalp. 2019. *Evaluation of Hue Shift Formula in CIELAB and CAM02*. Proceedings of the 29th CIE SESSION Washington D.C., USA, June 14 – 22.

Juric Ivana, et. al. 2013. *Optical paper properties and their influence on colour reproduction and perceived print quality*. Nordic Pulp & Paper Research Journal Vol 28 no. 2.

Kamenov, 2018.*Research on The Capabilities of Color Toner Based Printer for Quality Printing Using Custom Generated ICC Color Profiles.* International Scientific Journal Industry 4.0. ISSN 2534-997X. pp. 39-42.

Lin, Maohai. et.al. 2009. *Quality Analysis in Digital Printing Based on Color Management System.* Intenational Journal of Engineering and Technology Vol 1 No.2.

Liu Zhen, et.al. 2009. *The Research on Mechanism of Color Management System based on iCAM Color Appearance Model*. Computer and Mathematics with Applications 57 (2009) pp 1829–1834.

Oulton, David. 2013, *Technology for Colour Management.* Proceedings of the 1st International Conference on Digital Technologies for the Textile Industries Manchester, UK.

R H Liu, P Zeng, and Y F Wang. *"A color calibration method of printer using adaptive regression*,".Acta Electronica Sinica, 2007, vol. 35, no.11, pp. 2201-2204.

Sardjeva, Rossitza. 2014. Study of Color Quality Uniformity in Digital Dry Toner Electro-photographic Printing. International Journal of Modern Communication Technologies & Research (IJMCTR) ISSN: 2321-0850, Volume-2.

Singh, Nishan. et.al. 2017. *Color Control in Sheet-Fed Offset Printing Presses Using Mellow Colour Management System.* International Journal of Enggineering Sciences & Research. ISSN: 2277-9655

Zhao, Lei. 2016. Study on the Gamut Mapping Method Based on BP Neural Network. Journal of Computers Vol. 27, No. 3, pp. 149-162.