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PRELIMINARY STUDY ON POSSIBILITY TO USE AREA-BASED OPEN-SOURCE IMAGE ANALYSIS TOOLS IN ACCESSING SKIN TONE COLOR REPRODUCTION ACCURACY IN INK-JET PRINTING

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Introduction

The study of skin colour has been extensive over many years due to its importance in various industries, including photography, printing, medical fields, lighting, retail, and cosmetics where accurate reproduction is essential. Accurate reproduction of skin colour is crucial in most of these applications to ensure optimal results, whether it be for visual consistency, medical diagnostics, or product matching.

In terms of quantifying colour, objective quantification of colours through empirical models of the colour space is required.

Recently, there has been increasing interest in the quantitative colour measurement based on images captured using low-cost commercial technologies such as smartphones, scanners, and digital cameras for scientific applications. Commonly used colour analysis software by researchers for those purposes includes ImageJ, MATLAB, Pantone Studio, Digital Colorimeter by Apple, Trigit, and various developer-customized tools.

With this in mind, the present study explores the feasibility of utilizing two area-based open-source image analysis tools—ImageJ and Trigit—for assessing the accuracy of skin tone colour reproduction. Specifically, selected skin colour tones were printed using an inkjetprinting machines, scanned, and analyzed to extract colour coordinates using the aforementioned tools. Additionally, manual measurements were conducted directly on the printed samples using a spectrophotometer. By calculating colour difference values, the proposed colour measurement procedures were evaluated and characterized. The research led to conclusions regarding the applicability of area-based open-source image analysis tools for the characterization of skin tone colour reproduction.

Methods

For the purpose of this study, a test chart comprising twenty selected skin color patches was developed (Figure 1). The chart was created using Adobe Illustrator CC, with 20 patches chosen from Adobe's original skin color palette to represent the most commonly used skin tones in graphic design.

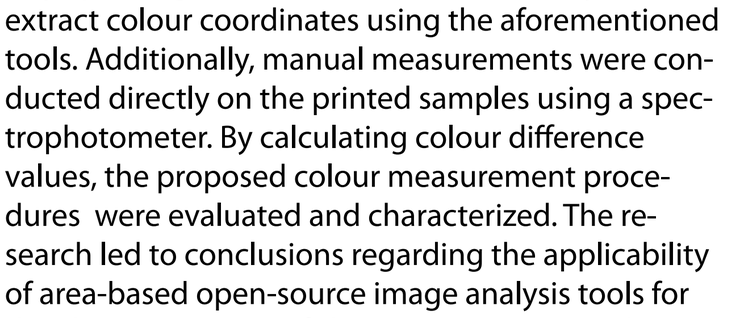

Figure 1

*The test chart and L*a*b* values of chosen samples with marked measuring points*

Test chart comprising twenty selected skin color patches was developed (Figure 1). Printing was conducted on two different fully calibrated ink-jet printing machines, using two distinct output resolutions—360x720 dpi and 720x1440 dpi—representing the lower and upper resolution limits, respectively. All other settings were consistent across both machines. The printing substrate used was commercially available Display PP paper.

The color difference values, ΔE00 , were calculated using the L*a*b* values obtained from both the spectrophotometer and the image analysis software.

Results

Figure 2

Color difference values;solvent ink -jet printing, output printing resolution of 360x720 dpi and scanning resolution of a) 300 dpi, b) 600 dpi, c) 800 dpi and d) 1200 dpi

Figure 3

Color difference values; silvent ink - jet printing, output printing resolution of 720x1440 dpi and scanning resolution of a) 300 dpi, b) 600 dpi, c) 800 dpi and d) 1200 dpi

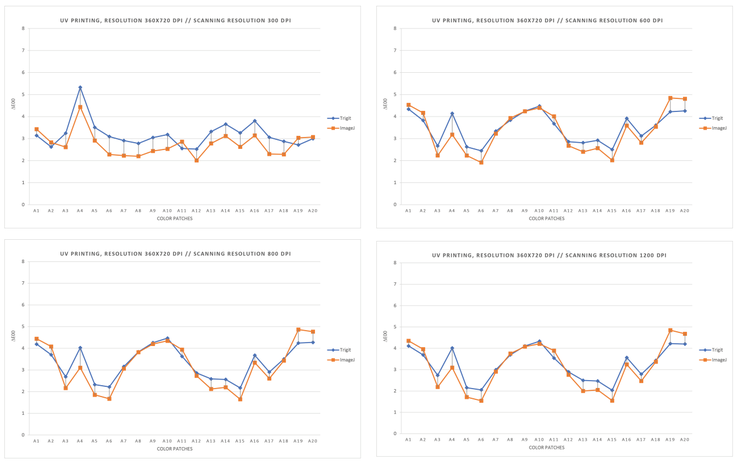

Figure 4

Color difference values; UV ink - jet printing, output printing resolution of 360x720 dpi and scanning resolution of a) 300 dpi, b) 600 dpi, c) 800 dpi and d) 1200 dpi

Figure 5

Color difference values; UV ink - jet printing, output printing resolution of 720x1440 dpi and scanning resolution of a) 300 dpi, b) 600 dpi, c) 800 dpi and d) 1200 dpi

Discussion / Conclusion

- Quantitative color measurements obtained from cost-free, tailor-made, user-friendly software solutions such as Trigit and ImageJ, combined with inexpensive image digitization technologies (e.g., scanning), can be characterized as straightforward and easy to perform.
- Both software tools require the manual definition of the region of interest (ROI). Trigit offers more convenient color calculations. The method of calculation can impact the final results in both cases.
- The calculated color differences between instrumentally measured L*a*b* values and those derived from scanned images of selected skin color patches ranged from 1.5 ΔE00 to 6.5 ΔE00, reflecting low to highly distinguishable differences.
- Color differences tend to be higher for lighter color patches compared to darker ones.
- Scanning resolution appears to have a lesser effect on color differences compared to image sharpness. Generally, lower scanning resolutions resulted in lower color differences.

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