J24 Validation of Quantitative Measures in the Non-Destructive Differentiation of Black Ballpoint Pen Inks

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After attending this presentation, attendees will understand the use and application of the measurement feature within Adobe® Photoshop® CS5 Extended as applied in the quantitative differentiation of black ballpoint ink samples.

This presentation will impact the forensic science community by demonstrating the validity and reliability of newly introduced objective measures in traditional qualitative non-destructive ink differentiation tasks involving the analysis of black ballpoint inks.

A previous published study conducted at the U.S. Army Criminal Investigation Laboratory demonstrated the use of L*a*b* color mode as a valid and reliable method in the non-destructive differentiation of black ballpoint pen inks. However, the results obtained through the use of L*a*b* color were based on visual observation and qualitative in nature. To extend the utility and discriminatory power of L*a*b* color as a tool in forensic document examination, this study investigates the use of L*a*b* color mode combined with analysis tools available within Adobe® Photoshop® CS5 Extended (APCE) as a new quantitative-based approach for non-destructive ink differentiation.

In the current study, the measurement feature within APCE was utilized via two different collection methods (manual and automated) to obtain the means of the gray values of each inked sample within a set of pen-pair samples previously converted from an RGB image to a processed L*a*b* color mode image. Theoretically, a statistical difference in the gray value (means) between two inks would provide quantitative support that the two inks were from different populations (i.e., different inks). Conversely, if the gray value (means) of two inks were not statistically different then this would provide quantitative support that the two inks were from the same population (i.e., indistinguishable ink(s)).

For the manual method of analysis, which requires the examiner to manually select the area of interest (AOI) within a given sample, 138 black ballpoint ink pen-pair samples were analyzed after converting the RGB images into L*a*b* color ("a" channel) images. These samples consisted of the following pen-pair types: (1) same ink/pens (N=35); (2) close non-match (N=70); and, (3) different ink/pens (N=33). As the names suggest, when the ink samples were produced, they were created either by using the same pen to create a pen-pair sample (control samples) or with different pens/inks. The close non-match samples are samples that are known to have been created using different pens that utilize different ink formulas but were not previously differentiated by optical examination of the resulting L*a*b* color image of the pen-pair sample. Quantitative analysis outperformed the previously conducted qualitative analysis (i.e., visual inspection of L*a*b* color images of the pen-pair samples) of the close non-match samples. However, qualitative analysis outperformed the quantitative analysis of the pen-pair samples written using the same ink. In the analysis of the pen-pair samples created using different inks, both methods were equally successful in correctly differentiating all of the samples tested.

For the automated method of analysis, the AOI within a given sample is selected automatically using a saved action script within APCE. One hundred and twenty-eight black ballpoint ink pen-pair samples were analyzed after converting the RGB images into L*a*b* color ("a" channel) images. These samples consisted of the following pen-pair types: (1) same ink/pens (N=35); (2) close non-match (N=70); and, (3) different ink/pens (N=23). Automated quantitative analysis outperformed the previously conducted qualitative analysis (i.e., visual inspection of L*a*b* color images of the pen-pair samples) of the close non-match samples. However, qualitative analysis outperformed the automated quantitative analysis of the pen-pair samples written using the same ink. In the analysis of the pen-pair samples created using different inks, both methods were equally successful in correctly differentiating all of the samples tested.

Preliminary findings suggest that this new, low-cost and nondestructive method for ink differentiation has a higher discriminatory power than the qualitative analysis of L*a*b* color images involving different and/or close non-match inks. However, in the absence of establishing a minimum gray value threshold, necessary to prevent or reduce Type I errors (i.e., false positives), manual quantitative analysis using the measurement feature within APCE falls short of the higher performance results produced using qualitative analysis of pen-pair samples produced with the same ink formulas.

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Writing Inks, Digital Imaging, L*a*b Color

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