J3 Evaluation of Gray Value Measurements of Visual Spectral Data to the Characterization of Alcohol-Based Inks From Colored Felt-Tipped Blending Markers

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Learning Overview: After attending this presentation, attendees will understand the use of gray value measurements to objectively detect and compare the most discriminating optical properties of colored felt-tipped blending markers.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by providing a simple method for analyzing a previously unstudied type of ink, expanding upon the limited knowledge of felt-tipped pens. The proposed protocols in this research can be used by questioned documents examiners to characterize these types of samples.

Ink analysis began in the early 1900s with fountain pen ink comparisons and has since expanded into one of the most researched areas in the questioned document field. Pen ink analysis includes determining the origin and components of the ink, comparing known and unknown samples, and dating ink samples. Ink analysis typically serves to authenticate documents and/or analyze any alterations. Most pen ink research concentrates on ballpoint pens and, more recently, gel pens, both of which are the most common types of pens encountered in questioned document examinations. Fiber- and felt-tipped pens first appeared in the mid-1900s and now are commonly used in artistic fields, such as drawing, graphic design, crafting, and calligraphy.

The felt-tipped markers used in this study were Copic® Sketch markers from the Japanese company Too Corporation. Initially, Copic® created markers for the manga industry. However, they are now being used in a wide variety of applications. Copic® markers are valued for their long shelf life, replaceable felt-tipped nibs, and refillable ink cartridges. The color name system has three main parts. The first part of the name is a letter or letters denoting color family, the second part is a numeric value of saturation, and the third part is a numeric value of brightness. Copic® Sketch markers are one of four types of markers sold by Copic®. The Copic® Sketch markers come in 358 different colors, as well as three types of nibs. They are also marketed to have the blending characteristics of watercolor paint. The applications of these markers vary from manga and comics to fashion and interior design.

Samples were prepared by marking one ink stroke on regular white office paper. Forty-two alcohol-based inks from colored felt-tipped blending markers were analyzed based on visual spectral data obtained from a Visual Spectral Comparator (VSC), and gray value measurements were recorded for purposes of differentiation. The types of markers studied have never been comprehensively researched, and no published research was found in the literature on the possibility of using the gray values gathered from images to analyze inks. It is hypothesized that the combination of illumination types and recorded gray values can be used to objectively distinguish between different inks in the context of comparative examinations. The present portion of this study deals with the implementation of the method of objectively comparing gray value data from alcohol-based blending marker inks.

The 42 ink samples were analyzed using various illumination types (i.e., Infrared (IR) reflectance, IR luminescence, and Ultraviolet (UV) fluorescence) and filters ranging from the visible to the near-IR range (up to 850nm) to detect the optical properties of the samples. The optical properties of the ink samples were observed. Standardized color checkers and images of samples collected in IR absorbance and/or luminescence modes were then analyzed using ImageJ to extract ten replicate gray values of the samples. The images of the ink samples could be separated into four main groups, depending on the samples' optical characteristics. Within these four groups, most comparisons of ink stroke pairs could be visually distinguished from each other based on their optical properties. Thirteen inks showed completely distinctive optical characteristics. Based on the standardized color checkers, gray values ranged from about 24 to 235. Many ink pair comparisons were discernible based on the gray values of at least one illumination source and filter. A few ink samples had overlapping ranges of gray values, which led to difficulty distinguishing between samples. The method of using the VSC6000 combined with ImageJ gray value analysis shows potential in distinguishing between ink samples from colored felt-tipped blending markers.

Questioned Documents, Ink Analysis, Blending Markers