E74 Advances in Color and Texture Analysis of Human Hair

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Learning Overview: After attending this presentation, attendees will understand that color and texture of hair samples can be quantified to support the classification of hair features in forensic analysis.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by providing methods to quantifying these features and various statistical techniques that can be used to classify different hair samples.

Hairs and fibers are very common types of trace evidence found in crime scenes. Hairs in particular are naturally shed by most mammals, giving them a higher transfer potential at a crime scene. The first stage in the forensic analysis of hair evidence is the attempt to determine the source of the hair and whether the hair is animal or human. Animal hairs contain significantly different features when compared to human hair and, in some cases, the animal species may be determined. As for human hair, it contains ancestral differences such as color, texture, cross-sectional shape, shaft form, and others that can aid in suspect identification. The analysis of human hair can sometimes be problematic due to the subjectivity of the descriptors used. Broad categorical descriptors derived from the examiner's skills and experience are sometimes used to classify different features, and these may vary between examiner. Also, there exists the potential for experimenter bias, which can be mitigated through the use of empirical data and more objective/quantifiable descriptors.

Forensic hair analysts evaluate features observed at both macroscopic and microscopic levels. Macroscopic features are those that can be easily seen by the naked eye, such as length, color, and hair form. Microscopic features evaluate the three main areas of the hair: the cuticle, the cortex, and the medulla. Each of the areas contain features that can be used to associate or discriminate between two samples. The cortex contains many characteristics that can be used for comparison (e.g., the texture and the color of the hair). However, when analyzing these two features, subjective and relative descriptors are usually used to describe them. Efforts have been made to empirically determine color with some success; however, little has been conducted to analyze the texture. Development of high-resolution digital microscopes allows researchers to closely examine these characteristics and obtain more accurate measurements. In this study, a VHX 6000 Keyence® digital microscope was used to explore the variance within the color and texture characteristics throughout the hair, as well as the inter - and intra-person variability. The color distribution of hair and texture analysis were obtained using MATLAB® image software. The samples consisted of 25 fallen hairs from 75 individuals of different ancestries between the ages of 18 and 35 years. Only samples with natural hair color were considered for this study. Analysis of variance was performed to assess the inter- and intra-sample variability among hairs. The color distribution of the hair was determined using a Red-Green-Blue (RGB) color model. This enables a more accurate description of the color of the hair given that it encompasses the natural variability of color change though the hair, allowing for a more comprehensive assessment. Clear differences can be seen in the distribution between the most common hair colors (black, brown, red, and blond). As for texture analysis, neural networks were used to attempt to classify the texture of hair based on grayscale images, allowing for a more objective analysis of texture.

This presentation will increase the knowledge of the variability within hair features and provide a novel method for quantitatively assessing color and texture of human hair. It is important to note that this study is aimed at supporting the forensic hair community by providing a tool to quantify features to classify unknown and known hair samples, not necessarily to compare hair samples directly.

Hair Analysis, Macroscopic Measurement, Neural Networks

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