B158 Multivariate Classification Model Transfer of Ultraviolet (UV) /Visible Spectral Data From Acrylic Fibers Without Standards

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The goal of this presentation is to illustrate the value of transfer of multivariate classification models for spectra of trace evidence fibers between laboratories. Such efforts could save time and resources in forensic analyses and contribute to an understanding of differences in spectra from multiple laboratories due to variations in sample preparation, environmental conditions, and instrumental signal response.

This presentation will impact the forensic science community by exploring the ability to transfer multivariate classification models between laboratories, which could save time and resources in forensic analyses. Successful sharing of such information between forensic laboratories may be valuable for confirming fiber identification and assessing the reliability of comparisons.

UV/visible microspectrophotometry is commonly employed for discriminating metameric fibers in forensic casework. Recent studies have demonstrated that multivariate classification techniques are an effective tool for characterizing such fibers. The ability to transfer multivariate classification models between laboratories could save time and resources in forensic analyses; however, issues transferring models of this type from one laboratory to another can arise as a result of differences in sample preparation, environmental conditions, and instrumental signal response. Spectra of 12 blue acrylic fibers were examined at five separate locations, including three academic research laboratories and two forensic laboratories. The data received from these facilities were analytically assessed in three manners. Multivariate classification models were initially constructed on each individual laboratory's dataset to evaluate intra-laboratory variability between samples. In a subset of the study, discriminant analysis was performed after merging all data collected in the study. Lastly, the transferability of classification models was assessed by predicting class membership of samples analyzed at a single laboratory using models built from the spectra collected at the four remaining locations.

Principal Component Analysis (PCA) followed by Linear Discriminant Analysis (LDA), Quadratic Discriminant Analysis (QDA), or Support Vector Machine Discriminant Analysis (SVMDA) was used to evaluate the agreement of results among the laboratories. An average classification accuracy of 93.2% was found after training discriminant analysis models using data collected at the four laboratories and using the information collected at the fifth laboratory as an external test set. For comparison, intra-laboratory studies that were conducted produced an average classification accuracy of 96.3%. The reduction in the discriminative abilities of the transferred models was likely due to the differences in spectral noise and peak intensities experienced between laboratories. On the whole, the errors generated by QDA were lower than those resulting from LDA and SVMDA. In conclusion, this inter-laboratory study confirms the ability to preprocess spectra to explore the agreement of spectral comparisons among forensic laboratories.

Inter-Laboratory Comparison, Classification Model Transfer, Inter-Laboratory Reliability