A21 Statistical Measures for Comparisons of Fiber Spectra: Forensic Database and Statistical Software

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After attending this presentation, attendees will be acquainted with the utility, ease of use, and applicability of a forensic fiber database containing fiber characteristics and user-friendly software for visual and statistical comparison of fiber spectra. These combined tools offer support for objective data-based decisions regarding the similarity of questioned and known fiber data and the reliability of match exclusions.

This presentation will impact the forensic science community by describing a combined data archiving and statistical graphics and analysis system that offers both data management and decision-making support to the forensic fiber examiner. Trace fiber investigations, where the hypothesis of a common source for two fibers could not be rejected and evidence was found to have probative value.

Testimony of FBI examiner Paul Stombaugh before the Warren Commission concerned some fibers stuck on a jagged edge of Oswald's rifle stock stated, "There is no doubt in my mind that these fibers could have come from this shirt." However, the next statement, "There is no way; however, to eliminate the possibility of the fibers having come from another identical shirt," epitomizes the problem of class evidence. The goals of this research include: (1) assess error rate performance in trace fiber evidence examinations based on UV/visible microspectrophotometry and infrared spectroscopy; (2) create a database of fiber characteristics, including UV/visible or IR spectra, to establish a performance baseline relevant to discussions of fiber discrimination; and, (3) evaluate intra- and inter-laboratory consistency, and improvements in forensic laboratory practice.

Statistical evaluation of trace evidence data from UV/visible or IR spectroscopy has great utility for assessment of assessing similarity or dissimilarity of spectra when comparing questioned and known trace evidence samples. The use of statistical hypothesis testing with both univariate and multivariate data, coupled with good experimental design, permits the investigator to exercise control over errors in statistical decisions arising from measurement uncertainties. Both univariate and multivariate statistical methods to judge the significance of discrimination of UV-visible and infrared spectra from a wide variety of textile fibers were employed. Statistical methods, coupled with informative graphics for comparing grouped data distributions, can produce statistical support for inclusion and exclusion decisions in forensic fiber examinations. This presentation will show statistical analyses of fiber spectra from a user-friendly software package that has been developed for this purpose. The second tool presented here is a forensic fiber database that facilitates archiving fiber data such as polarized microscopy measurements (birefringence, sign of elongation), physical characteristics (diameter, shape), and spectral data. One immediate advantage is the ability to store data in a documented manner and access this information on demand from a relational database. XML, an extensible markup language that can be employed to define a flexible and self-documenting, but human-readable and standardized text format for forensic data was adopted. XML has experienced recent growth because of its adoption by a multinational software corporation as a file format for office application documents. NIST has long recognized the significance of XML and several ongoing interagency efforts involve data format standardization using XML (e.g., the NIST ITL American National Standards for Biometrics and efforts by ANSI, NIST, and the FBI). The web-based SQL/ASP database currently holds information on about 500 fibers, and facilitates queries for rapid retrieval of data and interactive visualization, export of existing raw data, and import of new fiber data sets. Although there is little likelihood of establishing a truly comprehensive fiber database because of fast-moving trends in manufacturing and globalization of production, a combined data archiving and statistical graphics and analysis system offers both data management and decision-making support to the forensic fiber examiner.

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