B134 Image Recognition, Analysis, and Library Searching Applied to Photomicrographs

Suzanne C. Bell, PhD and Rebecca Hanes, BS, West Virginia University, Bennett Department of Chemistry, 217 Clark Hall, Morgantown, WV 26506-6045

The goal of this presentation is to describe applications of digital image processing to polarized light microscopy, specifically as applied to microcrystal testing. Attendees will obtain an overview of this application and how automated digital image processing techniques can be used to create databases and library search algorithms. These algorithms are con- ceptually similar to database searching used with instrumental techniques such mass spectrometry and infrared spectroscopy. Statistical analysis of digital image databases will also be addressed and will demonstrate how photomicrography can be integrated with instrumental data to increase specificity of identification and to associate probabilities and uncertainties to the results of digital image analysis.

This presentation will impact the forensic community and/or humanity by increasing the reliability and specificity of data obtained from microscopy and will facilitate data basing, statistical analysis, and devel- opment of Daubert admissibility principles to photomicroscopy across a broad range of applications.

Digital image processing is an established tool for the forensic analysis of fingerprints, firearm, and toolmark evidence. However, these algorithms have not been widely applied to other types of images such as photomicrographs. Existing instrumentation and software facilitates rapid collection of such images, leading to the creation of large databases. Such databases allow for data mining, statistical analysis, validation, pattern matching, and searching. Systematic data collection and analysis will be indispensable for moving microscopy from what is perceived to be a sub- jective analytical tool to an objective and quantitative one. This presen- tation will describe this evolution using microcrystal tests employed in drug analysis as an example.

Microcrystals of methamphetamine, amphetamine, and cocaine were obtained using ASTM Standard methods. Replicate images were collected under optimized and controlled conditions. Stages of crystal growth were documented, as were all observed variations of morphology. Images of common diluents and contaminants were also collected, along with images of mixtures as would be expected in actual evidence. Image processing and archiving using Image Pro® (Silver Springs, MD) followed. The extracted numerical descriptors were transferred to statistical analysis programs for comprehensive evaluation. These protocols will be presented in detail, as will the associated quality assurance and quality control procedures.

Extensive statistical and data mining procedures were used to identify fundamental morphological features of the different crystals from dry powder mixtures to mixtures of crystals and diluents. From this work emerged algorithms to search image databases, produce a list of potential “hits” and associated probabilities, and present the user with images for comparison. In effect, this database has become a searchable library similar to those used with mass spectrometry and infrared spectroscopy.

The power and potential of image processing and searchable libraries lies in combined applications. Consider the combination of color tests, crystal tests, and microspectrophotometry for the characterization of white powders: Since all analyses can or do rely on variations of a microscope as a detector, it is conceivable that these tests could be combined on a single slide. Proper design makes possible a device that miniaturizes the tradi- tional presumptive-screening-confirmatory test routine used in solid dose drug analysis. A simple, passive flow microfluidic device exploiting these ideas is the subject of another presentation.

Microcrystal Tests, Polarizing Light Microscopy, Digital Image Processing

 ** Presenting Author*