B196 Identifying Powdered Illicit Drugs Using Magneto-Archimedes Levitation (MagLev), Signal Processing, and Digital Finger Printing

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Learning Overview: After attending this presentation, attendees will have learned how MagLev can be used to separate and determine the composition of powdered mixtures. This presentation will focus on how signal processing of the MagLev data is used to generate digital fingerprints that are used for automated identification and attribution of illicit drugs (e.g., fentanyl and its analogs, heroin, methamphetamine, and cocaine) in powdered mixtures with adulterants and diluents.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by illustrating how the use of density-based analysis techniques and signal processing methods can simplify and accelerate the analysis of complex mixtures found in forensics. The digitalization of the MagLev data enables comparison with previously characterized samples, and this could aid forensic chemists in achieving attribution of their samples.

Methods: Dry and powdered samples are suspended in a solution of a non-polar paramagnetic gadolinium(III) chelate in a non-polar solvent inside a cuvette (polar compounds do not dissolve as they separate in the paramagnetic solution). The cuvette is placed between two magnets with like poles facing each other. The balance of forces (magnetic, buoyancy, and gravity) form a linear density gradient along the vertical axis of the cuvette, in which the individual components of the powder equilibrate at their characteristic density, forming a levitation profile. By photography, image analysis and digital classification (Dynamic Time Warping [DTW] and DTW Barycenter Averaging), the sample is automatically attributed to a class (a digital fingerprint), such as mixtures of "lidocaine·HCl" or "caffeine," and entered into a database of class representations of mixtures of powdered drugs. Unknown mixtures are compared to the class representations to determine their maximum likelihood-classification.[1]

Results: MagLev and signal processing techniques were applied to three problems relevant to the testing of illicit drugs: (1) identification of individual components (fractions) in powdered mixtures using automated signal processing of levitation profiles. In addition, classification techniques are used for the identification of components in mixtures of unknown composition (e.g., an unknown fraction of lidocaine HCl is identified in a powdered mixture from multiple different class representations, including fentanyl·HCl, heroin·HCl, acetaminophen, levamisole HCl, lactose, mannitol, and sucrose); (2) he abundance of lidocaine·HCl and caffeine in binary mixtures of different compositions were determined; and (3) classification techniques were used for the attribution of powdered samples identifying potential matches (batch and formulation) between previously characterized samples in a laboratory database.

Conclusions: MagLev is a rapid and portable method for screening of drugs. It separates mixtures into their individual components and reduces the time for identification of illicit drugs. This method establishes and uses a database of digital fingerprints of powdered mixtures of illicit drugs. In the future, the database could be combined with data about the point of seizure and a time stamp map drug trafficking patterns. The device and analysis methods are adaptable to other applications, such as powdered chemicals, food products, or explosives.

Reference(s):

1. Nemitz, Markus P., Ryan J. Marcotte, Mohammed E. Sayed, Gonzalo Ferrer, Alfred O. Hero, Edwin B. Olson, and Adam A. Stokes. Multi-Functional Sensing for Swarm Robots Using Time Sequence Classification: Hoverbot, an Example. *Frontiers in Robotics and AI* 5 (2018): 55.

Magneto-Archimedes Levitation, Drugs, Signal Processing

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