A151 The Application of Self Organizing Feature Maps (SOFM) for Lighter Fuel Classification

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The goal of this presentation is to introduce the application of self- organizing feature maps (SOFM), an unsupervised artificial neural network method to classify ignitable liquids from petroleum based products. This presentation will also demonstrate the powerful ability of Self Organizing Feature Maps (SOFM) to associate highly weathered samples to their associated un-weathered products.

This presentation will impact the forensic science community by providing an alternative to relatively more conventional chemometric analyses such as Hierarchical Cluster Analysis (HCA) and Principal Component Analysis (PCA) for pattern recognition purposes. The presented method helps to alleviate subjectivity issues when analyzing ignitable liquid samples in forensic arson investigations and can be potentially used for possible source identification.

Ignitable liquids are commonly used as accelerants to intensify and accelerate the rate of fire development in cases of deliberate fire setting. At present, gas chromatography-mass spectrometry (GC-MS) is widely accepted as an effective tool for the analysis and identification of ignitable liquids. Interpretation of the instrumental data and sample classification processes are based mainly on visual comparison. These methods can be difficult, time consuming, highly subjective, and rely heavily on the skill and experience of the analyst. Exposure to heat or evaporation due to aging can result in substantial changes in the ignitable liquid's composition, which in turn greatly affects their chromatographic profile. Another common complication encountered in fire debris analysis is the appearance of hydrocarbon by-products from the combustion and pyrolysis of background matrices.

The applications of multivariate pattern recognition to discriminate and classify ignitable liquid samples are suggested as a means of facilitating the pattern matching process and rendering it less subjective. Pattern recognition techniques using unsupervised approaches have been utilized to establish the underlying relationships amongst variables within complex datasets and can be used to self-organize established groups within a given dataset.

This work starts with the optimization of GC-MS temperature programming as recommended by ASTM E1618. Various brands of lighter fuel were obtained from commercial markets. For each lighter fluid brand, a set of partially evaporated samples was generated at approximately 10, 25, 50, 75, 90, and 95 percent weathered (evaporated) sample. The lighter fluids were analyzed by GC-MS and the resulting total ion chromatograms (TICs) were investigated. Upon examination of the TIC profiles, components selected as variables from all samples were pre-processed to assess the effectiveness of the method. The data was then processed using various chemometric techniques in order to distinguish between the various lighter fluid brands and whether it was possible to establish a link between the pure and evaporated samples of a specific lighter fluid brand.

Successful brand identification for highly weathered samples was achieved using HCA and SOFM. However, SOFM proved to have a more robust sample linkage capacity and confirmed visual similarities and differences between the samples in evidence within the chromatograms. It is also important to note that data pre-treatment was essential in order to obtain accurate classifications. This has demonstrated a potential

means whereby pure and evaporated ignitable liquid samples can be linked successfully by brand and, as such, presents a powerful new means of interpreting chromatographic data retrieved from fire debris samples. **SOFM, Ignitable Liquids, Pattern Recognition**

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