Abstract:

Hair fibers are ubiquitous to every environment and are the most commonly found form of trace evidence at crime scenes. The primary difficulty forensic examiners face after retrieving a hair sample is determining who it came from. Currently, the methodology of microscopic examination of potential hair evidence is absent of statistical probability and is inherently subjective. Another method, involving DNA analysis, takes months to conduct and the majority of times is unsuccessful due to its degradation and absence from the hair. Here, Attenuated Total Reflectance (ATR) Fourier Transform Infrared (FTIR) Spectroscopy, coupled with advanced statistics, was used to identify a hair sample, within a specific confidence, solely from its spectrum. Ten spectra were collected for each of ten human, cat, and dog donors and a single synthetic fiber for 310 total spectra. A spectrum is collected by simply placing a single strand of hair, without preparation, directly across the crystal (500μm) of the instrument. Two Partial Least Squares-Discriminant Analysis (PLS-DA) models were constructed: one to differentiate natural hair fibers from synthetic fibers and the second discriminating human hair from dog and cat hair. Both internal models were successful in separating the desired class from another; synthetic hair was completely separated from actual hair in the binary approach and all human samples were predicted as human in the species specific model. The training model was tested by loading spectra from ten external donors (three human, two cat and five dog) and examined the model's ability to correctly assign these spectra. The external validation confirmed our model's ability to correctly classify a sample as human. It also showed that a breed of dog not accounted for in the training data set was entirely misclassified, but more importantly led to the possibility that different breeds of dog can be separated based on their hair spectra. This preliminary investigation sheds light on the next step of the discrimination process to identify the gender and race of a human hair. Overall, the method is able to quantitatively identify a sample of hair as human with a high degree of confidence and is of ample importance to the field of forensic science. The method can be conducted without the need of a specialist, is non-destructive, is extremely quick and requires no sample preparation.