A208 Design of a Prototype Mid-IR Imaging System for Visualizing Blood at Crime Scenes

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After attending this presentation attendees will learn about advances in imaging that may enable visualization of blood at crime scenes via noninvasive remote infrared imaging with adequate sensitivity and with designed selectivity against interferences.

This presentation will impact the forensic science community by exploring how a common thread in the recent discussion of forensic techniques is the need for continuing research to establish limits and measures of performance for forensic analyses: to clarify the applicability and reliability of techniques for various purposes. The present work constitutes the first steps in evaluation of the performance of infrared imaging for crime scene investigations.

Current visualization methods for blood and semen are not specific, require dark conditions, and often are not very sensitive. Further, high discriminating power is important at crime scenes so that time and resources of forensic investigators are not wasted on the collection and analysis of false positive samples. A prototype portable camera using mid-infrared (IR) spectroscopy with a thermal imaging detector has been designed that has a spectral response tuned by filters of polymer films. Lock-in amplifier techniques are used to construct the contrast image of the scene, on a pixel-by-pixel basis in real-time, using techniques designed to enhance visualization of blood. An infrared source (e.g., a small heating plate, glow-bar, or space heater) is employed to illuminate a scene with IR light. Light reflected from the scene is employed to achieve imaging by chopping the source and digitally processing each pixel by a lock-in amplifier approach, producing an output that is proportional to contrast between stain/no-stain regions.

The infrared camera response is also sensitized to spectral regions where blood components (e.g., proteins) show absorbance using a combinatorial simulation-driven design process that selects chemical filters to maximize discrimination between blood-stained and unstained surfaces. There are many factors involved in optimizing discrimination by using optical filtering aids, including, but not limited to, the detector response, optical throughput of the system, optical properties of the samples, and optical properties of the materials for sensitizing films/filters. There are nearly infinite possible setups for the system, which means it is neither cost- nor time-efficient to physically test each one. In lieu of this, simulations of camera output were used, per pixel, beginning with measured spectra of calibration samples or standards, using an objective function or figure of merit (FOM) to measure simulated performance. Combinatorial simulations are performed to select from the large number of different filtering possibilities and the combinations of filter parameters that best discriminate between neat fabrics and one stained with blood were used.

Further data processing methods develop and display scene images, with regions indicative of the target analyte (latent blood) showing contrast from background. This approach has produced acceptably high signal-to-noise ratios and enabled visualization of blood well below 100×dilutions with visible contrast, while providing discrimination against some substances reported to give false-positive responses with other techniques. Besides being rapid, IR imaging for bloodstain detection offers advantages: examiners are not exposed to chemicals, the technique can be used indoors or outdoors under ambient light, patterns are not smeared, and stains are not diluted or altered by chemical reagents.

Fundamental studies were concurrently conducted to advance the scientific basis and the understanding of infrared imaging for crime scene

visualization. Additional instrument development and validation research is necessary for realization of the ultimate forensic goals of the present research. However, this research has opened up novel and intriguing applications of imaging, based on diffuse reflectance in the mid-infrared region of the spectrum that may have valuable forensic applications. **Imaging, Blood, Detection**

 ** Presenting Author*