D34 Hyperspectral Imaging of Post-Blast Explosive Residues

Diane K. Williams, PhD, Federal Bureau of Investigation, 2501 Investigation Parkway, Quantico, VA 22135; and Kerri Lynn Moloughney, BS, Oak Ridge Institute of Science Education, 2501 Investigation Parkway, Quantico, VA 22135*

After attending this presentation, attendees will gain a deeper understanding of the use of hyperspectral imaging systems to detect explosive residues.

This presentation will impact the forensic community by providing the explosives analyst with an additional tool to detect and visualize explosive residues on variety of substrates.

Hyperspectral imaging (HSI) allows for the conversion of spectra into image information, allowing visualization through a much wider range of wavelengths than is possible with other imaging methods. As compared to multispectral imaging, which has a single-digit order-of- magnitude wavelength range, HSI can record images over hundreds of wavelengths with very narrow bands. A highly specialized hyperspectral camera has previously been used to detect explosives on fabrics.[1] Based on these results, a study was initiated to detect and identify post-blast explosive residues using this hyperspectral system.

Post-blast residues present a different challenge from the previous work, due to various environmental factors. Debris, dirt, and human contact can all have an effect on the spectra of the residue. Control samples of explosives were provided by the FBI Explosives Unit and analyzed to determine the key wavelengths where spectral characteristics may be useful. Hyperspectral images were taken of samples obtained from an explosives demonstration. A range of explosives were detonated outdoors, and many of the samples obtained had dirt and debris on them. A variety of substrates was chosen to test, including plastic, wood, metal, concrete, fabric, paper, tape, and glass. All of the samples were collected immediately after the blast, placed into separate containers and appropriately labeled.

The data set represents three dimensions, two spatial and one spectral. Scans of wavelengths ranging from 400-950 nm collect a complete spectral profile for each pixel in the two dimensional image. The “data cube” constructed enables the user to determine the precise location on the image from which a particular spectrum was obtained. This spectral profile also allows visualization of chemical differences on the image itself. Using image processing software, specific spectral characteristics are isolated and illuminated during post-processing. The data will be presented in the context of both detection and visualization of the post-blast residues. A discussion of the reproducibility of the data will be included.

Based on the previous results obtained, it is hypothesized that the hyperspectral imaging system will provide the desired information regarding the key spectral wavelengths for visualization of the residues on a variety of substrates. A long-term study will follow the initial study to determine the effect of aging on the chemical signatures of the samples as well as a reproducibility study. Upon completion of the data set, these key spectral wavelengths will be used to develop a protocol for the detection and visualization of post-blast residues on a variety of substrates. The protocol will be particularly useful because hyperspectral imaging is a non-destructive analytical technique and allows for simultaneous detection and visualization, even when the residues are invisible to the human eye. Additionally, hyperspectral imaging cameras can be used for remote sensing; therefore, the research will be expanded to include the testing of the protocol for remote sensing capabilities.

Reference:

1 Williams, D.K., Ayub, H., “Detection of Explosives by Hyperspectral Imaging”, 234th Meeting of the American Chemical Society, Boston, Massachusetts, August 19, 2007.

Explosives, Hyperspectral Imaging, Remote Sensing

 ** Presenting Author*