

Forensics applications

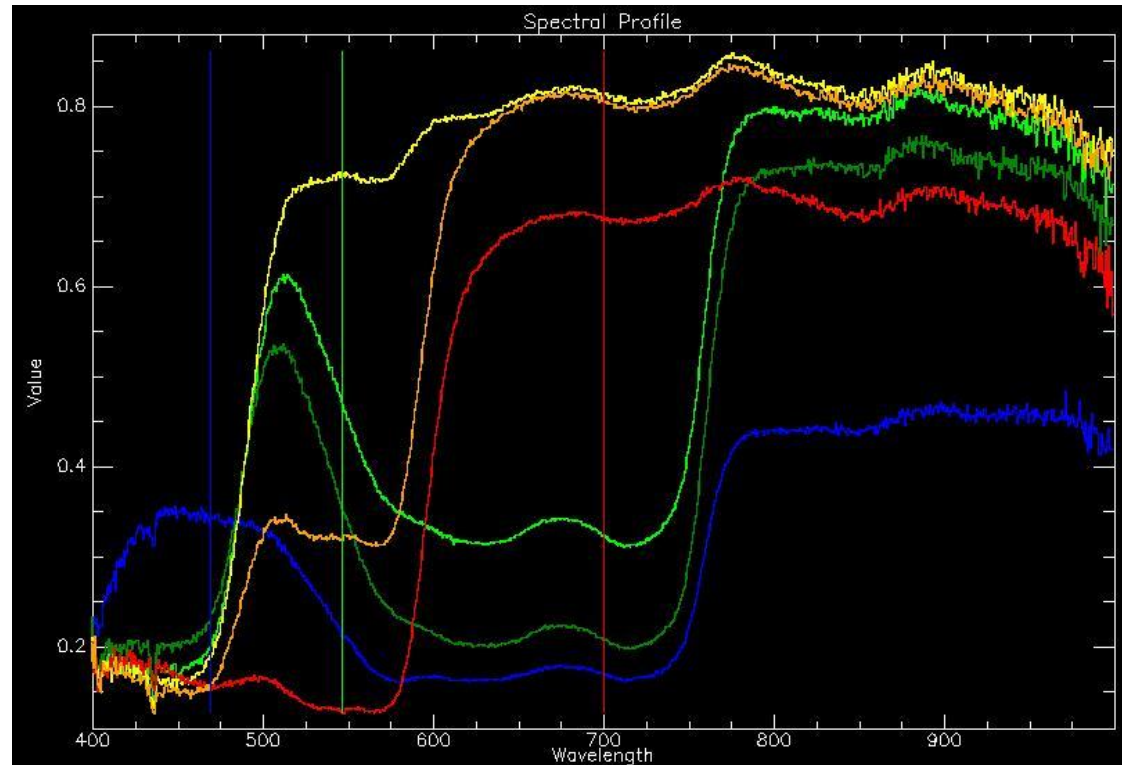
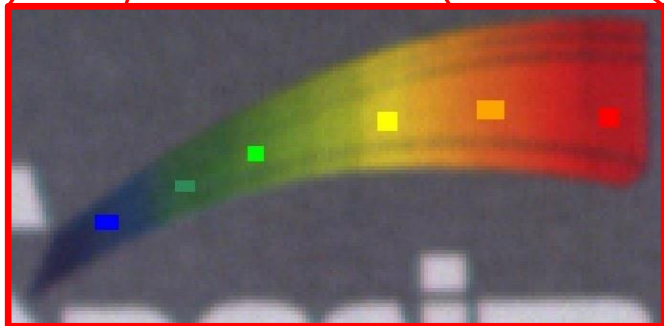
Hyperspectral Imaging HSI is a powerful technique

- to examine crime scene
- to document crime scene
- to verify security features of bank notes

These are customer examples of publicly available data. Successful implementation of HSI in forensics requires understanding in spectroscopy.

HSI Hyperspectral imager, VNIR (400 – 1000 nm)

Efficient for exact
determination of color,
regardless of the support.



VNIR CASE 1: HSI used to verify security features of banknotes and other questioned documents



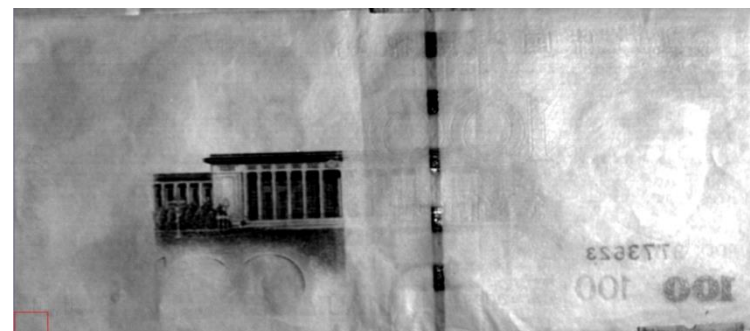
550 nanometer monochrome image



700 nanometer image



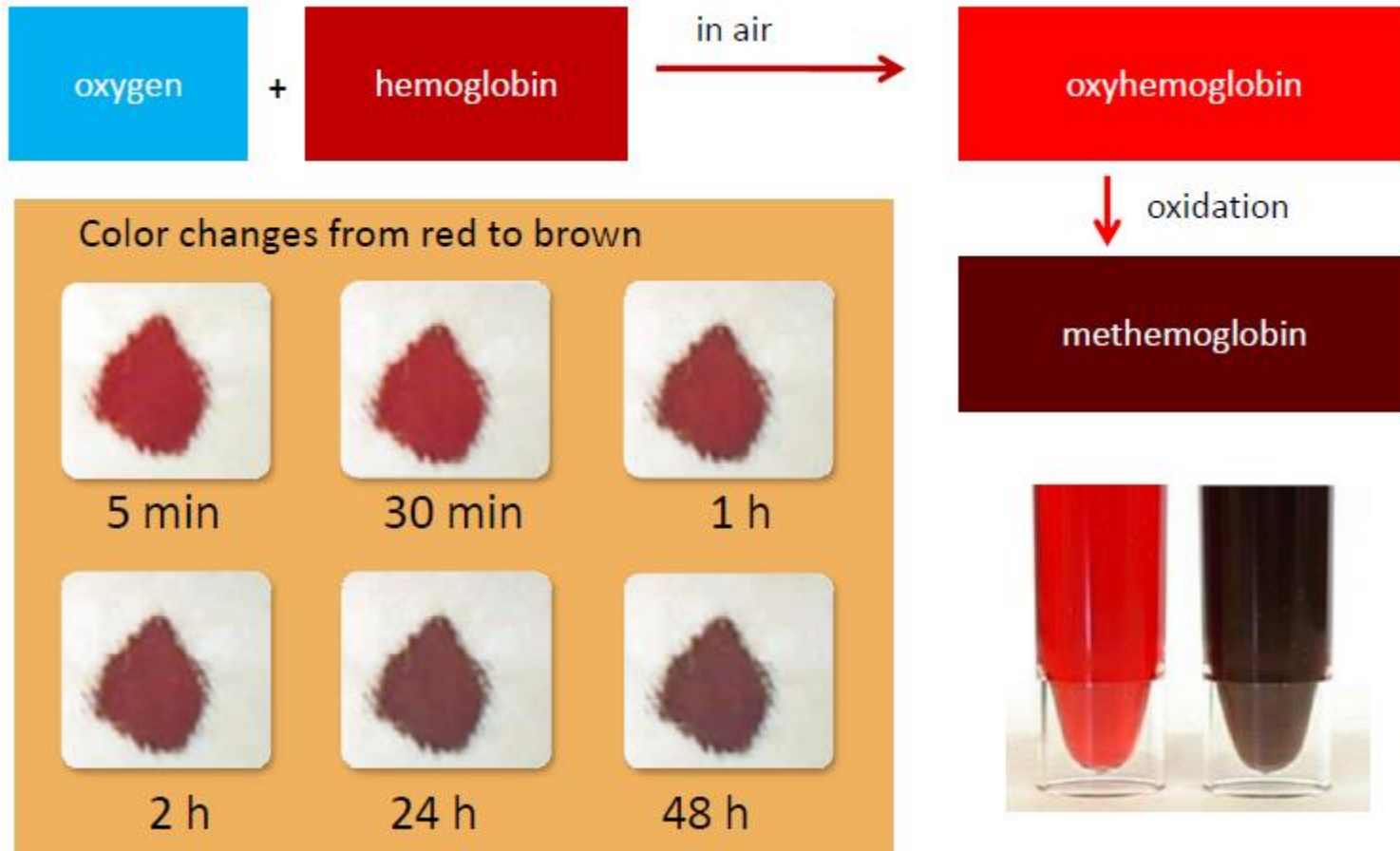
600 nanometer monochrome image



850 nanometer image

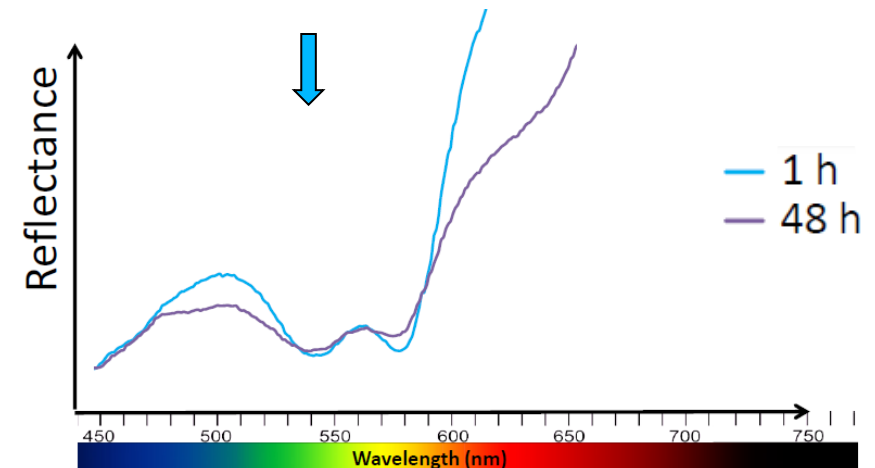
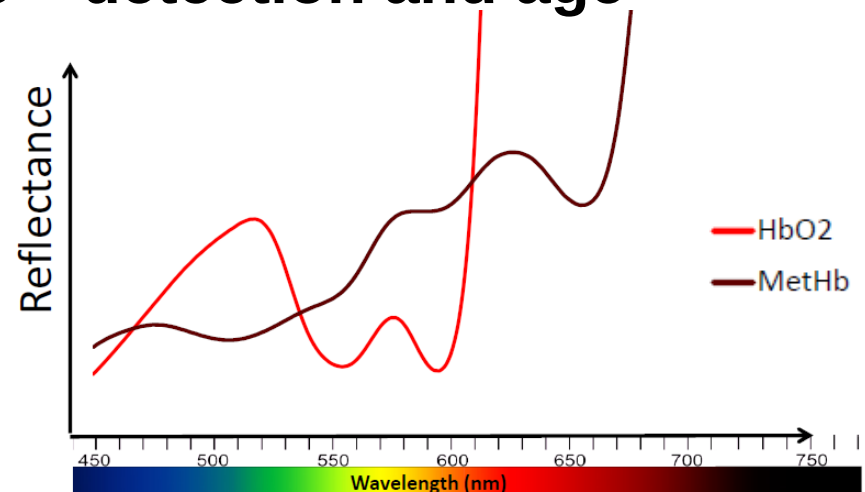
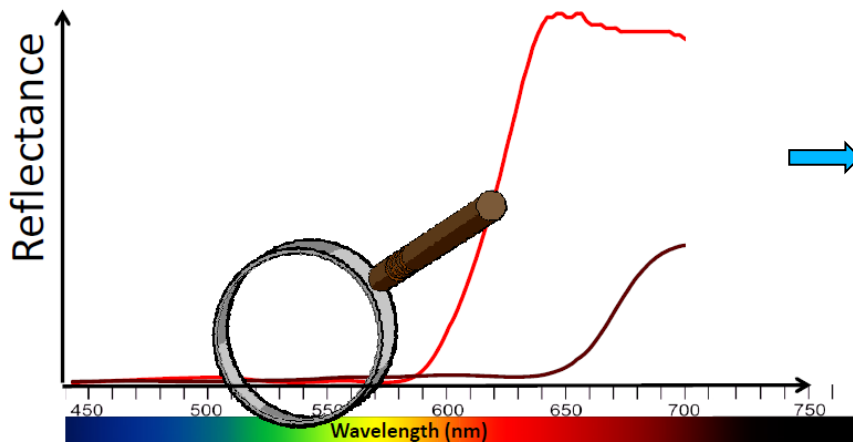
(C) Themis Vision

VNIR CASE 2: blood stains – detection and age



Blood changes its color outside the body.

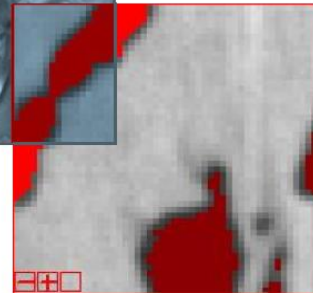
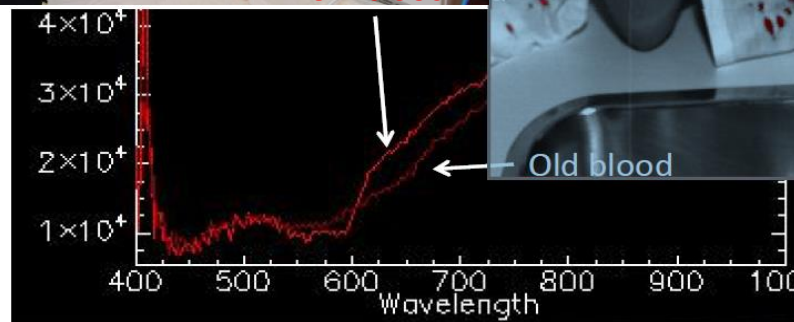
VNIR CASE 2: blood stains – detection and age



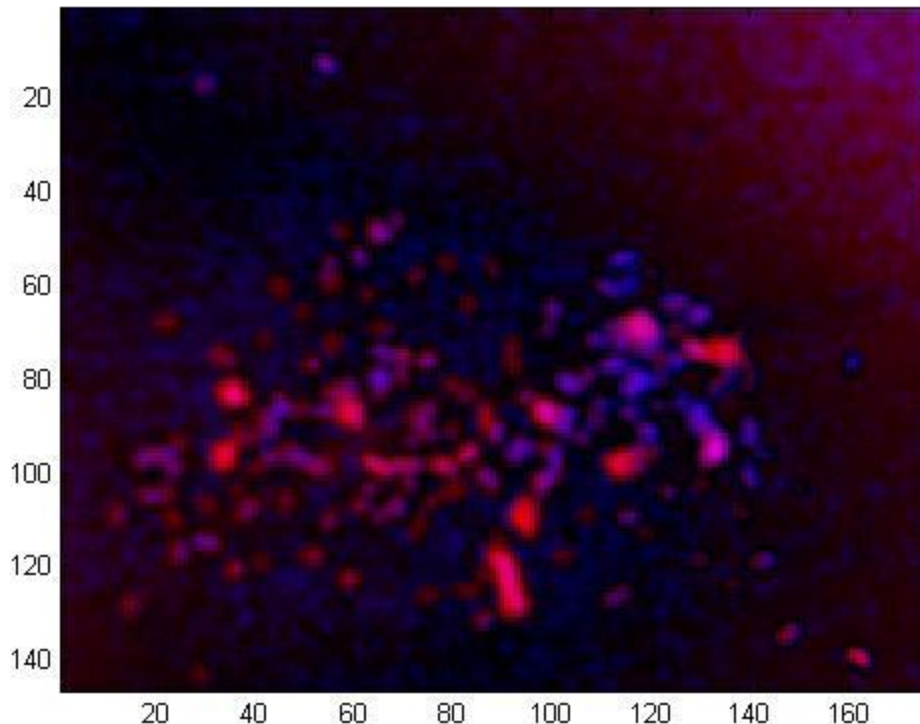
VNIR CASE 2: blood stains @ simulated crime scene



- Blood can be used to distinguish from other substances
- Fresh blood can be distinguished from old blood
- Read more in [www: 1](#) and [2](#)



VNIR CASE 3: Burnt and unburnt gunpowder residue¹



False color visualization of separating burnt and unburnt gunpowder.

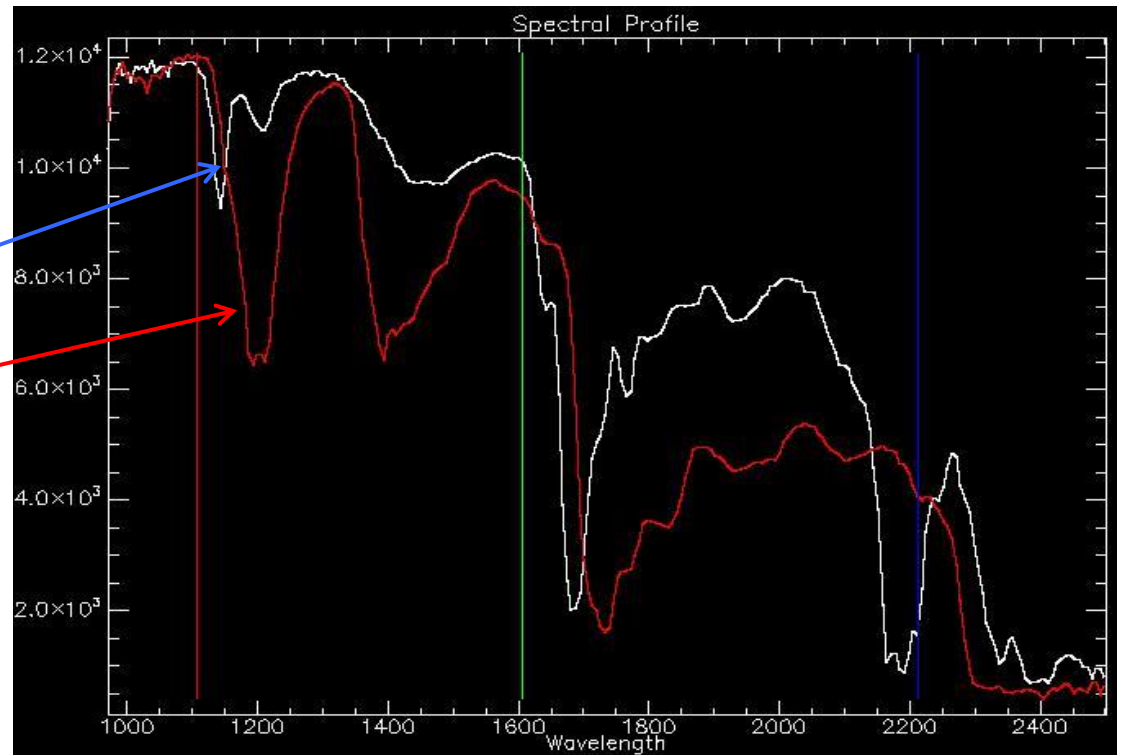
”During the examination, slightly visible subjects like traces gunshot residue were easily detected with VNIR spectral camera. It could also separate burnt gunshot residue from the unburned gunpowder. The VNIR cameras could not reveal subjects which are not visible for the human eye.”

¹ Jyväskylä University; National Bureau of Investigation, Finland; and Central Finland Police

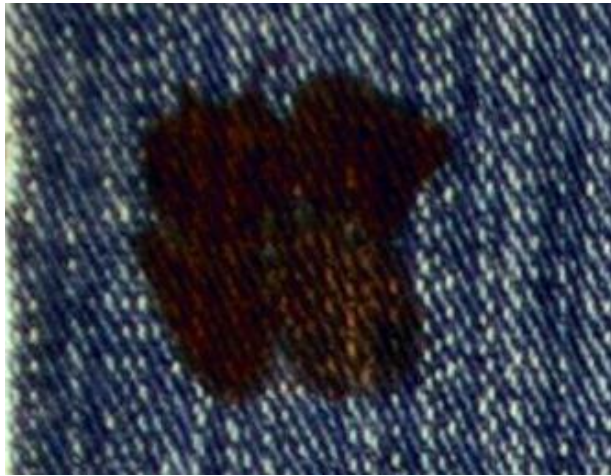
HSI Hyperspectral imager, SWIR (1000 – 2500 nm)

Efficient for chemistry.

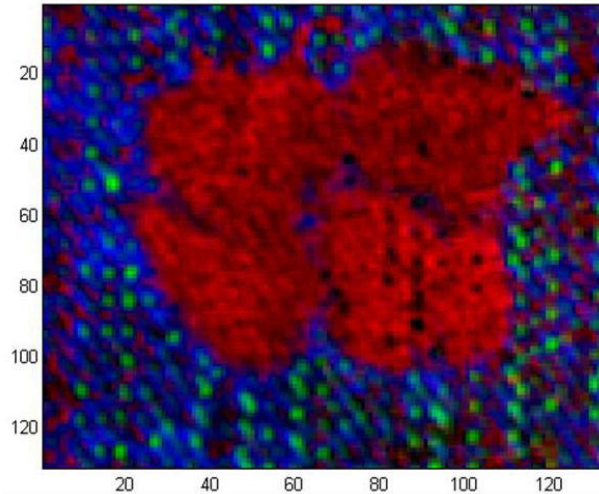
Separates items
invisible to human eye!



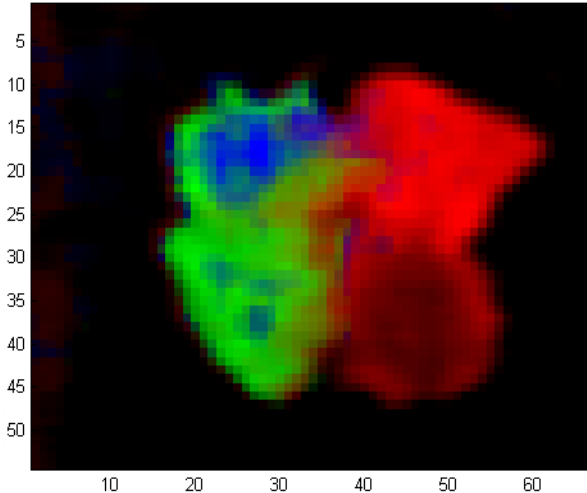
SWIR CASE 1: blood stains¹



RGB



VNIR (400-1000 nm)

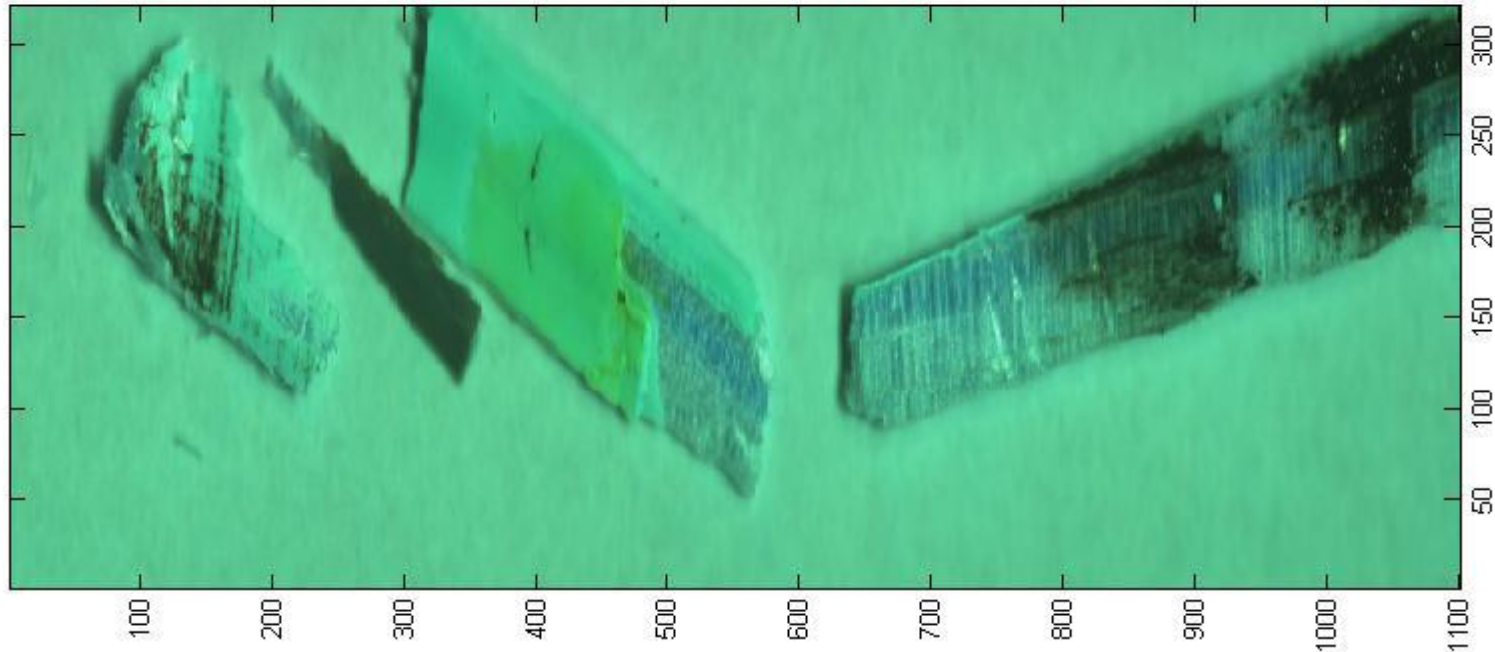


SWIR (400-1000 nm)

- four different types of blood absorbed in a denim cloth
- two male persons, one female person, and animal
- SWIR camera detected the differences in blood stains

¹ Jyväskylä University; National Bureau of Investigation, Finland; and Central Finland Police

SWIR CASE 2: separation of mixed and absorbed materials¹



A SWIR pseudo color image. Separation of mixed paints and filler on pieces of wood

- SWIR camera identified all tested materials on wood
- SWIR camera separated black filler and black marker pen

¹ Jyväskylä University; National Bureau of Investigation, Finland; and Central Finland Police

SWIR CASE 3: latent pepper spray / personal lubricants on fabric

Hyperspectral Imaging of Colorless Pepper Spray and Lubricants



The Federation of Analytical Chemistry and Spectroscopy Societies

Date: Tuesday, October 20, 3:20 pm

Symposium: Chemical Imaging and Its Use in Forensic Science

Topic(s): Forensic
Imaging
Infrared

Author(s): Kerri Moloughney (presenting) - 1
Diane Williams - 2

Institution(s): 1. Oak Ridge Institute of Science and Education
2. "FBI, Laboratory Division"



Abstract: In forensic investigations, a portion of the evidence being processed involves identification of colorless materials. While some types of evidence have standard methods for detection and visualization, such as latent fingerprints, there are some that do not, including residues of pepper spray and personal lubricants. Therefore, a research study was initiated to investigate the feasibility of using hyperspectral imaging (HSI) to locate these colorless materials on fabric. HSI systems collect both spatial and spectral information simultaneously. The resulting "data cube" enables the user to determine the precise location on the image from which a particular spectrum was obtained. MK-4 pepper spray and Astroglide® and KY® personal lubricants were deposited on a set of six different fabrics, including both light and dark colors and five different fabric types. Images were taken using two visible/near infrared (VNIR) and one short-wave infrared (SWIR) hyperspectral cameras, sensitive in the wavelength regions 400-950 nm and 950-1700 nm, respectively. Using ENVI® software for post-processing, false-color images showing chemical differences allow the visualization of the pepper spray and lubricants on both light- and dark-colored fabrics. This technique provides forensic examiners with a non-destructive method for determining the location of colorless materials on fabrics.

SWIR CASE 4: explosive residues invisible to human eye

Short-Wave Infrared Hyperspectral Imaging of Explosives



The Federation of Analytical Chemistry and Spectroscopy Societies

Date: Tuesday, October 20, 4:40 pm

Symposium: Chemical Imaging and Its Use in Forensic Science

Topic(s): Forensic
Imaging
Infrared

Author(s): Kerri Moloughney (presenting) - 1
Diane Williams - 2

Institution(s): 1. Oak Ridge Institute of Science and Education
2. "FBI, Laboratory Division"



Abstract: The development of a non-destructive method for detecting explosive residues invisible to the human eye would be invaluable to the forensic community, both as an aid to national security and in the investigation of criminal activity. This research explores whether visualization of explosives on various substrates is possible through the use of hyperspectral imaging (HSI) in the short-wave infrared (SWIR) region. Samples included microgram quantities of explosives on paper, plastic, and fabric as well as some post-blast material on metal, plastic, and fabric. The data set obtained using this system represents three dimensions, two spatial and one spectral. Scans collect a complete spectral profile for each pixel in the two dimensional image, with wavelengths ranging from 950-1700 nm. The "data cube" constructed enables the user to determine the precise location on the image from which a particular spectrum was obtained. Using ENVI® software, specific spectral characteristics are able to be isolated and illuminated during post-processing, allowing false-color visualization of chemical differences on the image itself.

Novelty of this Contribution: Provides for the visualization of explosives and explosive post-blast residues on a variety of substrates

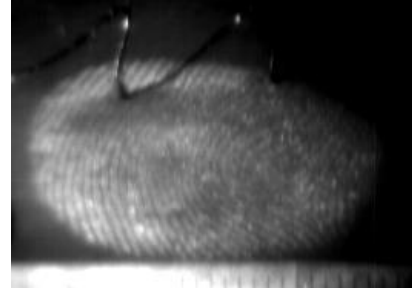
UV CASE 4: examination of latent fingerprints



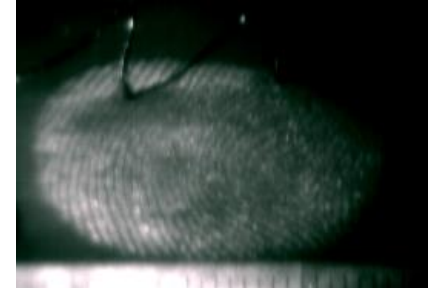
400 nm



207 nm



254 nm



Latent fingerprint at different wavelengths (ultraviolet).

HSI can be used

- to enhance the detection of latent fingerprints (UV)
- to improve specificity without damage to the prints (UV)
- to identify specific ridge patterns of the fingerprint (UV)
- potentially to detect chemical residues on fingerprint ridges (SWIR)