B92 Photogrammetry Using Visible, Infrared, Hyperspectral, and Thermal Imaging of Crime Scenes

Gerda Edelman, Netherlands Forensic Institute, The Hague, 2497 GB, NETHERLANDS; Maurice Aalders, AMC, Amsterdam, North Holland 1105AZ, NETHERLANDS*

Learning Overview: The goal of this presentation is to show the possibilities and challenges of the use of photogrammetry for 3D recording of crime scenes with various layers of information, such as thermal and chemical.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by offering a method for revisiting the crime scene in 3D, including the possibility of extracting chemical and thermal information of the objects in the scene.

Photogrammetry is used to obtain virtual 3D models of objects and scenes. The photogrammetry variant Structure-from-Motion (SfM) uses computer vision methods that detect and match features between multiple images to estimate camera locations and orientations and the 3D structure automatically, without the need for previously placed targets. The technique has proven its value in many application areas, especially in geoscience, remote sensing, and archaeology. In forensic casework, the technique is increasingly used to record the crime scene in its original, undisturbed state. Some application areas where this geometrical mapping is especially useful are the investigation of traffic incidents; for example, high resolution documentation of surfaces of human bodies that have been injured and reconstruction of a suspect's height have been accomplished. The technique also provides a complete and metric 3D registration of objects at the crime scene, thereby allowing digital revisitation of the crime scene after its release, in turn enabling additional measurements and inspection of the crime scene from different angular perspectives. Its rapid, remote, and non-destructive manner of operation renders photogrammetry a powerful analytical tool ideally suited to the needs of both forensic science and forensic casework. Furthermore, its low cost, speed, accuracy, and ease of-use facilitate its application at the crime scene by non-specialists and, consequently, its introduction into standard crime scene investigation protocols.

Recent developments of advanced imaging techniques have led to the exploration of the potential added value of cameras operating beyond the visible light range for forensic applications, in addition to the standard red/Green/Blue (RGB) imaging. For example, Infrared (IR) imaging can be used to detect gunshot residues or latent blood stains on dark surfaces. Furthermore, Edelman et al. showed that by using hyperspectral imaging (a combination of diffuse reflectance spectroscopy and digital imaging), it is possible to detect, identify, and even estimate the time of deposition of blood traces at the crime scene in an entirely non-contact fashion.[1] Similarly, thermal imaging has proven to be of forensic value in trace detection and is currently also being explored as a tool to measure postmortem human body temperatures. Together, these extra layers of information would be greatly beneficial in the reconstruction of crime scenes, revealing traces, invisible to the naked eye, along with their chemical composition and thermal properties.

In this presentation, several scaled 3D models made from stacks of visible, IR, hyperspectral, and thermal images will be shown using the photogrammetric technique SfM and will demonstrate the benefits for crime scene investigations. While some practical challenges remain to be addressed prior to standard application of the technique at real crime scenes, these results establish SfM as a powerful forensic tool and substantiate the added value of such consolidated data sets in forensic investigations.

Reference(s):

1. Edelman Gerda, and Maurice Aalders. 2015 Development of a Spectral Camera for Estimating the Age of Bloodstains in Casework. *Proceedings of the American Academy of Forensic Sciences*, 67th Annual Scientific Meeting, Orlando, FL. 2015.

Photogrammetry, Hyperspectral Imaging, Thermal Imaging

*Presenting Author