B123 Development of a Spectral Camera for Estimating the Age of Bloodstains in Casework

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After attending this presentation, attendees will understand the principles of hyperspectral imaging and the chemical reactions taking place within a bloodstain.

This presentation will impact the forensic science community by showing the possibilities and limitations of a technique for age estimation of bloodstains at the crime scene.

If the age of bloodstains could be determined, this would provide investigators with valuable information regarding the timeline of events. Although several techniques for the age estimation of bloodstains have been explored in forensic laboratories, no method has yet been applied in forensic investigations. The transition from laboratory measurements to crime scene analysis brings some typical challenges. While ideal substrates are selected in a laboratory setup, many different and far-from-ideal substrates can be encountered at a crime scene. Likewise, the measurement setup is less controlled.

Recently, it was demonstrated how diffuse reflectance spectroscopy could be used to measure the concentration change of oxyhemoglobin, methemoglobin, and hemichrome, all reaction products of hemoglobin, in order to estimate the age of bloodstains in a laboratory setup without destroying or even touching the sample. Measurements were demonstrated on 40 bloodstains performed at ages ranging from fresh to 200 days old and estimated the age with an error margin of approximately 20%. This method has now been adapted to the specific requirements of forensic practice. A wireless spectral camera was introduced to replace the optical fibers used for point measurements in the laboratory. By combining spectroscopy and digital imaging, spectral imaging enables investigators to record the reflectance spectra and the distribution of many bloodstains simultaneously. To be able to perform measurements on (non-ideal) substrates possibly found at the scene, the algorithm used for the age estimation was adapted to correct for background absorptions.

The developed technique was successfully tested at a simulated crime scene in which bloodstains of five different ages were deposited. The absolute error of the age estimation task increased with age, with a median relative error of 13.4% of the actual age. Finally, the technique was applied in several real murder cases. In these cases, the research questions were twofold: (1) what is the age of these bloodstains; and, (2) were these bloodstains deposited during the same event?

Regarding the first question, when an absolute age estimation is asked, the influence of humidity and environmental temperature on the speed of the chemical reactions has to be taken into account. When this information is not available, it may be possible to perform a relative age estimation, which gives investigators information about the sequence of events.

In this presentation, the theory of bloodstain age estimation and spectral imaging is explained, followed by a description of the experimental verification and several case examples. Insight is given not only in the possibilities of this technique but the limits and challenges of this technique in forensic practice are also described. Applied in casework, this technique provides new objective information which can be used by investigators to create a timeline of events.

Spectral Imaging, Bloodstain Age, Timeline