B183 Inferring Bloodstain Age With a Mobile Spectrometer for Forensic Crime Scene Investigation

Nichole Sutton, BS, 2014 Horizon Court, Apt 204, Woodbridge, VA 22025; Michael Harradon, BS, Massachusetts Institute of Technology, 233 Massachuesetts Avenue, Cambridge, MA 02139; Paul C. D'Angio, PhD, Booz Allen Hamilton, 3811 N Fairfax Drive, Ste 600, Arlington, VA 22203; Michelle R. Mendonca, MFS, 825 New Hampshire Avenue, NW, Apt 413, Washington, DC 20037; Kristen L. O'Connor, PhD, Booz Allen Hamilton, 3811 N Fairfax Drive, Ste 600, Arlington, VA 22203; Zigurts K. Majumdar, PhD, Booz Allen Hamilton, 3811 N Fairfax Drive, Ste 600, Arlington, VA 22203; and Daniele S. Podini, PhD*, Department of Forensic Science, 2100 Foxhall Road, NW, Washington, DC 20007*

After attending this presentation, attendees will better understand the evaluation of aging bloodstains using optical spectrometry to develop an application for a smartphone-like device capable of predicting the age of a bloodstain based on a picture captured with a camera phone. Data obtained from an Ocean Optics® spectrometer was compared to data obtained with a portable mobile spectrometer to determine the mobile device's ability to quantify bloodstain age.

This presentation will impact the forensic science community by providing preliminary data for the development of a tool for crime scene investigators who need field-ready, hand-held forensic solutions to allow them to process, prescreen, triage, and analyze forensic evidence in the field.

The application is based on the principle of reflective spectroscopy. Spectral reflectance of a bloodstain changes over time, as the blood itself undergoes changes in its chemical composition while exposed to the environment. By analyzing how the spectroscopy data changes as blood ages, the data may be characterized in order to create a smartphone application. The smartphone application would be used together with a modular attachment used to record the spectral reflectance and analyze the data to predict the age of the bloodstain. Spectroscopic measurements of bloodstains of varying ages from zero hours to 1,400 hours were taken with two different devices: (1) a commercially available, laboratory-grade spectrometer (Ocean Optics®) using its respective analysis software; and, (2) a smartphone with an attached module that uses the camera to acquire a dispersed optical spectrum. The devices were set up adjacent to one another and measurements of one sample at a time were taken by each device. Samples consisted of bloodstains, approximately 2.5 centimeters in diameter. The samples were collected from a single individual via a lancet prick on a finger (Institutional Review Board-approved procedure). Once the finger was pricked, it was touched directly to a square of white cotton cloth until the 2.5 centimeter diameter was obtained. The samples were then placed, ten at a time, on a rotating platform that moved under the two collecting devices. The platform, accompanied with a Light-Emitting Diode (LED) light source, operated on a timer so that spectra data could be collected on each sample at specific time intervals. A blank white cloth was included to normalize the reflectance data. The platform rotated one sample at a time, paused for 30 seconds at the new location, a measurement was taken by both devices, and rotated once again. At 25 seconds into the pause, the LED light turned on, each device took a measurement, and the light turned off before the platform rotated again. This was done for two complete rotations of each sample set. This allowed each of the ten samples to be measured every five minutes.

Analysis of the data has resulted in the development of a method that allows for the prediction of the age of a bloodstain based on the spectroscopic measurements with an inference error that increases with the age of the stain. Based on prior studies and on data generated in this project, an algorithm was developed that can process data in real-time on a smartphone. Results suggest that the processing algorithms are promising for use in crime scene analysis to distinguish samples of differing age. Preliminary results are based on 318 spectra, for which confidence intervals at 95% or greater were calculated, based on the t-distribution, to determine if samples of varying age could be reliably distinguished when assuming a constant temperature and humidity over the measurement conditions. The following statements can be made with a 95% confidence interval from current data: a bloodstain <1.5 hours old can be identified as younger than a >5.0-hour-old stain; a <5.0-hour-old stain can be identified as younger than a >24-hour-old stain; a stain <24 hours old can be identified as younger than a stain >20 days old. The algorithms are being refined to increase accuracy and to provide greater robustness against variations in temperature and humidity. Accuracy in predicting the absolute age of the bloodstain will be discussed using more data points. Further analysis and development will enable the production of a field-ready smartphone application that can quickly help prioritize sample collection and processing, resulting in increased efficiency at the crime scene.

Bloodstain, Mobile, Spectrometer

Copyright 2015 by the AAFS. Unless stated otherwise, noncommercial *photocopying* of editorial published in this periodical is permitted by AAFS. Permission to reprint, publish, or otherwise reproduce such material in any form other than photocopying must be obtained by AAFS.