A134 The Forensic Utility of Photogrammetry in Surface Scene Documentation

Elizabeth Church, Boston University, Boston, MA 02118; James Pokines, PhD, Boston University School of Medicine, Boston, MA 02118; Christopher J.H. Ames, PhD, University of Wollongong, Wollongong, New South Wales 2522, AUSTRALIA*

Learning Overview: After attending this presentation, attendees will understand how Structure from Motion (SfM) can be implemented as a forensically viable photogrammetric technique for 3D documentation of crime scenes, providing a more detailed understanding of evidentiary and environmental relationships in comparison to 2D mapping and eliminating subjectivity in documentation by capturing the scene as a genuine whole. Additionally, this presentation will examine the utility of open-source and commercial photogrammetric software.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by contributing to the growing literature surrounding standards of accuracy for reconstruction methodology and will help evaluate the adoption of a digital technique.

Applied SfM reconstructs models through image point comparisons. A 3D model is produced from a reference photoset that captures a 360-degree view of the subject, and the software employs triangulation to match specific points, datums, across individual photos. The datums are arranged into a point cloud that is then transformed into the final model. Modifying the point cloud into a final product requires algorithms that adjust the points by building a textured mesh from them. One of the disadvantages of SfM is that the point cloud can be "noisy," meaning that the program is unable to distinguish the features of one datum from another due to similarities, creating coverage gaps within the meshed images. To compensate for this, the software can smooth portions of the model in a best-guess process during meshing. As commercial software does not disclose the adjustment algorithms, this documentation technique, while very useful in other disciplines that regularly apply SfM, such as archaeology, would fail to meet the standards of the *Daubert* and *Kumho* criteria.

A potential solution to this problem is to use open-source software, which discloses the adjustment algorithms to the user. It was hypothesized that the output of open-sourced software solutions would be as accurate as the models produced with commercial software and with total station mapping techniques. To evaluate this hypothesis, a series of mock outdoor crime scenes were documented using SfM and traditional mapping techniques. The scenes included a dispersed set of plastic human remains and various objects that might reasonably be associated with a crime scene. Ten of these scenes were laid out in 10m x 10m units in a New England forested environment, each grid with a slightly different composition, and then documented using a total station/data logger system and camera. The resulting models were built using PhotoScan® by AgiSoft®, the commercial software, and MicMac/Meshlab for Mac OSX as the open-source comparison software. However, accuracy is only part of the concern; the full utility of any one of the workflows is defined additionally by the overall cost effectiveness (affordability and accessibility) and the visual quality of the final model. Accuracy was measured by the amount of variance in fixed-datum measurements (example, femur length) that remained consistent, while visual quality of the photogrammetric model was determined by the ability to see non-fixed datums (example, a syringe) that moved locations between grids.

While there was variance in the metric outputs between the total station and photogrammetric models, the average total variance from an individual scene, regarding the fixed-datum lengths, fell within 0.635cm. This standard is the recommended measurement accuracy for scene documentation as suggested by "The Technical Working Group on Crime Scene Investigation."[1] However, the quality of the SfM model was extremely variable, with smaller objects and details being lost entirely. Conditions such as light, ground foliage, and topography were found to effect model quality significantly, as well as the amount of available computing power. There was no issue of losing objects or computing power when mapping by total station and processing the data in AutoCAD®. This research demonstrates that there is potential for SfM to be a rapid, accurate, and low-cost resource for research and forensic investigation, but there are limitations that must be taken into consideration.

Reference(s):

1. Technical Working Group on Crime Scene Investigation. *Forensic Science Communications.* Volume: 2. Issue: 2 Publication date: April 2000.

Forensic Anthropology, Forensic Scene Recovery, Photogrammetry