

# OSAC RESEARCH NEEDS ASSESSMENT FORM



**Title of research need:**

Development, Testing & Validation of 3D Imaging Technologies for Footwear & Tire Impression Evidence

**Describe the need:**

There is a need to develop, test and validate 3D imaging technologies and associated products (used for both acquisition and output) for use in the recovery and examination of footwear/tire impression evidence. In addition to validating a specific technology or product currently on the market, there is a need to set 3D imaging standards (i.e., establish minimum requirements and specifications) to ensure that the data acquired (and its associated output) and new products created meet the needs of the footwear/tire impression evidence community. Specifically, the technology/product must be able to reproduce footwear/tire impression evidence with sufficient “resolution” to record fine detail (including manufactured texturing and small wear features) and the dimensional characteristics of the evidence. It must be able to meet these requirements with both precision and accuracy. In addition to these requirements, the product should be affordable (for law enforcement agencies at all levels), portable, and easy to use. There is a need to improve the precision and accuracy of recovered evidence in order to ensure high-quality results are consistently produced. Currently, the recovery methods consist of two-dimensional DSLR photography and casting or lifting. These methods are highly dependent on the crime scene technician’s expertise in the detection, collection and enhancement of this type of evidence and his/her ability to apply the best practices to the evidence encountered. The proper technique for capturing exam-quality photographs of this evidence include: placing a scale adjacent to the impression at the same depth as the bottom of the impression, placing the camera on a tripod, aligning the plane of the camera’s sensor with the plane of the impression, using the appropriate aperture setting (to maximize the depth of field), and illuminating the impression from various angles (to maximize the impression detail). However, the evidence often prohibits adherence to this protocol so even the best photographers are unable to apply the proper technique in every case. In addition to the fact that casting and lifting require experience to perform correctly, these processes can be destructive so there is normally only one opportunity to capture the impression. Note that despite the positive impact that 3D imaging could have on evidence collection methods, the 3D data acquired must be useful to the laboratory examiner. This means that there must be an interface between the field and the lab for this technology to be adopted. Therefore, the examination process and laboratory capabilities must be considered when evaluating a technology/product and validating its use for footwear/tire impression evidence. Moreover, the examiner community will best be able to interpret the results of any research related to 3D imaging technology if the technology/product is evaluated against existing recovery and examination methods.

**Keyword(s):**

Laser Scanning, Structured light, 3D Printing, 3D acquisition, Three Dimensional Impressions, Footwear, Tires

**Submitting subcommittee(s):**

Footwear & Tire Subcommittee

**Date Approved:**

October 24, 2022

## Background Information:

1. Does this research need address a gap(s) in a current or planned standard? (ex.: Field identification system for on scene opioid detection and confirmation)

2. Are you aware of any ongoing research that may address this research need that has not yet been published (e.g., research presented in conference proceedings, studies that you or a colleague have participated in but have yet to be published)?

This is an active topic of research. Please review conference proceedings and NIJ's funded projects abstracts for additional information regarding research currently under investigation.

3. Key bibliographic references relating to this research need: (ex.: Toll, L., Standifer, K. M., Massotte, D., eds. (2019). Current Topics in Opioid Research. Lausanne: Frontiers Media SA. doi: 10.3389/978-2-88963-180-3)

Yi-Hong Liao, Jae-Sang Hyun, Michael Feller, Tyler Bell, Ian Bortins, James Wolfe, David Baldwin, Song Zhang. (2020). Portable high-resolution automated 3D imaging for footwear and tire impression capture. J Forensic Sci, Vol. 66, No. 1. <https://doi.org/10.1111/1556-4029.14594>

Andalo, F., Calakli, F., Taubin, G., & Goldenstein, S. (2011). Accurate 3D footwear impression recovery from photographs. 4th International Conference on Imaging for Crime Detection and Prevention 2011 (ICDP 2011).

Buck, U., Albertini, N., Naether, S., & Thali, M. J. (2007). 3D documentation of footwear impressions and tyre tracks in snow with high resolution optical surface scanning. Forensic Science International. Vol. 171(2-3), pp. 157-164.

Gamage, R. E., Joshi, A., Zheng, J. Y., & Tuceryan, M. (2013). A high resolution 3D tire and footprint impression acquisition for forensics applications. 2013 IEEE Workshop on Applications of Computer Vision (WACV).

4. Review the annual operational/research needs published by the National Institute of Justice (NIJ) at <https://nij.ojp.gov/topics/articles/forensic-science-research-and-development-technology-working-group-operational#latest>? Is your research need identified by NIJ?

No.

5. In what ways would the research results improve current laboratory capabilities?

The examiner is limited by the information that can be gleaned from the evidence submitted. The current evidence collection methods provide challenges to reproducing the same level of impression detail observed at the scene and the impression's dimensional characteristics accurately. Current methods are time-consuming and difficult to execute without extensive training and experience. The results of this research could identify technology/products that improve the quality of the evidence and make the collection process quicker and easier to perform. If the process is easier, more evidence will be collected, and more information will be available for consideration by the examiner. Ultimately, 3D imaging technology has potential to reduce the number of inconclusive results provided by examiners in laboratories.

6. In what ways would the research results improve understanding of the scientific basis for the subcommittee(s)?

This research would allow the Subcommittee to understand the potential and tradeoff-space of using 3D imaging technology over conventional 2D capture and reproduction methods.

7. In what ways would the research results improve services to the criminal justice system?

Possible benefits: increase quality of evidence, improved evidence collection, improved evidence examinations (since examiners would spend less time grappling with what to do with distorted photos and/or broken casts), a decrease in the number of inconclusive opinions, an increase in the number of conclusive opinions, improved evidence integration across cases for investigators/attorneys/juries/judges.

8. Status assessment (I, II, III, or IV):

**II**

	Major gap in current knowledge	Minor gap in current knowledge
No or limited current research is being conducted	<b>I</b>	<b>III</b>
Existing current research is being conducted	<b>II</b>	<b>IV</b>

*This research need has been identified by one or more subcommittees of OSAC and is being provided as an informational resource to the community.*