

Producing Datasets: Creating Mock Crime Scene Footwear Impressions

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Project Rationale and Goals

One of the fundamental problems in forensic science is a lack of data, especially data representative of real casework. OSAC (the Organization of Scientific Area Committees for Forensic Science) have identified key places where forensic research needs improvement and pattern analysis is one of them. Analysis algorithms cannot be made successfully without being tested rigorously with data, so lack of data remains a major barrier to the development of quantitative methods for the field of forensic footwear analysis.

The generation of new quantitative tools such as comparison algorithms may aid forensics examiners in the comparison of crime scene and test impressions. In order develop and evaluate new algorithmic approaches, researchers need high-quality, robust datasets that are representative of real casework.

The goal of this project is to create an open-source database containing a sizeable number of high-quality shoe impression images, which can be made available to the public for use in and out of research needs.

Collection Design

Materials

- Types of flooring: vinyl and tile
- Print mediums: Forensic spatter Blood and Graphite fingerprinting powder
- Printmaking supplies: paper towels, tarp, cleaner, lint roller, brush, paper/trays
- Camera setup: tripod, scale, lighting (lights and reflectors/ modified RC car for light painting)
- Camera used: Canon T81, 18-55mm lens kit, and a Canon Speedlight 600EX II-RT flash attachment
- BVDA Gellifters



Nike zoom Winflo (L) and Adidas Seeley (R)

Database Design - We solicited input from US forensic science practitioners and researchers on the database conceptualization and design. We documented feedback on what types of shoes, prints, and flooring are commonly found in crime scenes. Researcher teams were also consulted to ensure that the data would be useful for the development and evaluation of comparison algorithms.

Protocol Development and Testing - Our primary focus was developing a detailed protocol which would produce images consistent with real casework. Our first round of test images had issues with angle distortion, image blurring, and inconsistent lighting. In order to combat these issues, we constructed 2 types of photography setups to consistently take images, so they didn't have the same issues we had from the trial run. We wanted to control outside variability, such as lighting or focus, and make the only variable the print itself.



Figure 1 shows the setup used to capture images of blood prints. This same protocol was used for each image

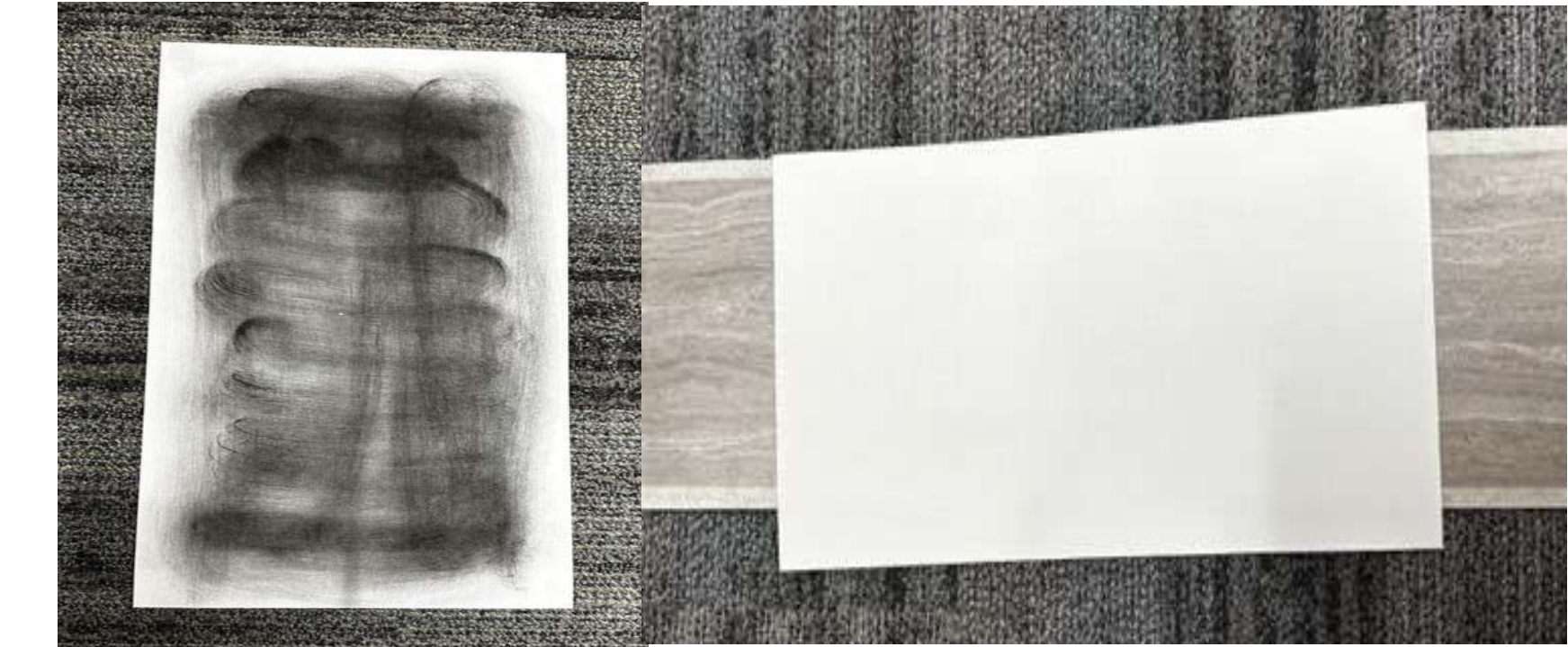


Figure 2 shows the setup used to capture images of gel lifts using the Rufus RC car for "light painting" to capture consistent images.

Data Collection

Methods

- Two full prints and two partial prints with synthetic blood on vinyl and tile flooring per shoe. The image of the print was captured directly from the flooring.
- One full print using graphite powder on vinyl flooring per shoe. The graphite prints were lifted with gel lifts for imaging.
- Handiprint exemplars from a previous study are matched in the data set. They show the most detail in the shoes which can be helpful for analysis.



These figures show the typical setup for collecting blood print images (L) and the methods used for collecting gel lifts including the process of lifting the graphite prints onto the gel lifters @.

Images

- 624 blood prints (4 prints per shoes with 156 shoes-78 pairs)
- 156 gel lift images (1 print per shoe with 156 shoes-78 pairs)

Image Editing and File Types

Once captured, images were edited to fix any angle distortion that might have occurred and cropped down to the angle scale.

- All images are contained in three file types: RAW (CR2), JPG, and TIFF. Original images as well as the edited versions are all saved within these files.
- Images were also matched with handiprint files, giving us another way to view the full tread of each shoe.

All files were renamed to show the changes in variables among images and allows user to easily sort through the data.

- Variations in labeling included "L" or "R" to represent which shoes was used, "B" or "G" was used to differentiate between blood and graphite images, "F" and "P" were used for blood images to show whether the print was a full or partial print, and lastly, "T" or "V" was included to represent either tile or vinyl as the medium used for the print.
- Along with these variations, the shoe label, date the image was taken, and the initials of the individual(s) who took the images were added to the image labels. Once the images were edited, the date of editing and the editors' initials were then added to the photo label as well.

Future of the database

- Our data are currently being used by multiple research teams at CSAFE.
- We will make the first round of data publicly available in the ISU DataShare and be assigned a Digital Object Identifier (DOI) which will make our data easy to cite, trace, and locate.
- Future goals for this project would be to expand the shoe type/brand, expand the substrates that we make prints on, and test with less rigid protocols, so there would be more data to work with and it would be more representative of casework.

References:

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- [3] "OSAC Research and Development Needs" *National Institute of Standards and Technology (NIST)*. February 22nd, 2023. <https://www.nist.gov/organization-scientific-area-committees-forensic-science/osac-research-and-development-needs>