Expanding ShoeCase: A Mock Crime Scene Footwear Impression Database

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Project Rationale & Goals

One of the fundamental problems in forensic science is a lack of data, especially data representative of real casework. 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 to 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 expand the open-source database with more high-quality shoe impression images using new shoes that have similar but different outsoles, to ensure that algorithms can distinguish between soles even when they have similarities.

Database Expansion

Database Design – A previous project that CSAFE conducted was the ShoeCase dataset. This dataset used Nike Zoom Winflos and Adidas Seeleys to start the database of mock crime scene footwear impressions. To expand our existing database, we chose a shoe that had similar outsoles to the Nike Winflos, the Nike Air Zoom Pegasus.

Protocol following – The first thing we did with the shoes was collect handiprints and blood impressions according to the previously made protocol. This was so we could directly add more data to the database, and not alter any over-arching protocols or rules.

We did run into issues while trying to make blood prints on the vinyl which required us to slightly alter the protocol, the changes have been documented.

Shoes
- 10 pairs of Women's Nike Air Zoom Pegasus 39
  - Five pairs of size 9
  - Five pairs of size 10

Materials
- Types of flooring: tile and vinyl
- Print mediums: forensic spatter blood and graphite fingerprinting powder
- Printmaking supplies: paper towels, tarp, cleaner, brush, paper/trays, handiprints
- Camera setup: tripod, scale, flash and reflector

Methods
- Two full prints and two partial prints with synthetic blood on tile flooring per shoe. The image of the print was captured directly from the flooring.
- One full print using graphite powder on Handiprint per shoe.

Images
- 480 blood prints (10 pairs of shoes, two prints per shoe, 12 angles/heights)
- 20 Handiprint scans (one print per shoe with 20 shoes-10 pairs)
- 240 Handiprint images (20 shoes, 12 angles/heights)

Example of size 9 Nike shoes (above)

Creating New Data With Alternative Photo Protocol

Presently, the algorithms utilized in ShoeCase extract and recognize interest points from image data at fixed heights and angles. In order to enhance the algorithm's ability to recognize interest points, we have implemented a modification that involves capturing the graphite and blood prints at varying heights and angles for each image.

Heights:
- 95.5cm (original)
- 90cm
- 85.5cm
- 80cm

Angles:
- Right
- Left
- Parallel (original)

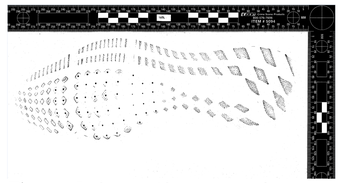


Figure 1 shows the exemplar Handiprint scan with ideal quality. The prints below show variations in prints for the same shoe.

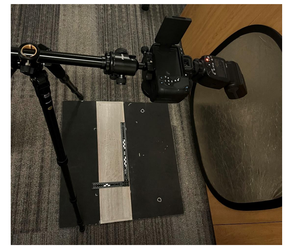
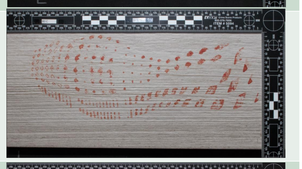
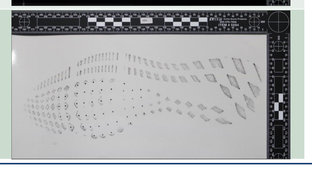
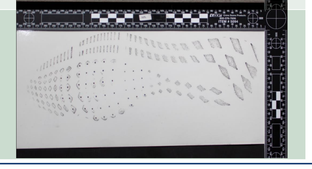


Figure 2 shows the setup used to capture images of all prints. This same protocol was used for each image.

	Left Angled	Center (parallel)	Right Angled
Partial			
Full			
Handiprint Match			

Next Steps

- Our data is currently being utilized by multiple research teams at CSAFE.
- As part of our ongoing efforts, we plan to expand the database and incorporate it into the current public database.
- The future objectives of this project revolve around an extensive diversification of shoe types, styles, and brands, as well as the inclusion of a broader range of substrates for our prints.
  - By implementing these enhancements, we aim to significantly enrich the database, rendering it more comprehensive and representative of real-world casework.
- Furthermore, our dedicated team is actively working on publishing an article in "Data In Brief" to report the details of our database.

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

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