Science & Technology in Policing

POLICE STAR FUND 24/25

WHEN ALL IS TREAD AND DONE: IS THERE EVIDENTIAL VALUE?

Summary

This project will investigate the potential evidential value of footwear uppers caught on camera (e.g. CCTV) as a form of identification. It will investigate factors that influence the interpretation of class and individual characteristics (e.g. brand and damage, respectively) that could influence the evidential outcome of a comparison.

Organisations

West Yorkshire Police (Yorkshire and the Humber Regional Scientific Support Services)
University of Staffordshire

Challenge

The use of footwear mark evidence in criminal investigations is well-established, but there is little research investigating the comparison of footwear uppers caught on camera; a subject matter that could assist with identifications.
For example, footwear worn in CCTV could be:
1) identified by using its make and model and disseminated asintelligence to generate a suspect (the predominant focus of phase 1);
2)compared to footwear seized from a suspect and the evidential strength reported.
Phase 2 aimed to investigate the evidential potential of footwear upper comparisons to ensure comparisons are accurate and reliable.

Innovation or research

This research aimed to answer two fundamental questions:
• Can certain class and individual characteristics be observed on shoes when viewed in CCTV under different environmental conditions?
• Do these characteristics offer discriminatory potential? How common are they and do they persist over time?
To address these questions, the research investigated:
• Environmental factors that may affect the quality of footwear characteristics gathered from CCTV images. These included factors such as lighting conditions, distance and angle of the footwear from the camera.
• The persistence of individual characteristics over time. This involved a long-term study monitoring the development of, and changes in, individual characteristics over a 9-month period. Are some characteristics more permanent and reliable for use in comparisons than others?
• The commonality of individual characteristics on shoe uppers. Which features (e.g. creases, stains, damage) were most commonly encountered and where on the shoe did they form? This could assist the interpretation of findings, to prevent under- or overstating the level of evidential strength.
• The composition of shoe uppers, including textile types and dyes. If certain footwear dyes and/or materials behaved in particular ways under near infrared (NIR), is it possible to predict the colourway of a trainer in white light, when it has only been viewed under NIR?

Findings

The work generated evidence-based insights into footwear uppers in real-world conditions, focusing on the visibility, commonality, persistence and material-dye interactions of footwear characteristics, particularly under NIR imaging. Key outputs included a novel image quality assessment tool, a dynamic footwear characteristics database, and analytical findings with direct forensic relevance. Each work package contributed distinct findings:
• Lighting, shoe colour, distance, and material influence characteristic detection. Notably, light-coloured shoes performed better under white light, while dark shoes showed improved contrast under NIR. Glare and material reflectivity were also found to impact visibility. Characteristics were tracked over nine-month period, revealing that features such as creases, dents, and stains often persist, while others—particularly dirt—tend to degrade. Some characteristics evolved over time, supporting the forensic value of longitudinal shoe data.
• 10,000 images were captured from 1,000 shoes, with over 7,600 annotated characteristics. Common features included stains, creases, and dents, predominantly located on the toe and sole. Less frequent but more distinctive features such as holes and fraying may hold greater evidential value.
• Analysis of 30 shoes showed that material type alone did not fully explain NIR visibility. FTIR and HPLC results suggest that dye types and binding agents influence how materials appear under NIR.

Next steps

The final challenge in this project is to:
• Operationalise the use of this evidence to empower investigators and those interpreting the evidence for court;
• Improve the efficiency of manually searching an uppers reference database to reduce crucial intelligence from being missed;
• Maximise the potential of footwear mark and footwear upper evidence, by investigating combined conclusions.
This work makes up Phase 3 of the project and will address the challenge via three distinct objectives.
• Operationalising this work via training, knowledge exchange and the creation of a shoe upper evidence network to facilitate further research and expand the footwear upper dataset;
• Creating an effective Machine Learning (ML) tool for experts to gain fast intelligence from scene images to identify the make and model of footwear from footage;
• Ensuring the evidence's success in court by addressing 2 key challenges; combined reporting of footwear mark and footwear upper evidence and the potential influence of bias during comparisons.