B8 Establishing Likelihood Ratios for Patterned Garment Comparisons From Seam Measurement Data

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After attending this presentation, attendees will understand how common garment manufacturing processes can support variations in the appearance of patterned garments, and how these variations can be measured and exploited to calculate a conservative estimate of the probability of an accidental match between two random garments.

This presentation will impact the forensic science community by establishing a methodology to assign quantitative measures of evidence strength to patterned garment comparisons.

Surveillance images of a crime scene present a potential wealth of evidence that may be used to facilitate identification of objects relevant to an investigation; however, it is often a challenge to ascribe an objective metric of confidence for a particular identification. In the case of patterned garments, an apparent match between the item seized from a suspect and the one captured in the surveillance images of the crime scene can represent a compelling piece of evidence, if properly quantified. This work develops a rigorous statistical model for estimating such quantitative metric—the Likelihood Ratio (LR)—for this class of forensic comparisons.

A visual match between two patterned garments is established if the pattern offsets at the seams of all the visible individual pieces are sufficiently similar, i.e., all the differences can be explained by the limited precision of the measurements on the surveillance image data. Accordingly, the probability that the match is accidental (and hence its likelihood ratio) depends on the quality and resolution of the surveillance imagery, the number of visible garment seams/pieces, and the joint statistical distribution of pattern offsets of the observed garment pieces. The developed model provides a methodology to measure or estimate these parameters. Upper-bound validity is maintained throughout the model ensuring that the probability of accidental matches is not underestimated and LR not overestimated. The model builds on previous work by the authors which developed similar methods for camouflage garments based on direct measurement of the manufacturing process parameters. The new approach extends applicability to all patterned garments and greatly simplifies the model and its practical implementation by not requiring access to the manufacturing facilities. Instead, a limited set of the same garments is acquired and the statistical distributions and dependence of the pattern offsets for different garment pieces are evaluated empirically. Model simplifications and empirical parameter estimation result in larger uncertainties and, hence, somewhat lower bounds on LR values. This can be partially compensated by increasing the sample size: while not affecting the unbiased LR estimates, larger samples reduce the confidence intervals and thus generate tighter upper and lower bounds for probabilities and LR, respectively.

The model was demonstrated and validated through a large scale empirical study with simulated automatic garment comparisons and manual image comparisons. An empirical study of 12 garment sets, each with 25 to 50 samples, yielded LRs ranging from roughly 10-to-1 to over 400-to-1, i.e., from weak and inconclusive to strong evidence. In all test cases, accidental match probabilities were lower than the upper-bound model predictions, confirming that the developed framework produces conservative and defensible lower-bound LR estimates. A software tool was developed and is freely available to assist examiners in executing studies in this area.

Individualization, Patterned Garments, Statistics