D82 Are Camouflage Uniforms Unique? Estimating the Probability of Accidental Match for Camouflage Uniforms

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The educational objective of this presentation is to introduce and familiarize forensic scientists and investigators with new, quantitative methods and tools for evaluating matching of camouflage uniforms.

This presentation will impact the forensic science community by disseminating information about new forensic technology, thus investigators will know that it is available when confronted with certain types of uniform matching challenges.

It is well known that criminals and terrorists have worn camouflaged and military clothing during the commission of terrorist acts, robberies and other felonies. Fortunately, the increase in video surveillance means that these criminal acts are often caught on digital or analog media, which in turn becomes forensic evidence useful for analysis. In these videos the subject's face is not always visible for further identification, thus non-facial clues must be studied in an attempt to establish identity. The association of a garment worn during the criminal act, and appearing in the surveillance video, to the suspect is a key area of interest to forensic investigators.

In forensic investigations surrounding military environments, many of the garments encountered are part of a camouflage uniform. The problem faced by investigators in such environments, then, is how to identify suspects solely upon matches of a camouflage pattern (uniform) when other forensic evidence is unavailable or inconclusive. The answer lies in how one can measure the uniqueness of a uniform match – that is, given a qualitative observation of match by a forensic examiner, how many other uniforms will yield the same match?

While finding unique matches for most garments typically depends on visible differences (e.g., wear-marks or manufacturing imperfections), camouflage uniforms are an exception. This is because (1) the portion of the pattern observed at a fixed point on a given garment is unlikely to be the same as the same point on another garment made from the same pattern, and (2) there is an adherence to a consistent specification and a relatively standardized process for manufacturing. These factors enable the creation of a statistical model of all significant sources of variation in the manufacture of a camouflage uniform garment. Hence, while the association of a camouflage garment to a surveillance image may not preclude the *possibility* of an accidental association, the *probability* of an accidental association can be quantified objectively.

The probability of an accidental match is computed by statistically modeling the portion of camouflage pattern that is visible at any point on the uniform, and finding all distinct portions of the pattern that are qualitatively similar. Some parameters of the statistical model are measured directly, whereas others can only be estimated. In the interest of computing a probability that is sufficiently robust to be presented as evidence, a conservative upper-bound is applied for every parameter that cannot be reliably measured. Hence the true probability of an accidental match is guaranteed to be lower than the bound computed by the statistical model. The model is general and can be applied to any camouflage uniform and can be expanded to other types of patterned or camouflage garments. Furthermore, the model allows the forensic examiner to input relevant information about the context of the investigation. For example, if it is known that all the camouflage garments in the vicinity were sourced from a single manufacturer, then the probability of an accidental association is greater than if the garments were sourced from many different manufacturers.

In this presentation, an overview of a year long research study on the statistical individualization of camouflage patterns will be provided. The research shows that a qualitative match of a military camouflage uniform, specifically the Army Combat Uniform (ACU), can be quantitatively assessed via an estimate of probability of accidental match. The presentation will describe the research (including visits to uniform manufacturers) and outcomes, and specifically will focus on a software tool that has been created to assist forensic investigators (the Military Uniform Uniqueness Statistical Evaluator – MUUSE). The tool provides forensic investigators a way to easily and accurately perform this analysis and generate reports suitable for use in legal proceedings.

This work is a major, unique contribution to the area of garment matching for forensic purposes, and will strengthen uniform matching evidence in future cases.

Digital Evidence, Camouflage Pattern, Photographic Comparison

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