A194 Virtual Tool Mark Generation for Efficient Tool Mark Analysis

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After attending this presentation, attendees will be informed about ongoing research into a computer-aided method for tool markanalysis that uses virtual tool marks to predict the angle of a real tool mark. Attendees will learn about the basic procedure, scientific principles, and potential advantages of this new technique and see a preview of the current state of the software development. They will also have the opportunity to provide input on the direction and quality of the research and suggestions for future methods that could be developed.

This presentation will impact the forensic science community by demonstrating a statistical method that can not only strengthen the rigor of impression evidence analysis, but also increase its efficiency. In particular, the presentation will focus on an application of the statistical algorithm to estimate the tool-marking angle and twist of a real mark. This knowledge could prevent examiners from generating extra marks at unprofitable angles, saving time and reducing possible damage to evidence.

In 2009, a National Academy of Sciences Report called for investigation into the scientific basis behind tool mark comparisons.[1] Answering this call, the authors have attempted to prove or disprove the hypothesis that tool marks are unique to a single tool. Recently, it was demonstrated that a statistical algorithm could, in most cases, discern matching and non-matching tool marks made at different angles by sequentially numbered screwdriver tips.[2] Moreover, in the cases where the algorithm misinterpreted a pair of marks, an experienced forensics examiner could discern the correct outcome. While this research serves to confirm the basic assumptions behind tool markanalysis, it also suggests that statistical analysis software could help to reduce the examiners workload.

This led to a new analysis approach that relies on 3D scans of screwdriver tip surfaces at the micrometer scale from an optical microscope. These scans are carefully cleaned to remove noise from the data acquisition process, and then they are assigned a coordinate system that mathematically defines angles and twists in a natural way. The marking process is then simulated by using a 3D graphics software package to impart rotations to the tip and take the projection of the tips geometry in the direction of tool travel. The edge of this projection, retrieved from the 3D graphics software, becomes the virtual tool mark. Using this method, virtual marks are made at increments of 10 degrees and compared to a scan of the real tool mark. The previously developed statistical package performs the comparison, comparing the similarity of the geometry of both marks to the similarity that would occur due to random chance.[2] Finally, the method informs the forensics examiner of the angle(s) of the best matching virtual mark, allowing the examiner to focus his/her mark analysis on a smaller range of angles and twists.

The preliminary results seem promising. The virtual marking software is capable of importing and cleaning a 3D tool tip in about a minute and producing a virtual mark profile in a matter of seconds. The statistical mark-to-mark comparison can also be performed in seconds. These time estimates are from a standard desktop computer with a 3.20 GHz processor and an inexpensive graphics card. Therefore, the proposed method is capable of making comparisons at several angles in a reasonable amount of time.

References:

1. Petraco NDK, *et al.* Addressing the National Academy of Sciences' challenge: a method for statistical pattern comparison of striated tool marks. J Forensic Sci 2012;57(4):900–911.
2. Chumbley LS, *et al.* Validation of tool mark comparisons obtained using a quantitative, comparative, statistical algorithm. J Forensic Sci 2010;55(4):953–961.

Tool Marks, Impression Evidence, Software Development

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