A167 Tests Using the Congruent Matching Cell (CMC) Method for Optical Image Correlations of Cartridge Cases Fired From Consecutively Manufactured Pistol Slides

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After attending this presentation, the attendees will be introduced to the method for the objective quantitation of impressed tool mark comparisons using Congruent Matching Cells (CMC). The results of the comparisons of fired cartridge case breechface tool mark images from consecutively manufactured pistol slides will be reported.

This presentation will impact the forensic science community by the introduction of an accurate and objective mathematical method for the measurement of the similarity of impressed tool marks, in this case fired cartridge case breechface tool marks. This method can be used with comparison microscope photographs.

Outline of Objectives: The National Institute of Standards and Technology (NIST) Ballistics Identification System (NBIS) is developed based on 3D topography measurements and correlation cells. The NBIS aims to provide objective, high-accuracy, and high-speed ballistics identifications. The National Ballistics Evidence Search Engine (NBESE) is proposed by NIST for ballistics evidence searches using the Congruent Matching Cells (CMC) method with system interoperability and error rate report. Feasibility of applying correlation cells for 3D topography correlation is successfully demonstrated by validation tests using 40 cartridge cases fired with 10 consecutively manufactured slides. The results show a significant separation between the Known-Matching (KM) and Known-Non-Matching (KNM) distribution. However, most existing ballistic identification systems are based on intensity image comparisons and a huge number of intensity images are stored in the national ballistic database. It is necessary to conduct a validation test that demonstrates the feasibility of the CMC method for the identifications of optical intensity images. One primary benefit of an independent, objective, mathematical measurement method is that it can use images captured during the microscopic comparison of firearm or tool mark evidence.

Brief Methodology: A Leica® comparison microscope is used to capture the breech face intensity images of the same set of 40 cartridge cases fired from handguns with ten consecutively manufactured pistol slides. To confirm the equipment accuracy, repeatability and reproducibility tests are performed. In the correlation tests using the CMC method, a total of 780 correlations including 63 KM and 717 KNM were implemented. The effects of different lighting conditions for the image correlations were also tested and analyzed.

Summary of Results: In the initial tests using the single correlation parameter of the whole image, the cross-correlation function maximum CCFmax, the KM and KNM distributions cannot be separated. However, by using the CMC method with three identification parameters (the correlation function maximum CCFmax, the registration angle θ, and registration position in x, y), the KM and KNM distributions show clear separations with no overlap. There is no false positive or false negative identification in all 780 correlations.

General Conclusions: The results show that the CMC method works well for correlation of both the 3D topographies and optical intensity images. Significant improvement can be achieved by applying the CMC method with three identification parameters on intensity image data compared with the correlation of whole image using a single correlation parameter CCFmax. The CMC method also shows a good robustness to lighting condition variance. The identification accuracy can be further improved by optimization of the cell numbers and the thresholds of the correlation parameters.

CMC, Identification, Impressed Tool Mark

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