B167 Analyzing a Firearms Proficiency Test Using the Congruent Matching Cells (CMC) Method of Computer-Aided Topography Comparisons

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After attending this presentation, attendees will understand how computer algorithms can be used as a powerful tool for firearms examiners to quickly identify potentially matching regions on a surface.

This presentation will impact the forensic science community by addressing concerns about the scientific method in forensic science through the use of quantitative surface comparison algorithms and drawing connections to comparisons made by human examiners.

The underlying technology in this presentation is a computer algorithm developed at the National Institute of Standards and Technology (NIST) to compare impressed tool marks on ballistics evidence in an impartial, automatic, and quantifiable way. The algorithm is called the CMC method, which is based on the discretization of a surface into cells that are compared individually with another surface. The registration location of each cell is found which corresponds to the location of highest physically similarity on the other surface. Cells registered in the same relative orientation on the second surface are considered congruent and the number of congruent matching cells constitutes a similarity score. The CMC method has been effectively used to analyze select sets of data containing known matching and known non-matching tool mark pairs.[1] One of the key advantages of this method is that it is effective in isolating valid areas that contain unique surface topography from invalid areas without unique surface topography. In a way, this is similar to the human examiner's ability to disregard an area on a surface that is damaged, has pre-fired surface features, or does not contain useful features for correlation. Therefore, a direct comparison of the regions used to justify identifications can be made. This feature also allows the CMC method to be used as a tool to help a trained examiner quickly identify potentially matching regions for further scrutiny.

In this experiment, the CMC method was applied to a firearms comparison proficiency test administered by Collaborative Testing Services (CTS). The results of this proficiency test, along with comments by test takers, are provided by CTS. Therefore, the computer comparison algorithm can be directly compared with known data and known results from human examiners. The CTS test set was also analyzed under a comparison microscope. The features that were identified using the comparison microscope will be presented along with the areas that were identified as contributing to a match using the CMC method. These results will be supplemented with results and comments published by CTS regarding this test. A summary of the various evaluations shows that certain features are more easily identified using computer algorithms, but a holistic approach which utilizes the examiner's knowledge of firearm mechanics and class, sub-class, and individual characteristics is necessary to make informed ballistic evidence comparisons.

By identifying features that examiners and computers are able to effectively detect, a better understanding of the strengths of each type of examination technique can be reached. By combining the respective strengths of human examiners and computer algorithms, it is possible to achieve more robust and efficient surface comparisons. The primary goal is to speed up work flow by providing a tool to identify key features that could potentially match and strengthen an examiner's ability to justify and quantify their conclusions. This presentation demonstrates how the CMC method is able to achieve these goals in order to address recent concerns about the scientific method in forensic science.

Reference(s):

1. Chu W., Tong M., Song J. "Validation Tests for the Congruent Matching Cells (CMC) Method Using Cartridge Cases Fired with Consecutively Manufactured Pistol Slides," *AFTE Journal*, 45(4), 361–366, 2013.

Ballistics Comparisons, Proficiency Tests, CMC Method

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