Implementing 3D Virtual Comparison Microscopy into Forensic Firearm/Toolmark Comparison

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- 3 - Administrative Support

- Forensic Examinations
  - Firearms, Toolmarks, Distance Determination, Ammunition Components, Serial Number Restoration
- Crime Scene Response
  - Shooting Trajectory Analysis
Can technology be used to enhance the forensic pattern based discipline of firearms/toolmark identification by providing objective information to establish a statistical significance and the associated uncertainty with a conclusion?

The Federal Bureau of Investigation does not support or endorse any of the products that will be discussed during the course of this presentation.
Cartridge Case

- Breechface
- Firing Pin Impression
- Aperture

Firearm

- Breechface
- Firing Pin
- Aperture
FBI/FTU Research Group Virtual Topography

- Sensofar®-Confocal, Interferometry, and Focus Variation 2013
- Alicona®- Infinite Focus- Focus Variation 2014
- EvoFinder® - 2015
- GIGAMacro® - 2016
FBI/FTU Research Group Virtual Topography Comparison/Evaluation

- Cadre Forensics® – TopMatch GS 3D - 2012, Photometric Stereo
FBI/FTU Research Group Virtual Topography Comparison/Evaluation Phase I

• Phase 1 : Assessing recorded images with 3D detail to evaluate whether this methodology is more specific than traditional comparison

• Proficiency Tests – Proficiency Tests from 2003-2015
  • Virtual Comparison (VC) evaluation - Completed 2016
  • 927 Virtual Comparisons - no False ID (FID)

• Consecutive Manufactured Barrels/Slides
  • VC evaluation - Completed 2016
  • 1602 virtual comparisons – no False ID (FID)

• Validation of VC microscopy involving casework – Completed 2017
Original Comparison 2016-01426-6

- Item 1: 9mm Luger (9x19) CZ Pistol, Model 75B
- Item 2: Cartridge Case
- The Item 2 cartridge case was identified as having been fired in the Item 1 pistol.
- Blind verification – second examiner
VC Test Design:
• Decision already rendered CM
• Evidence relabeled
• Ground truths added
• Proctor
• Algorithm blocked from examiner
Ground Truth 2016-01426-6

5 Correct Eliminations Selected
Ground Truth – Identification 2016-01426-6
Virtual Comparison Result 2016-01426-6
• Participants recorded 24 correct identifications with 1 inconclusive for “true” identification results.

• Test Sensitivity\(^1\): the number of correct identifications divided by the number of exam results for “true” identifications. \([24/(25\times5)] = 0.192, [25/(25\times5)] = 0.2\), \(0.192/0.2 = 96\%\).

• Test Specificity\(^1\): the number of correct exclusions divided by the number of exam results for “true” exclusions (20 true exclusions, 11 Exclusions, 9 Inconclusive) = 55\%, similar class characteristics – FTU SOP\(^2\) “an elimination occurs when there is a discernible or measurable difference in class characteristics.”
Virtual Microscopy Results

• 3445 Total Virtual Comparisons with No False Positives, 916 VC evidence from casework
• Inconclusive decision changed using VC
• Standard Operating Procedure
• Live May, 2017

• Phase II Collaboration with NIST (2014) to determine an objective degree of similarity between two toolmarks as well as attaching an error rate to the analysis.
Coming Soon

Decision Analysis Study for Firearms

- FBI Laboratory and Ames Laboratory

Decision Analysis Study (DAS) is designed to provide the forensic community quantifiable metrics on accuracy, repeatability, and reproducibility.
Firearms/Toolmarks Unit

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