B119 Evaluating the Gray Scale Response Difference Associated With Bullet Comparisons Using Optical Microscopy

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After attending this presentation, attendees will gain a greater appreciation for how tedious and delicate the task of bullet comparisons is and understand that the inherent error associated with these types of comparisons can be overcome with the proper approach.

This presentation will impact the forensic science community, specifically the firearms examiner faction, by providing results from a controlled experiment with a known bullet profile. The reproducibility of this research will provide an opportunity for a starting point for future methodology that produces bullet comparisons with greater reliability.

Firearms examiners have long been interested in a method that would image the striae of a bullet so that it could be entered into a database for subsequent comparison to other bullets. As the development, use, and application of these databases grew, so did the problems associated with them. The algorithms were breaking down and the software was not functioning at the level of precision expected by firearms examiners, thus analysts stopped using the databases and returned to the traditional laborious methods of bullet analysis using the comparison microscope; however, the use of the comparison microscope is not without its own set of limitations. When using a comparison microscope, two separate stages with two separate light sources are necessary because the determination of the distribution of striae on a bullet is sensitive to bullet position and orientation. It is suggested that many of the problems associated with bullet-based database systems are directly related to methods in which images are captured, along with the number and type of images.

The goal of this research was to ultimately determine if bullet comparisons using optical microscopic imaging were possible, rather than live bullet-to-bullet comparisons. Once that was determined, which microscope would produce the best results for bullet comparison utilizing captured images and the minimum number of images that should be taken of a single land impression to account for all potential variations in bullet profiles was identified. To identify profile measurement error inherent in orientation and rotational and translational miss-orientation, the profile of a National Institute of Standards and Technology (NIST) Standard Reference Material (SRM) 2460 standard bullet was measured while misoriented in systematic ways using a light microscope. These measurements were then repeated with a Zeta 3D-20 optical microscope and a Leica® FSC comparison microscope to determine which microscope produced the greatest correspondence for misoriented NIST bullet profiles. The method applied utilized captured images that were converted into light contrast profiles, which were a representation of the bullet surface based on light intensities. From these profiles, identified peaks and valleys were grouped into resolution bins or segments of a particular length which were used to subdivide the land impression of the bullet and discriminate peaks and valleys. The results showed that the light microscope produced the highest level of correspondence with 100% total peak correspondence for both laterally and rotationally shifted profiles, 330µm and 6° respectively, with a 20µm bin resolution.

Based on this study it was concluded that bullet comparison through the use of images captured by optical microscopy is possible. It is thus suggested that something similar to the Zeiss Universal light microscope with reflected through-the-lens illumination be used for this methodology for bullet analysis and comparison using a bin resolution no less than 15 microns. With this microscope, the minimum number of images required to account for potential misorientation, or bullet profile variations, are 11 images per land impression.

NIST Bullet Comparisons, Bullet Comparisons, Bullet Images