B30 Statistical Analysis of Firearms: A Comparison Between the 2D and 3D Integrated Ballistic Identification System (IBIS®)

Keith B. Morris, PhD, 208 Oglebay Hall, 1600 University Avenue, PO Box 6121, Morgantown, WV 26506-6121; Roger Jefferys, BS*, 27 Dafonzo Hill Road, Pursglove, WV 26546; and Eric F. Law, BS*, 35 Metro Towers Lane, Apt 205, Morgantown, WV 26505*

After attending this presentation, attendees will understand how Bayesian networks can be used to estimate likelihood ratios based upon information available during a specific firearms-related investigation, how to interpret that data in order to obtain the best results for use in a court of law, and how to provide validity for the state and the accused.

This presentation will impact the forensic science community by providing a greater understanding of the means to interpret firearms evidence by using Bayesian networks which were developed from data retrieved from 2D and 3D IBIS®.

IBIS®, developed by Forensic Technology International (FTI), serves as the backbone of the National Integrated Ballistic Information Network (NIBIN) system.[1] This system allows for the databasing of images of cartridge cases and bullets.

The goal of this study was to perform a 3D IBIS® analysis and compare the results to that of a 2D IBIS® analysis. The intra- and inter-variation of the results were also analyzed. A West Virginia University (WVU) Legacy IBIS® and the new 3D FTI IBIS® were used during this study. The cartridge cases from a sample set of 12 9mm firearms were used to study 3D correlations with the cooperation of FTI. These 12 firearms were selected based on preliminary data which displayed their performances of Breechface (BF) and Firing Pin (FP) IBIS® scores via their Receiver Operating Characteristic (ROC) curves and the accompanying Area Under the Curve (AUC) values. ROC curves can be used to determine the crossovers between match and non-match. The ROC curve demonstrates the discriminating power of the method. In other words, it determines how well the method can differentiate between different states of the samples to which the method has been applied. This discriminating ability is directly related to the area under the ROC curve.

A Bayesian network was created to help compare IBIS® scores from the 2D and 3D IBIS® correlations using Netica®, a program for working with belief networks and influence diagrams.[2] Scatter plots, density distributions, and ROC curves were generated for the 2D and 3D data using RStudio®, a user interface for R[3], a computer programming language and environment for statistical computing and graphics.[4]

The worst discriminating power category from FTI with respect to all the firearms analyzed is 2D BF whereas the best discriminating power category is 3D FP. The worst discriminating power category from WVU with respect to all firearms analyzed is coincidentally the BF scores while the best is the FP. Comparing all of the data from both instruments, they behaved similarly, resulting in the worst performance resonating from a Ruger® LC9 in the category of 2D BF scores. Also noteworthy is the benefit of the addition of the side light feature for analyzing the BF. Overall, with regard to an added dimension (i.e., 2D vs. 3D), there was no significance in the results to conclude that one is better than the other.

Reference(s):

1. http://www.forensictechnology.com, accessed 07/28/2015
2. https://www.norsys.com/netica.html, accessed 07/28/2015
3. R Development Core Team. R: A Language and Environment for Statistical Computing. *R Foundation for Statistical Computing*, Vienna, Austria, 2014. ISBN 3-900051-07-0.
4. RStudio, Inc. About RStudio. Retrieved from http://www.rstudio.com/about, 2015.

Firearms, IBIS®, Bayesian

*Presenting Author