B163 Automated Fingerprint Identification System Calibration Study

Rebecca L. Fitzsimmons, BS, Keith B. Morris, PhD, Jennifer E. Pierce, Ayako Hagiwara, and Jessica M. Boyle, West Virginia University, 3040 University Avenue Suite 3102, PO Box 6217, Morgantown, WV 26506-6217*

After attending this presentation, attendees will understand the principles of ensuring that an AFIS system is operating within statistical control. The methods, procedures and calculations for setting up the standards will be explained during the presentation. The concepts of process stability and calibration will also be linked to the operation of an AFIS system.

This presentation will impact the forensic community and/or humanity by presenting the requirements of ASCLD/LAB and ISO 17025 Laboratory Accreditation systems, which require that all instrumentation operating within a forensic laboratory should be calibrated prior to use. The utilization of AFIS systems within forensic laboratories does not receive the attention, which it deserves. The purpose of this paper is to demonstrate practical methods of achieving this requirement.

The Automated Fingerprint Identification System (AFIS) score of a fingerprint may be affected by its acquisition method. This can have a direct influence on the calibration and validation of the system. To better gauge the degree of effect, a series of fingerprints were processed using a Sagem-Morpho Metamorpho system controlling for the following criteria: the type of print (flat impression, lighter flat impression, tip and partial fingerprint), fingerprint classification, number of minutiae, image size, image position, and image rotation. The two main factors tested that related to acquisition were the process stability of the AFIS and rotation of the print. Process stability is a process that exhibits only common variation or variation resulting from inherent system limitations.

The process stability of the AFIS was tested by processing 100 replicates of each of the basic fingerprint classes (plain whorl, ulnar loop, radial loop, plain arch, and tented arch) through the system. The process stability was evaluated using statistical process control charts. Control charts provide tools to analyze the past, present and future states of a process. Analysis of trends, maintenance of present status, and prediction of instabilities and bottlenecks can greatly improve the quality of a process. Thus armed with a comprehensive understanding of a process, appropriate preventative measures can minimize variation and maximize stability.

In the rotation study, the flat impression from each fingerprint was rotated from -180° to +180° in 5º increments using Adobe Photoshop CS2.The resolution of these images was maintained at 500 pixels per inch, which is the acceptable resolution for AFIS. The resulting scores for each 5º rotation approximated a normal distribution. This indicates that there is an optimal orientation range for the acquisition of prints to ensure the best correlation score.

In the minutiae study, the number of minutiae from flat impressions was changed to determine the effect on the AFIS scores. For each fingerprint, the minutiae were automatically chosen by the AFIS. In each experiment, the minutiae were automatically encoded on the test print. A certain number of minutiae were then removed in a random manner and this process was replicated 25 times. At a certain point, the score generated by the target print becomes indistinguishable from the background score; the background is defined as the scores generated by non-matching fingerprints. This point then defines the minimum number of minutiae needed to make a potential AFIS correlation.

Selecting 33 minutiae from a potential 65 minutiae of a fingerprint will result in a vast number of combinations of minutiae. The number of combinations is defined as $\binom{n}{r}C$ where n is the population and r is the sample and thus $\binom{65}{33}C$ equals 3.6097 x10^{18} combinations. The data were analyzed statistically to determine at what point the removal of the minutiae made a significant difference to the AFIS match score.

All data obtained in the studies performed yielded key information to allow AFIS users to be more aware of variation that may occur and how to maintain optimal stability in all facets of an AFIS system.

AFIS, Process Stability, Calibration

 ** Presenting Author*