

Criminalistics 2

Congruent Matching--Theory and Application in Forensic Evidence Identification and Error Rate Estimation

John Song, National Institute of Standards and Technology (NIST), United States

Abstract: Reporting an error rate for forensic evidence identification is a fundamental challenge in forensic science. It is a national priority to establish a scientific procedure for quantitative error rate reports to support forensic evidence identifications in court proceedings. The Congruent Matching Cells (CMC) method was recently invented at NIST for accurate image-related forensic evidence identification and error rate estimation. The measured forensic images and topographies are divided into correlation cells. Four identification parameters are derived for identifying correlated cell pairs originating from the same source. This enables the estimation of error rates based on statistical analysis of the total number of correlation cells, the number of qualified CMC cell pairs, and the statistical distribution of the four identification parameters.

Initial validation tests on 780 topography image pairs of 40 cartridge cases ejected from guns with 10 consecutively manufactured pistol slides did not produce any false identifications or false exclusions. Validation tests have also been made using optical intensity images, using a different set of samples and three different correlation programs, all yielded clear-cut separation between known matching (KM) and known non-matching (KNM) image pairs. Validation tests using 946 image pairs of 44 fingerprints selected from the NIST's fingerprint database also showed correct identification and exclusion results. A statistical procedure using the validation testing results has been developed for estimating error rates. The false positive and false negative error rates for the validation tests are estimated; the Likelihood Ratio (LR) is above the "extremely strong" level as specified in the "2010 ENFSI Guideline in Evaluative Reporting in Forensic Science". The CMC method provides a statistical foundation to enable the estimation and reporting of error rates for court proceedings regarding ballistics identifications, thus emulating methods used in forensic identification of DNA evidence.