B25 Electric Network Frequency (ENF) Database Validation for Digital Media Authenticity

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After attending this presentation, attendees will better understand Electric Network Frequency (ENF) analysis for forensic media authentication and criteria necessary for creating, maintaining, and validating a database of ENF fluctuations.

This presentation will impact the forensic science community by discussing inter- and intra-variability tests conducted at the National Center for Media Forensics (NCMF) to analyze random fluctuations of ENF and the hypothesis that ENF databases would not contain repetitive sets of data.

In order to determine the time/date of a recording made where ENF is present, a time-synchronous database of ENF variations must be available and have been recorded during the time in question. At the NCMF, the ENF database configuration records non-stop ENF variations of the U.S. Western grid with an 8kHz sampling frequency and 16bit, mono, uncompressed files. Recording of ENF is redundantly made on two completely isolated computers. The NCMF is in partnership with the Target Forensic Services Lab (TFSL) in order to create a network of ENF databases currently covering the western and eastern U.S. power grids. Sites include: NCMF Denver, CO, TFSL Las Vegas, NV, and TFSL Minneapolis, MN. This network is under constant evaluation and testing and will soon be expanded to cover the Texas grid. Bi-annual validation of ENF information between the NCMF/TFSL ENF databases is scheduled which will help ensure database integrity and meet forensic best practices. Several databases have been reported in continental Europe and the UK.

After having analyzed ENF variations in Western U.S. grid over a period of one year, and continental Europe for more than nine years, it has become clear that there is no precisely repetitive pattern. The fluctuations over time around 50Hz or 60Hz are purely random. Exceptions can be considered where some events occur during the morning and in the evening that are generated especially by maintenance operations or network components switching on or off. Even so, their shapes and values cannot be predicted. In order to maximize confidence in results yielded from ENF examinations, the method proposed by the authors relies on redundancy data at each stage of the examination: two ENF databases, minimum of two techniques for ENF extraction (Fast Fourier Transform, Zero Crossings, and/or Spectrogram), and two methods of automated ENF comparison (correlation coefficient mean quadratic difference).

This presentation will discuss inter and intra -variability tests conducted at the NCMF to analyze the random fluctuations of ENF and the hypothesis that an ENF database would not contain repetitive sets of data. Analysis was conducted using the Denver and Las Vegas databases, and both correlation coefficient and mean quadratic error methods. This consisted of comparing sets of one- to ten -minute segments against all other segments within that same period and evaluating the maximum correlation coefficient (CC) and minimum mean quadratic difference (MQD) for the corresponding and different time frames. Results indicate two things: (1) that each ten-minute segment is much more correlated to itself than any other ten-minute segment within the recorded 18-month databases; and, (2) that MQD provides better discrimination power than CC.

Labs coordinating the acquisition and archival of ENF data must be aware of potential dangers and take precautionary measures to ensure data maintains integrity and accuracy. This must extend to the procedures employed in forensic examinations. This presentation will provide a proposed format for validating database material as well as a list of known potential errors and suggested corrective actions. These are mandatory in order to meet the strict demands for accuracy and consistency of forensic materials to be used in labs, along with the development of and adherence to best practices and guidelines.

ENF, Audio Forensics, Database Validation

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