B15 An Alternative Method for ENF Data Analysis

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After attending this presentation, attendees will understand current ENF (Electric Network Frequency) analysis techniques for use in the area of digital and multimedia evidence (DME). ENF analysis attempts to detect, analyze, and evaluate embedded power line information that occasionally is recorded on analog and digital recordings. An alternative method to record ENF data will be presented and assessed for accuracy and suitability.

This presentation will impact the forensic science community, especially the sub-disciplines of forensic audio, video, and image analysis, by showing an alternative method available for ENF analysis. Cautions concerning the resolution and accuracy of ENF analysis will provide the DME practitioner with important *Daubert* and *Frye* testimony information.

Hypothesis: An alternative method to evaluate ENF (Electric Network Frequency) data can be accomplished using single-purpose power logger instruments.

Synopsis: Single-purpose power logger instruments were used to compile archive ENF data in the Eastern Interconnect grid of the United States. Comparison of simultaneous power logger and audio recordings showed that pattern matches depend on the resolution selected of the data.

Forensic audio examiners are evaluating the suitability of using ENF information that is occasionally embedded on analog and digital recordings. The goal of the analysis is to match the ENF pattern of embedded power line information found on evidence recordings to the ENF patterns archived from electric power grids. Potential shortcomings in data resolution, database collection and custody, and the searchability of ENF databases have not yet been resolved. This paper presents an alternative method to collect, store and evaluate ENF data in the eastern grid of the United States.

In the past, power line information (50/60 Hz hum and harmonics) on evidence recordings has been used in audio signal analysis and authenticity examinations. This information can assist audio examiners to correct the speed of recordings and to indicate areas of possible recording alterations when an interruption in the power line hum is detected. The analysis of ENF information using pattern matching is a recent focus in forensic audio research. ENF analysis attempts to match the power line hum pattern on evidence recordings to a hum pattern archived in databases of previously recorded electric grid information. This paper describes the results of test recordings to collect ENF data in Virginia (the eastern interconnect grid of the United States) using stand- alone, single-purpose instruments, AEMC Power Quality Loggers, Model PQL 120. This type of instrument measures and stores the electric power information directly with a frequency resolution of 0.01 Hertz. Power Loggers are plugged directly into wall sockets and sample electric grid parameters, including voltage, current, frequency, and power.

This paper describes the characteristics of Power Loggers and their suitability for analyzing ENF grid information. Test data indicates that there is a distinct trade-off between data accuracy and pattern matching. At the highest resolution of test data gathered, the data from multiple loggers in the same building indicates differences in simultaneous recordings. This result is contrary to previous ENF test results which claim that simultaneous ENF recordings on the same electric grid always match. Data was recorded simultaneously on three power loggers during an audio recording on which ENF power line hum was intentionally recorded. The first comparison analysis evaluated the power logger data resolution needed to uniquely identify a known recorded interval with the same pattern in the power logger database. The test results indicate that multiple pattern matches can occur as the data quality is reduced.

Tests were then conducted with simultaneous power logger recordings and known audio recordings that have 60 Hz induced interference coupled into the audio recording. Comparison analysis was made of the power logger data with the known audio recording. Additional tests were conducted which compared the Logger data with intentionally altered known audio recordings. The results indicate that a trade-off must be made between desired resolution and successful matches of ENF patterns. This evaluation to detect known interruptions in audio recordings is an ultimate goal of ENF analysis. Test results indicate that power line interruptions can be made without detection. In addition, the power logger data will be used to calculate this method's 'error rate' for *Daubert* hearing purposes.

These results indicate data incompatibility can exist between power line hum information derived from audio evidence and that archived using data collection methods not designed for the analysis of power line hum information. Another result of this analysis is highlighting the importance of conditioning the data. Successful ENF analysis to date has used traditional data conditioning techniques (resampling and filtering) in order to have compatible data patterns for analysis. This data conditioning can have unknown effects for ENF data analysis.

Audio, ENF, Data Analysis

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