C33 Electromagnetic "Soundscapes" and Their Relevance in Media Forensics

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After attending this presentation, attendees will understand: (1) Electromagnetic Fields (EMF) and their origins; (2) quantification of the electromagnetic soundscapes in urban areas and in buildings; (3) the recording equipment and its susceptibility to EMF measurements; and, (4) what traces are left in audio recordings.

This presentation will impact the forensic science community by demonstrating how EMFs stemming from the Electric Network Frequency (ENF) have value for the authentication and "time stamping" of digital recordings carrying audio; however, EMFs stemming from other sources may have a value for the determination of the site of recording.

EMFs stemming from the ENF has, when accidentally recorded, proven to have a value for the authentication and "time stamping" of digital recordings carrying audio; however, magnetic fields stemming from sources other than power lines may, when present and recorded, also become useful for the forensic investigation of digital (and analog) recordings.[1] The electromagnetic signature recorded as audio may provide information of the site of recording.

This paper presents the results of an initial study in the field.

In urban planning as well as in sound art, the term "soundscape" has been applied to site-specific recordings since being introduced by Michael Southworth in 1969.[2] The analysis of the soundscape reflects incidents of the environment (i.e., noise in or around urban spaces (near or distant), buildings, traffic, natural sources, installations, peoples' activity, music, etc.). This type of analysis is also valuable for the assessment of background sounds on forensic recordings.

For years, artists have also searched for the sound of underwater locations using hydrophones, the sound of vibrating structures using accelerometers, and the sound of electromagnetic fields using various forms of coils connected to the input of audio recorders. Work of this type has now and then revealed various interesting electromagnetic signatures, which to some extent are regarded as site specific.

That said, no recording device should ever transform the EMFs into audio. The general standards (IEC 61000, CISPR 1x, etc.) for Electromagnetic Compatibility (EMC) provide a set of rules that ensures that no generator of such electromagnetic disturbances exhibits a magnitude large enough to be detected in audio recorders; however, casework has shown that site-specific electromagnetic events accidentally have been recorded/transmitted by (mobile) recording systems, such as voice recorders and cell phones. These incidents are the motivation for an initial study to indicate whether or not this a serious matter in media forensics. The magnitude of ENF-related electromagnetic fields in different (urban) environments has been previously documented.[3] This presentation discusses some of the other electromagnetic sources and some possible ways they end up as audio.

Examples of sources (Audio Frequency (AF) -range) occasionally appearing in forensic audio recordings are: (1) ignition noise (cars, bikes); (2) noise on power lines (machinery-induced noise, for instance, spot-welding devices); (3) noise in public transportation (electric trains, subways, light rail); (4) induction loops for assisted listening (spill); (5) elevators (relays and motors); Nad, (6) other sources.

Examples of recording devices are: (1) cell phones with and without a headset attached; (2) voice recorders (analog and digital) with and without an external microphone: and, (3) laptops with gamer gear.

The test was conducted by feeding a sine sweep into a power amplifier loaded by a 3.3-ohm resistor in series with a .47mH coil. The Device Under Test (DUT) was placed 10cm above the coil. The system was calibrated using a reference coil system (400mA/m ~ 0.775V). Devices were tested in EM-fields up to 1A/m, operating the unit alone with no attachments and also using the unit with external earbuds and microphone.

The general result demonstrates that modern mobile recording devices tested exhibit high susceptibility to Audio Frequency (AF) broadband electromagnetic signals; however, of course, old tape-based systems are indeed sensitive. The conclusion from this survey is that electromagnetic fields above 100Hz and with a field strength below 100mA/m are hardly detectable in modern digital devices.

In normal urban surroundings, a field strength above 100Hz and higher than 100 mA/m is rare. When audible in digital recordings, it typically concerns recording/phone units mounted with external microphones or units connected to poorly filtered power lines.

The impact on crime scene analyses is relatively small as it seldom occurs; however, one must be aware of the existence of the phenomenon.

Reference(s):

1. SWGDE. Best Practices for Digital Audio Authentication. Version 1.2, 2017.
2. Southworth, Michael Frank. *The Sonic Environment of Cities.* MIT. 1967.
3. Brixen, Eddy B. ENF; Quantification of the Magnetic Field. *Proceedings of the Audio Engineering Society's 32nd International Conference.* Denver, CO, USA. 2008.

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