

## **ANOMALIES ASSOCIATED WITH COMPUTER EDITING OF RECORDED TELEPHONE CONVERSATIONS**

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During a two to three year period, a Midwestern entrepreneur had been interested in filing a patent on an innovative new product. As a home-based business man, much of his product development and marketing strategies were accomplished through contact with several dozen product development attorneys and other business advisors over his home and office telephones. When requested to provide the original telephone tape recordings, he claimed they had been inadvertently misplaced but that he had made copies of the relevant conversations which he later surrendered for forensic analysis. Although unsuccessful in ever examining the original tapes, I did have two copies of each of the original tapes. The original recorders were described as Radio Shack type portable machines together with a telephone interface device and two consumer brand high speed dubbing cassette recorders which purportedly were used in the selective dubbing of individual telephone conversations from the original tapes.

During review of ten composite copy tape conversations, it became apparent through both aural and spectrographic/waveform analysis, that there existed a number of suspicious record events (i.e. "anomalies") which deserved further instrumental attention. A KAY Digital Spectrograph Model 5500 was used for the bulk of the analysis. As the original tapes were not available, magnetic development was not deemed appropriate and therefore traditional digital waveform/spectrographic techniques were utilized in the examination process.

Before displaying examples of the computer-related edited phenomena, it may prove beneficial to review the traditional analog anomalies often associated with falsification of recordings. These include:

1. Deletion: the elimination of words or sounds by stopping the tape and over-recording unwanted areas.
  2. Obscuration: the mixing in of sounds of amplitude sufficient to mask waveform patterns which originally would show stop/starts in inappropriate places.
  3. Transformation: the rearranging of words to change content or context.
  4. Synthesis: the adding of words or sounds by artificial means or impersonation.
- Anomalies often times include the following phenomena:

1. Gaps: segments in a recording which represent unexplained changes in content or context.

2. Transients: short, abrupt sounds exemplified by clicks, pops, etc.
3. Fades: gradual loss of volume.
4. Equipment Sounds: context inconsistencies caused by the recording equipment (such as hum, static, and varying pitches).
5. Extraneous voices: background voices which at times appear to be as near as the primary voice or can even mask the primary voice. (1)

Modern day technology and the development of the DSP chip have greatly complicated the issue of tape tampering detection and further increases the likelihood

that altered tapes can escape detection. The Federal Bureau of Investigation Signal Analysis Branch has already acknowledged, "it is difficult to detect some alterations when a recording is digitized onto a computer system, physically or electronically edited and recopied onto another tape. (2) Recently there have been at least 20 different manufacturers of desktop computer editing workstations or digital recorders which can be used as "turn key" editing systems. Software related computer cards can transform a personal computer into a sophisticated digital audio editing machine. Some of the systems do require that the initial conversion of the analog format be accomplished by a digital audio recorder before accessing the computer hardware.(3)

Digitization of speech can sometimes leave discernable artifacts, especially "aliasing" effects. This phenomena of digitizing the speech signal involves two distinctive processes known as Sampling and Quantizing, which are the true core of the digital recording process. Speech digitization requires filtering by an appropriate low pass filter which should remove any high frequencies that are beyond the sampling rate of the equipment. The sampling process refers to the transforming of the low-filtered electronic waveform into many thousands of small units of time. Each of these time units are later quantized with respect to its respective amplitude.

The Nyquist Theorem, however, requires that the sampling frequency be twice as high as the highest frequency converted into digital format. If this theorem is not followed, an undesirable effect known as Aliasing occurs.(4) High frequency changes in amplitude are not properly encoded, leaving some information lost and occasionally new erroneous signals are generated. "If the throughput frequency is greater than one-half the sampling frequency, aliasing inevitably occurs."(5) For example if S is the sampling rate and F is a higher frequency than one-half the sampling rate and N is an integer, a new sample frequency, Fa is also created at  $F_a = \pm NS \pm F$ . Therefore, if S equals 44 KHZ and we sampled at 36 KHZ, another sample frequency would occur at 8 KHZ. If we sample at 40 KHZ, a 4 KHZ aliasing signal would occur. (6)

Other aliasing effects involve Image Aliasing which occurs in multiple images produced by the sampling process. If a 44 KHZ sampler is utilized and a 36 KHZ input signal is analyzed, some of the resulted output frequencies would 8 KHZ, 52 KHZ, 80 KI-IZ, etc. In addition, Harmonic Aliasing can exaggerate the problem. Complex tones, for example, could result in aliasing frequencies generated separately for each harmonic. The practical result of this would be additional harmonics would be added to the digitized signal which normally would be multiples of the harmonic of the fundamental frequency.(7)

As DSP technology and their respective chips become more sophisticated and available to the consumer, the ability to edit, alter or fabricate audio recordings will be enhanced. Computer-based digital editing now permits the generation of lengthy, fabricated audio segments, sometimes devoid of the traditional transients in other editing artifacts associated with analog tape tampering.

The results of an aural/waveform/spectrographic analysis on the evidence tape copies disclosed a number of computer related editing anomalies associated with significant portions of the recorded telephone conversations, namely:

1. Uncharacteristic tones in the recordings sometimes occurring at even numbered multiples of each other (i.e. 4, 8, 16, 20 KHZ).
2. Omission or deletion of material.
3. Abrupt beginning and ending of ongoing speech.
4. Aliasing effects.

The more subtle effects of the digital editing process involving "aliasing" artifacts can sometimes be heard but are more readily apparent in the spectrographic/waveform analysis of the altered speech signals.

Examples of the digital editing process associated with this case are displayed in the accompanying sets of overhead transparencies. A short term aural composite tape was produced and should further corroborate the nature and extent of the digital editing anomalies associated with the computer edits found in this examination process.

(COMMENT: Overhead transparencies of computer-related editing phenomena)

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