C9 Time Domain Analysis of Lossy Compression Decoding Artifacts

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The goal of this presentation is to disseminate important findings related to the behavior of various MP3 decoding libraries and software as they relate to time domain forensic audio analyses and analytical results.

This presentation will impact the forensic science community by providing the results of a study that impacts laboratory performance and best practices in the handling and processing of forensic audio, especially MP3 files.

This presentation reports a preliminary study on the artifacts left by different audio decoders. Lossy compressed files are common in real forensic cases, can be produced with different digital audio hardware and software systems, and their forensic analysis and/or authentication can end up being crucial in the courtroom or other extrajudicial investigations. This study reports on the time domain artifacts introduced by some of the most common freeware and commercial tools (e.g., Adobe® Audition 3.0.1; FFmpeg N-85604-g207e6de; LAME 32/64bits version 3.99.5; MATLAB® 2016a/2017a using the audioread built-in function; mpg123 1.11.0; and QuickTime® Pro 7.7.9 on original MP3 files created with 16 different OLYMPUS® digital audio recorder models: DM-520, DM-620, VN-713PC, VN-722PC, WS-550M, WS-560M, WS-600S, WS-700M, WS-750M, WS-760M, WS-802, WS-811, WS-821, WS-822, WS-823, and WS-853). Extending a previous paper presenting the zero-level sample padding problems of various MP3 decoders, the following table provides examples of the materials and results collected in this study.[1]

OLYMPUS®	**Adobe® Audition**		**FFmpeg**		**LAME**		**MATLAB®**		**mpg123**		**QuickTime® Pro**	
	median	std	median	std	median	std	median	std	median	std	median	std
MP3 Recordings	234	155	22	143	49	180	239	162	0	82	0	95

Table 1. The number of zero-level samples after decoding

The preliminary results of this study indicate that different decoders pad with a different number of zero level samples at the beginning of the Pulse Code Modulation (PCM) decoded files. The tested versions of mpg123 and QuickTime® Pro decode the original .MP3 files with minimum zero padding while Adobe® Audition, FFmpeg, LAME, and MATLAB®, using the built-in audioread function, pad with greater numbers of zero-level samples at the beginning of the PCM converted files. The artificially introduced zeros affect results of time domain processes and measurements like Quantization Levels (QL), energy, power, and Direct Current (DC) component. This can also lead to inconsistent results when the same analysis of the same acoustic event is conducted by two different scientists using different decoding tools (e.g., butt-splice detection) that will produce results at different counters. Another challenging problem can be found in forensic video where the transcoding can introduce an offset between audio and video streams. With these findings, this study proposes the use of different decoding libraries and settings that are cross-verified in forensic analyses and presented in accompanying reports.

Reference(s):

1. Berman, J. (2015) *Analysis of Zero-Level Sample Padding of Various MP3 Codec.* MSc Thesis, National Center for Media Forensics, University of Colorado Denver.

Audio Forensics, Multimedia, Digital Evidence

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