C18 Forensic Audio Analysis of Apple iPhone® Voice Memo Recordings

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Learning Overview: The goal of this presentation is to disseminate preliminary findings related to the behavior of various Apple iPhone® voice memo recordings and different Advanced Audio Coding (AAC) decoding libraries as they relate to frequency and Modified Discrete Cosine Transform (MDCT) analyses.

Impact on the Forensic Science Community: 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 audio and video containers that imbed AAC-encoded audio.

The Scientific Working Group on Digital Evidence (SWGDE) best practice guidelines for forensic authentication of digital audio recordings includes the MDCT and compression level analysis of the evidence recording.[1] This study is part of a larger research project regarding audio lossy compression artifacts analyses for forensic purposes.

This presentation will provide the results of a preliminary study on the discrimination between AAC lossy compression artifacts left by Apple iPhone® Voice Memo app and different other mobile phones and audio encoders and decoders. AAC lossy compressed signals are common in real forensic cases, can be produced with different mobile phones and software, and their forensic analysis and/or authentication can end up being crucial in the courtroom or other extrajudicial investigations.

This study reports on: (1) applications of MDCT to analyze the artifacts introduced by different recording devices, operating systems, and apps (e.g., Apple iPhone® Voice Memo, Samsung™ Voice Recorder; faad, fdk aac, FFmpeg, Nero, Adobe® Audition, iZotope RX Advanced, MATLAB, NCH, SuperSetup, etc.); (2) a fusion between Long Term Average Sorted Spectrum (LTASS), Compression Level (CL), and MDCT analyses of the lossy compression artifacts; (3) an automatic comparison method between the evidence signal and a database containing AAC, AC3, MP3, OGG, and WMA reference samples collected over a five-year span from more than 100 mobile phones, apps, OS, digital audio recorders, and core software applications; (4) an unbiased method to report the comparison results as Likelihood Ratios (LR) and error rates, and the automatic conversion of LRs on a verbal scale; and (5) the recording's length influence on the final results.

The suspect mobile phone, or original samples from it, and a database of reference recordings are necessary for a detailed forensic analysis, including the assessment of previous traces of lossy compression. Following previous research presenting the format and structure analysis, the preliminary results of this study indicate that the proposed framework can be used: (1) to verify Pulse-Code Modulation (PCM) signals and detect the presence or absence of MDCT artifacts left by previous lossy compression algorithms; (2) to discriminate between MDCT and up sampling artifacts; (3) to verify if an evidence AAC signal is consistent with an original or edited Apple iPhone® Voice Memo.M4A recording; and (4) to verify if a WAV PCM signal (e.g., an audio CD rip) is consistent with an original Apple iPhone® Voice Memo recording and discriminate between different iOS versions.[2,3]

Future presentations will present extended results and applications of the proposed framework on AAC, MP3, WMA verification and/or identification, and social media analysis. With these findings, the use of the proposed framework in forensic audio analyses together with other scientific validated methods is recommended.

Reference(s):

1. *SWGDE Best Practices for Digital Audio Authentication*. Version: 1.2 (February 21, 2017).
2. Grigoras C., Smith J.M. (2017) *Large Scale Test of Digital Audio File Structure and Format for Forensic Analysis*. 2017 AES International Conference on Audio Forensics, Arlington VA, USA.
3. Smith, J., Lacey, D., Koenig, B., Grigoras, C. (2017) *Triage Approach for the Forensic Analysis of Apple iOS® Audio Files Recorded Using the "Voice Memos" App*. 2017 AES International Conference on Audio Forensics, Arlington VA, USA.

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