

Report regarding digital audio analysis

'Başçalan Erdoğan'in Yalanlarının ve Yolsuzluklarının Kaydı.mp4'

February 27, 2014

From the forensic laboratory of Catalin GRIGORAS and Jeff M. SMITH

Re: Digital audio analysis

As requested, this report contains details in the analysis of the digital media file as well as additional test material described below. One media file was downloaded from <https://www.youtube.com/watch?v=Cvf4aeRLu0E> on 02/27/2014.

The client in this case requested the audio analysis of the evidence file with regard to its authenticity.

1. Description of evidence

The evidence file has the following name, size, and MD5/SHA1/SHA256 Hash values:

Filename: Başçalan Erdoğan'in Yalanlarının ve Yolsuzluklarının Kaydı - YouTube.mp4

Filesource: <https://www.youtube.com/watch?v=Cvf4aeRLu0E>

Filesize: 34073229 bytes

MD5: ee38ab1a908c979568a44891b5bb4e13

SHA1: a9652d57f4da9e01f1adc930a38372dec789e4e7

SHA256: e9c1c6a96855dd3a9342b20225139697518d46ad6dad1ece479f3d1d1144af87

2. Format analysis

Appendix I shows the file format analysis details.

3. Hex analysis

The hex analysis of the file header indicates that the container is MPEG-4 format.

```
Offset(h) 00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F
00000000 00 00 00 20 66 74 79 70 4D 34 56 20 00 00 00 00 ... ftypM4V ....
00000010 4D 34 56 20 4D 34 41 20 6D 70 34 32 69 73 6F 6D M4V M4A mp42isom
00000020 00 03 26 4C 6D 6F 6F 76 00 00 00 6C 6D 76 68 64 ..&Lmoov...lmvhd
00000030 00 00 00 00 00 00 00 00 00 00 00 00 00 00 03 E8 .....è
00000040 00 0A 76 D2 00 01 00 00 01 00 00 00 00 00 00 00 ..vÒ.....
00000050 00 00 00 00 00 01 00 00 00 00 00 00 00 00 00 00 .....
00000060 00 00 00 00 00 01 00 00 00 00 00 00 00 00 00 00 .....
00000070 00 00 00 00 40 00 00 00 00 00 00 00 00 00 00 00 .....@.....
00000080 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
00000090 00 00 00 03 00 01 E5 31 74 72 61 6B 00 00 00 5C .....åltrak...\
000000A0 74 6B 68 64 00 00 00 07 00 00 00 00 00 00 00 00 tkhd.....
000000B0 00 00 00 01 00 00 00 00 00 0A 76 D2 00 00 00 00 .....vÒ....
000000C0 00 00 00 00 00 00 00 00 01 00 00 00 00 01 00 00 .....
000000D0 00 00 00 00 00 00 00 00 00 00 00 00 00 01 00 00 .....
000000E0 00 00 00 00 00 00 00 00 00 00 00 00 40 00 00 00 .....@...
000000F0 00 00 00 00 00 00 00 00 01 E4 CD 6D 64 69 61 .....äïmdia
00000100 00 00 00 20 6D 64 68 64 00 00 00 00 00 00 00 00 ... mdhd.....
00000110 00 00 00 00 00 00 AC 44 01 CD 77 F9 55 C4 00 00 .....-D.ÍwùUÄ..
00000120 00 00 00 22 68 64 6C 72 00 00 00 00 00 00 00 00 ..."hdlr.....
00000130 73 6F 75 6E 00 00 00 00 00 00 00 00 00 00 00 00 soun.....
00000140 00 00 00 01 E4 83 6D 69 6E 66 00 00 00 10 73 6D ...äfminf....sm
00000150 68 64 00 00 00 00 00 00 00 00 00 00 00 24 64 69 hd.....$di
00000160 6E 66 00 00 00 1C 64 72 65 66 00 00 00 00 00 00 nf....dref.....
00000170 00 01 00 00 00 0C 75 72 6C 20 00 00 00 01 00 01 .....url .....
00000180 E4 47 73 74 62 6C 00 00 00 67 73 74 73 64 00 00 äGstbl...gstsd..
00000190 00 00 00 00 00 01 00 00 00 57 6D 70 34 61 00 00 .....Wmp4a..
```

For further analysis the audio stream was extracted from the evidence file.

4. Critical listening

The critical listening, waveform, and spectrogram analysis revealed that the audio recording contains stereo music, zero samples, and the intended dialogue(s) which were recorded double mono. The rest of the analysis was performed on the signal without music.

5. Global analysis

The long term average spectrum, the sorted spectrum, and the compression level analysis indicate traces consistent with: voice bandwidth below 4 KHz, signal up-sampling around 10 KHz, and two generations of signal lossy compression between 10 - 22 KHz (see Figure 1).

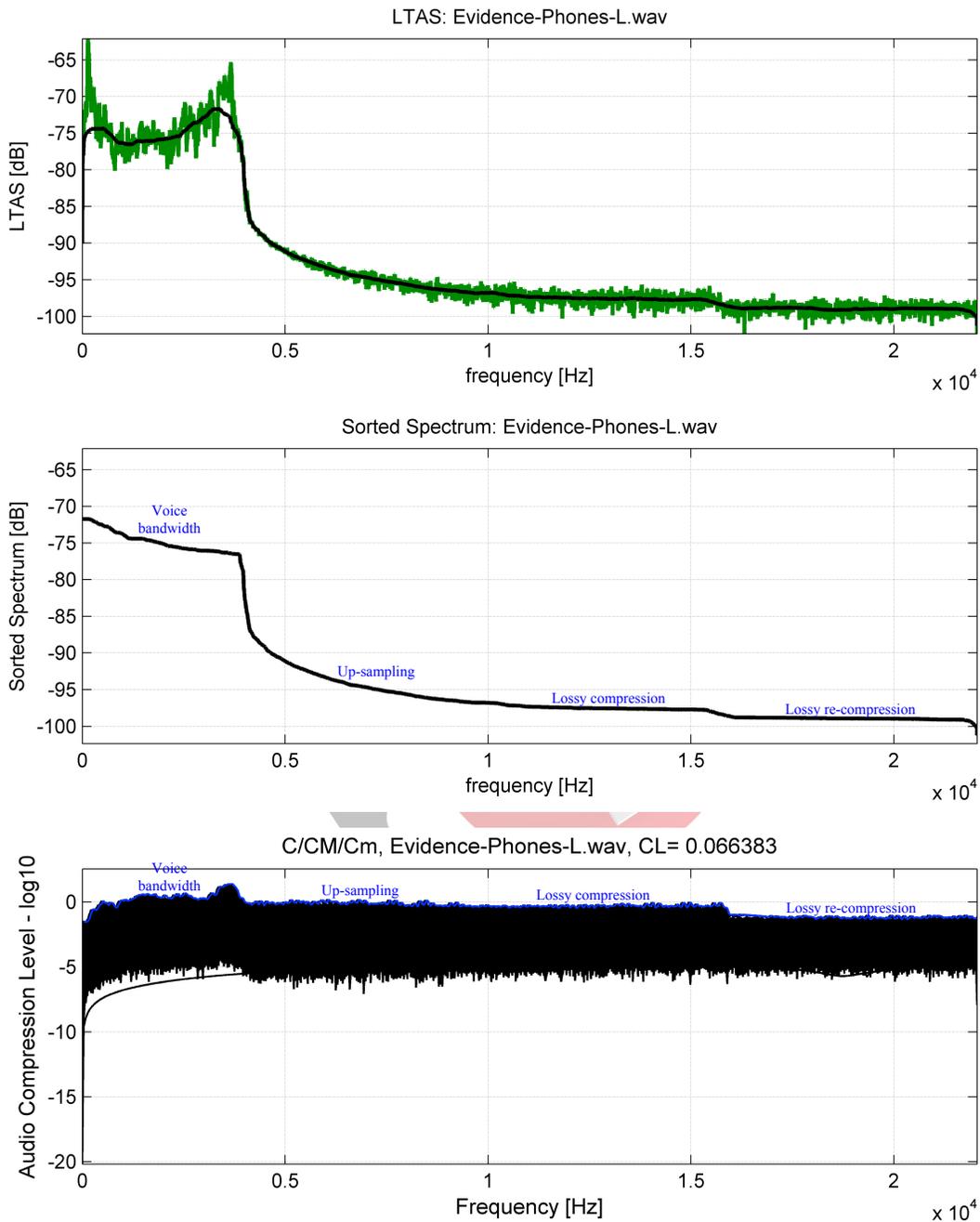


Figure 1: Long term average spectrum, sorted spectrum, compression level analysis

6. Local analysis

The Power and DC analysis indicate inconsistencies in the intended speech signal, five regions with different Power and DC distributions, consistent with signals from five different recordings

(see Figure 2). The Waveform and Energy analysis revealed four groups of consecutive zero quantization level samples: 9094170 - 9176692, 13162022 - 13202218, 15695778 - 15777603, and 23304074 - 23327632.

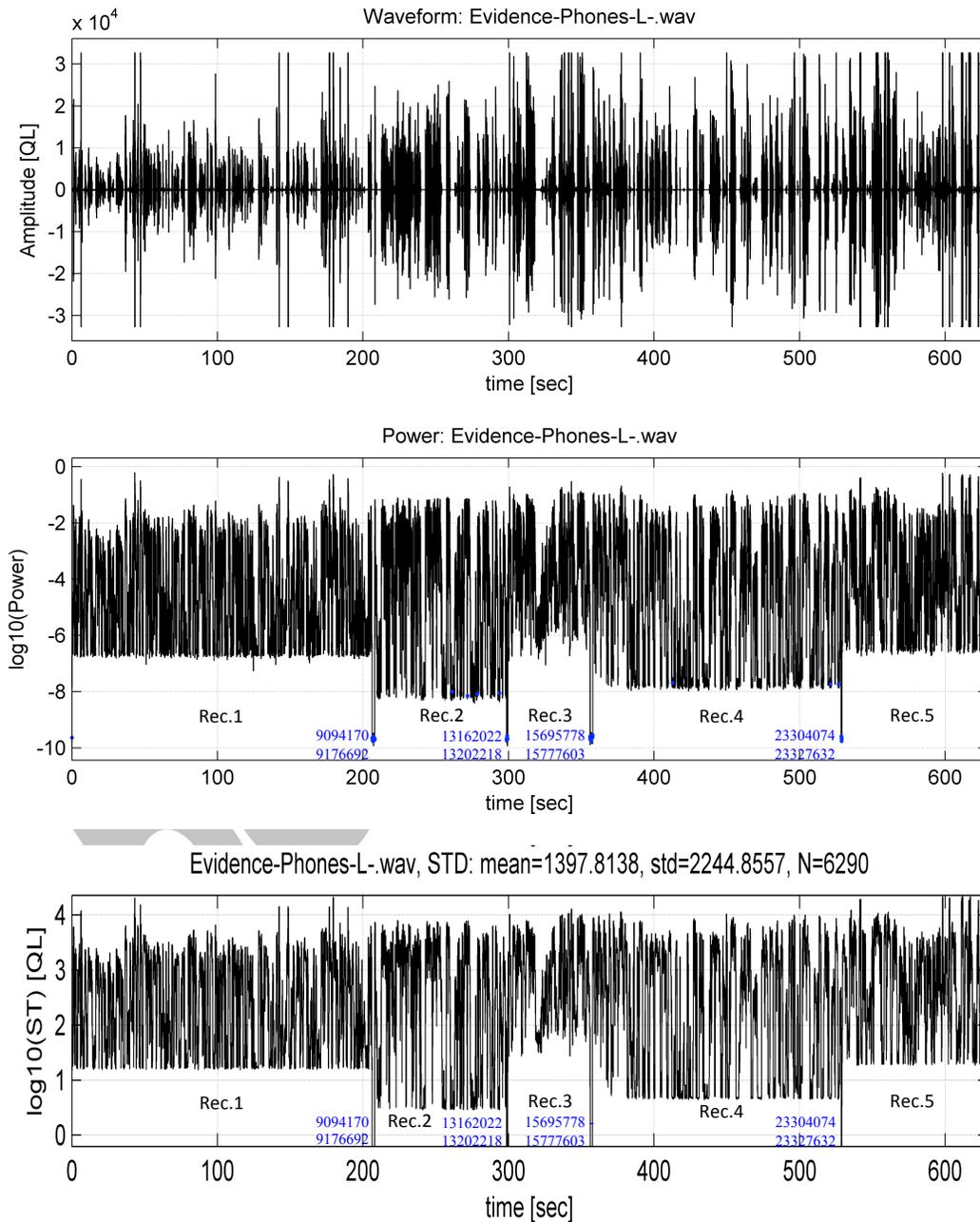


Figure 2: Waveform, Power, and DC analysis

The four groups of consecutive zero quantization level samples are placed right between the five regions with different recordings.

7. Other analysis

The signal's quantization level analysis revealed traces of 8-bit depth from a previous generation of the audio signal.

No traces of butt-splice or interpolation deletion were detected. The lossy compression algorithms mask these kind of traces.

For more analysis a previous generation or a clone of the original recording is necessary to be provided.

8. References

- [1] Grigoras C., and Smith J.M. (2013) *Audio Enhancement and Authentication*. In: Siegel JA and Saukko PJ (eds.) *Encyclopedia of Forensic Sciences*, Second Edition, pp. 315-326. Waltham: Academic Press.
- [2] Koenig, B.E., Lacey, D., Grigoras, C., Price, S., Smith, J. (2013) Evaluation of the Average DC Offset Values for Nine Small Digital Audio Recorders, *JAES* Volume 61 Issue 6 pp. 439-448; June 2013
- [3] Grigoras, C., Rappaport, D., Smith, J., (2012) Analytical Framework for Digital Audio Authentication, *AES 46th International Conference: Audio Forensics*, Denver, USA
- [4] Grigoras, C. (2010) *Statistical Tools for Multimedia Forensics: Compression Effects Analysis*, *AES 39th International Conference Audio Forensics*, Hillerod, Denmark

3. Conclusion

Based analysis of the evidence audio signal, it is our opinion that the evidence audio recording:

- a) is not consistent with an original, copy or clone of an original recording
- b) contains traces of at least two signal lossy re-compressions, the last one most probably due to Youtube compression scheme
- c) contains traces of five different dialogues.

Signed, Catalin GRIGORAS and Jeff M. SMITH, 02/27/2014

APPENDIX I

General

Format : MPEG-4
Codec ID : M4V
File size : 32.5 MiB
Duration : 11mn 25s
Overall bit rate : 397 Kbps

Video

ID : 2
Format : AVC
Format/Info : Advanced Video Codec
Format profile : Main@L3.0
Format settings, CABAC : Yes
Format settings, ReFrames : 3 frames
Codec ID : avc1
Codec ID/Info : Advanced Video Coding
Duration : 11mn 25s
Bit rate : 259 Kbps
Width : 640 pixels
Height : 360 pixels
Display aspect ratio : 16:9
Frame rate mode : Constant
Frame rate : 25.000 fps
Color space : YUV
Chroma subsampling : 4:2:0
Bit depth : 8 bits
Scan type : Progressive
Bits/(Pixel*Frame) : 0.045
Stream size : 21.2 MiB (65%)

Audio

ID : 1
Format : AAC
Format/Info : Advanced Audio Codec
Format profile : LC
Codec ID : 40
Duration : 11mn 25s
Bit rate mode : Constant
Bit rate : 126 Kbps
Channel(s) : 2 channels
Channel positions : Front: L R
Sampling rate : 44.1 KHz
Compression mode : Lossy
Stream size : 10.3 MiB (32%)
mdhd_Duration : 685778