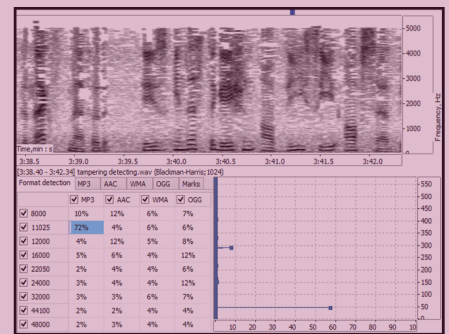
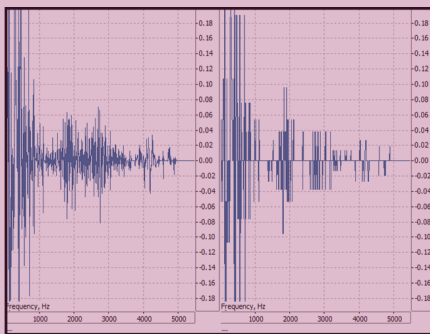




PRODUCT CATALOGUE

Audio Forensics



Forensic Speaker Voice Identification
Authenticity Aproval of Audio Evidence
Identification of Recording Devices
Automatic Speaker Recognition

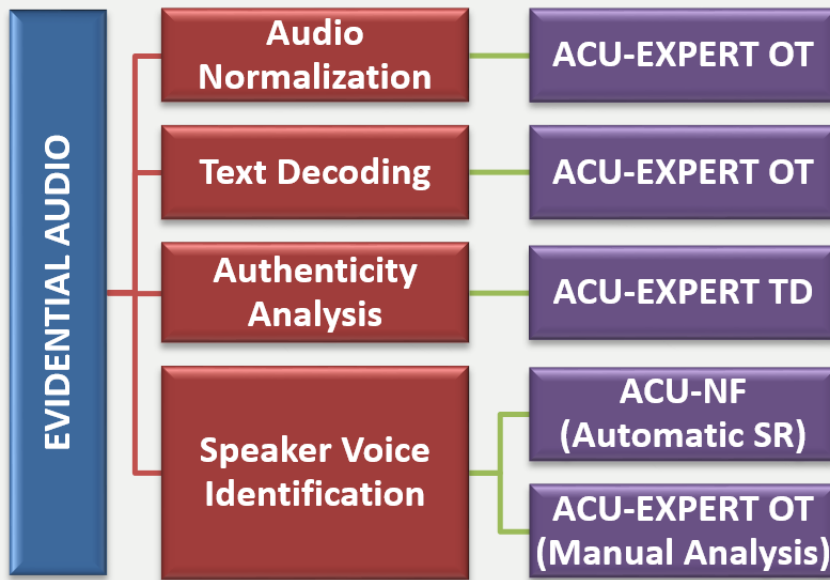


Forensic Audio Solutions

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ACUSTEK Forensic Audio Lab is a unique set of professional tools and methods for forensic audio investigation and analysis developed hand in hand with practicing governmental and private forensic audio experts all over the world.



ADVANTAGES

Complete solution to meet all forensic audio tasks with best precision and accuracy.

- Ready to use
- Easy to operate
- Fast data access
- Adaptive and user-friendly
- Processes automation
- Powerful
- Representative reporting

Typical **ACUSTEK Forensic Audio LAB** workstations configuration guarantees efficient working process and improves expert team work.



SYSTEM FUNCTIONALITY

ACU-EXPERT OT

- Accurate segmentation
- Speech normalization
- Noise reduction
- Text decoding
- Accurate signal analysis
- Speech quality assessment
- Speaker Voice Identification (Expert approach)

ACU-NF

- Automatic segmentation
- Gender and Language ID
- Automatic Speaker Recognition (LLR assessment)

ACU-EXPERT TD

- Authenticity analysis of evidential recordings
- Recording device identification

ACU-EXPERT OT is a powerful speech analysis platform especially designed for forensic speech and audio analysis and **Forensic Speaker Voice Identification** task. **ACU-EXPERT OT** provides accurate analysis of different voice features accordingly to contemporary approaches in speaker voice identification.

FUNCTIONALITY

RECORDING and PLAYBACK

- Input / Output level control, Clipping notification, Easy editing;
- Loop playback, consequent playback of chosen fragments from two different files;
- Pseudo stereo mode, tempo correction.

FILTERING and NORMALIZATION

- High/Low/Band-pass, Inverse and Spectrum-saving filtering;
- Filtering noise by sample, filtering to target spectrum;
- Spectrogram region attenuation;
- Amplitude attenuation;
- Mixing.

TEXT DECODING

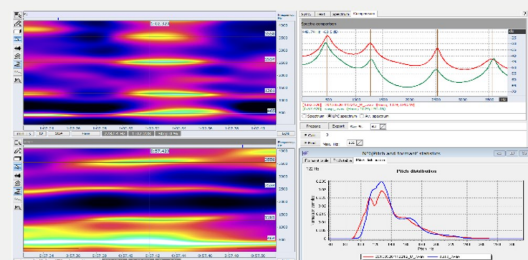
- Color highlighting of speakers' utterances;
- Convenient speech segmentation;
- Text-to-audio binding and fast text navigation;
- Automatic search of matching words and phrases for further comparison analysis.

FORENSIC SPEAKER IDENTIFICATION

- Automatic extraction of speaker characteristics;
- Pitch and formant traces extractor, manual correction options via visual control;
- Calculation, comparison, and storing of pitch and formants statistics;
- Full MS Word data export

ADVANTAGES

- Support of any audio file format;
- Different signal representations changed with one HotKey stroke:
- waveform / energy,
- spectrogram / LPC-spectrogram,
- cepstrogram;
- Additional experts' information shown over main layer (energy, pitch, formants, user marks and notes);
- Fast signal navigation and view attenuation (frame type and size, spectrogram view normalization);
- Project organization of files (all types: jpeg, docx, pdf, etc.) in case tree structure with fast access;
- Fast real-time redraw, parallel computing and information management;
- Automatic ID features extraction and comparison;
- Text import;
- Rich colour pre-sets pallet. Image export with user pre-sets, customized list of HotKeys;
- Reporting and Back-up.

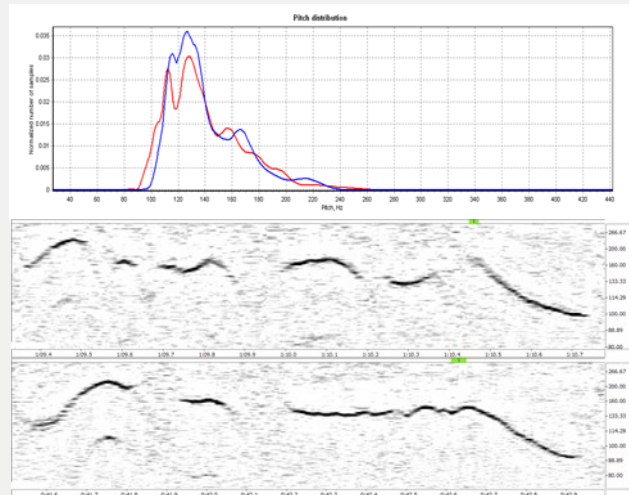


PITCH COMPARISON

Pitch distribution reveals the individual manner of intonation and physical characteristics of vocal cords.

Comparative analysis of pitch distributions statistics reveal the speakers difference or similarity.

Speaker prosodic patterns set correspond to individual speech behavioral manner. Match of prosodic patterns supports the true identification hypothesis.



Vowel	Speaker	Word	F1	F2	F3	F4
[O]	M2	all	530	1130	2330	3130
	M2	open	490	1100	2360	3160
	M2	cold	550	1080	2400	3150
	M2	stow	550	1160	2370	3120
	M2	won't	440	1120	2330	3160
	M2	on	550	1120	2360	3150
Aver.			518	1118	2358	3145
[A]	M2	mart	300	1980	2580	3690
	M2	chart	300	1990	2600	3700
	M2	star	370	1970	2600	3720
	M2	out	270	2010	2610	3690
	M2	onion	300	1970	2560	3720
	M2	alt	250	2010	2540	3720
	M2	out	290	1990	2560	3670
Aver.			297	1989	2579	3701
[U]	M2	fool	360	850	2530	3330
	M2	loop	340	820	2540	3310
	M2	cool	350	890	2540	3330
	M2	wood	290	840	2520	3360
	M2	true	420	840	2530	3340
	M2	round	320	820	2540	3380
	M2	wood	370	820	2570	3320
Aver.			350	840	2539	3339
[I]	M2	heel	320	1550	2550	3560
	M2	sleep	360	1540	2550	3600
	M2	feel	330	1560	2540	3580
	M2	still	370	1560	2570	3610
	M2	listen	330	1550	2510	3570
	M2	pit	400	1580	2560	3560
Aver.			352	1557	2547	3580

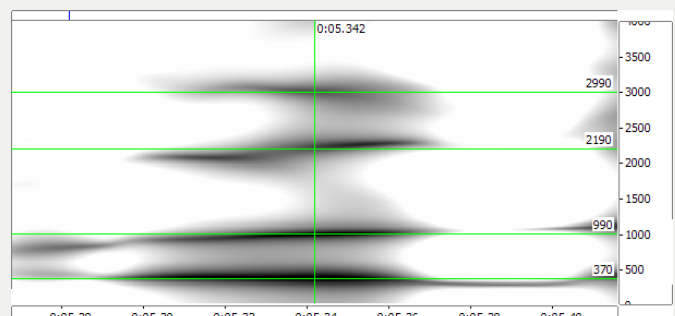
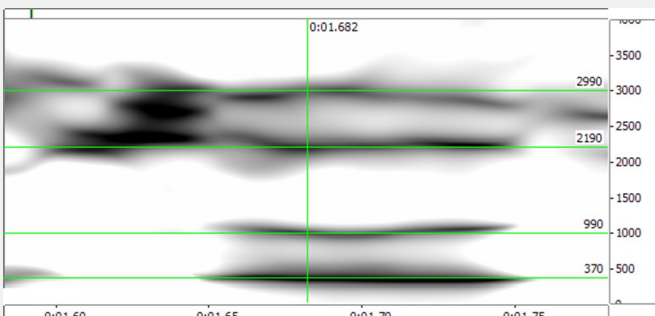
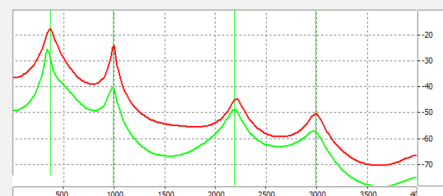
FORMANT TRACKS ANALYSIS

Spectral shape of vowels correspond to individual geometry of speakers' vocal tract.

Analysis of matching articulatory events, implemented in the system is a language independent method based on investigation of neurodynamic patterns used for speech production. Matching vocal tract configurations bring the same traces to the spectral layout of the acoustic event.

ACU-EXPERT OT provides:

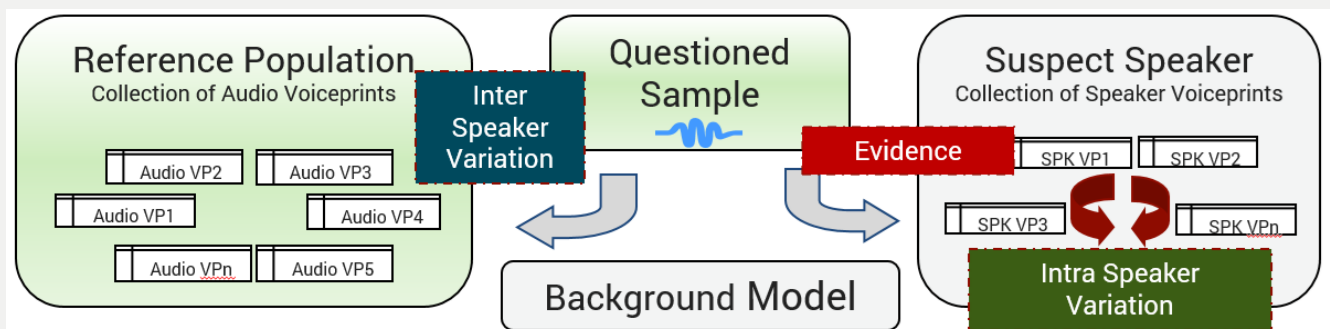
- Search for matching words / sounds in two texts;
- Collecting individual speaker phonetic set;
- Search for matching articulations;
- Formant statistics for each phonetic set;
- Speaker profiles comparison.



ACU-NF is a voice biometric software designed to provide forensic examiners and investigators with the ability to accurately match an individual's identity with content captured through any type of audio channel.

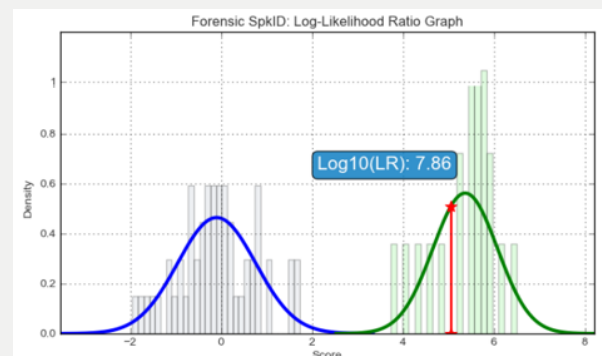
ACU-NF analyses recorded speech and then compares that sample to a comprehensive speaker profile and a robust reference population to statistically assess whether an individual can be associated with that speech.

Based on innovative industry-leading algorithms, this solution provides a complete set of tools to develop reference populations, build comprehensive speaker profiles, and assess the likelihood that speech of an unknown matches a target speaker profile.



ADVANTAGES

- Support for Robust **Reference Populations**. Reliably estimate Inter-Speaker Variation by defining a representative set of voice samples with common features (gender, language, dialect, etc.) to estimate the probability that a given voice sample belongs to a known speaker, rather than to a random individual. **68** built-in reference populations are provided;
- Verify Reliability with **Observed Tippett Plots**. Measure the strength of voice evidence graphically with a system-generated Tippett Plot graph comparing the log likelihood ratio (LLR) and the residual error in the system. Tippett Plots represent all the certified results of previous comparisons, including matches and mis-matches, and demonstrate how strongly the present LLR supports the prosecution's hypothesis;
- Automatic **Segmentation, Language & Gender Identification**. Detect gender as well as spoken language leveraging advanced speech technologies and allow for files to be filtered by language as an audio attribute. Support for twenty-two language models;
- Multi-language support and pre-defined reference populations segmented by dialect, gender and language to assist in a wide range of investigations;
- Accurate Pre-forensic **Speaker Identification** – associate speaker identities with recorded audio files, using cutting-edge voice biometric technology;
- Detailed **forensic report** containing a graphical representation of the Log Likelihood Ratio.



ACU-EXPERT TD is a full featured modern forensic audio examination module that provides a wide spectrum of tools and methods dedicated to authenticity analysis of speech recordings.

Authenticity analysis of speech recordings is the one of the most important tasks of contemporary criminalistics. Due to innumerous software solutions for audio editing available today, tampering has become an easy way to fake original audio and hide the traces of editing.

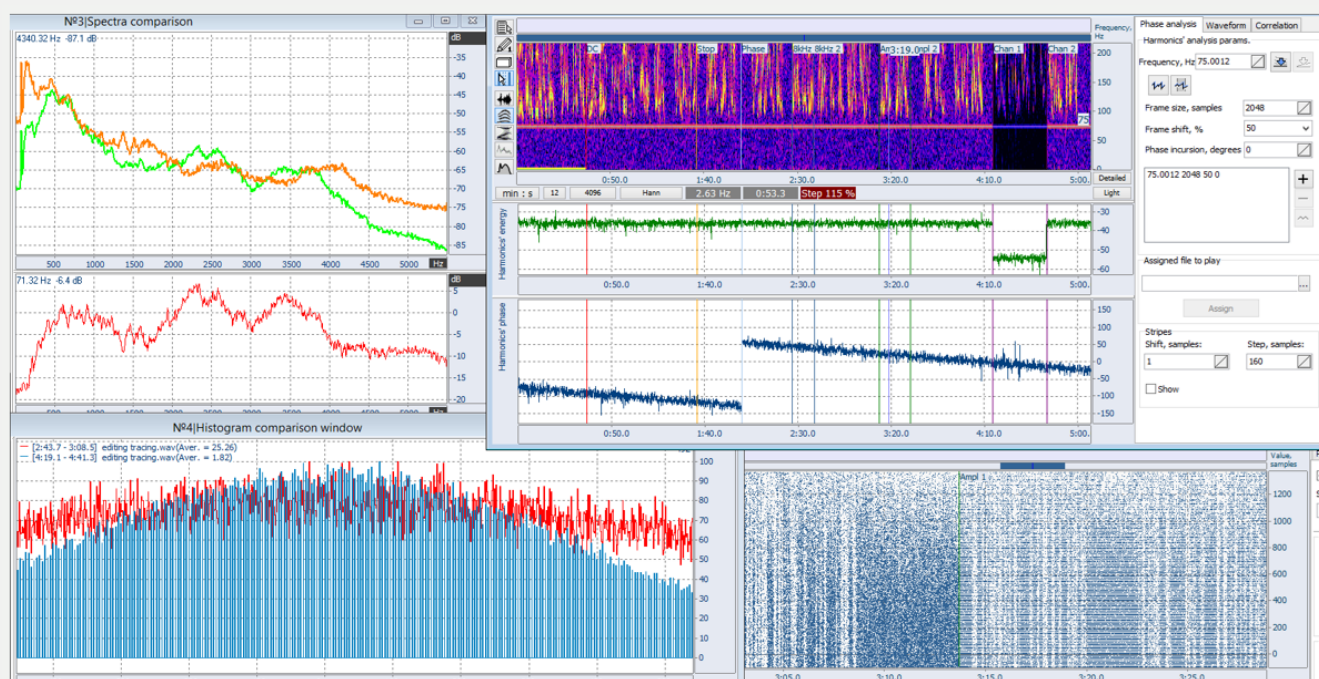
A lot of solutions and methods for revealing the fact of audio tampering are invented and developed during forensic audio examination of real cases. Every speech recording contains unique intermixture of circumstances: from background noises and surrounding acoustics to specific features and characteristics of the recording device used to create the audio evidence.

The **ACU-EXPERT TD** – a powerful software application tool developed hand in hand with experts practice and experience.

ACU-EXPERT TD includes the following methods of audio authenticity investigation:

- Harmonics phase analyzer
- Histogram of samples analysis
- Levelogram tool
- DC Offset analyzer
- REC Stop/Pause detector
- Matching signal fragments detector
- Codec frames analyzer (**UNIQUE!**)
- Spectral and Autocorrelation analysis

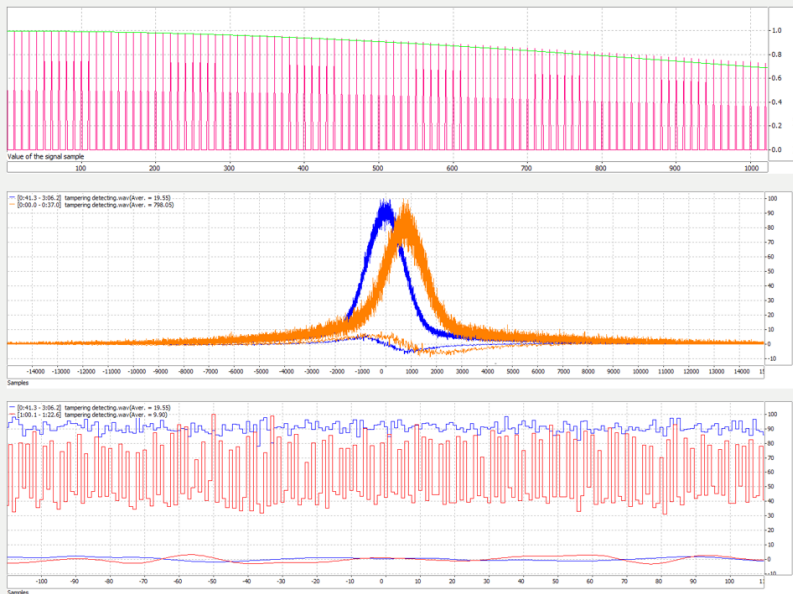
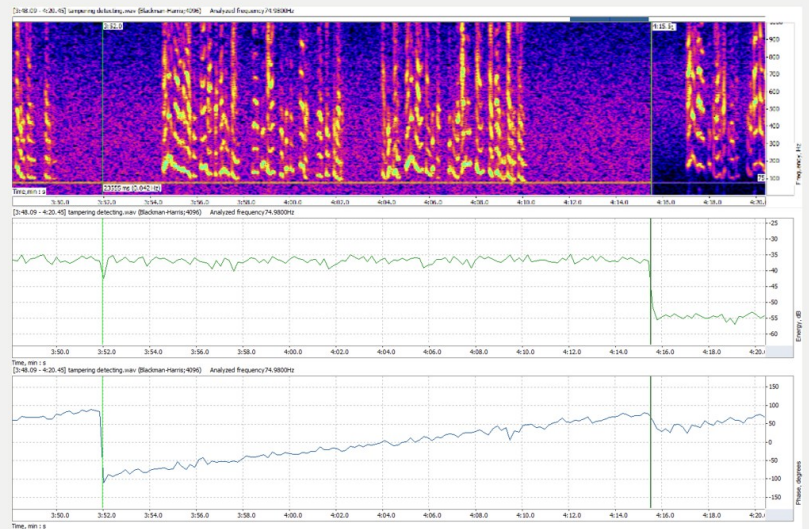
All audio and majority of video files types supported: 3gp, aac, ac3, amr, ape, asf, au, avi, avm, avs, cda, dat, divx, dts, flac, flv, m4a, mka, mkv, mov, mp2, mp3, mp4, mpa, mpc, mpeg, mpg, mts, nsx, ofr, ogg, ogm, ppk, ra, rm, rmvb, tp, ts, tta, vdr, vob, voc, wav, wma, wmv, wsd .



PHASE CONTINUITY DETECTION

Inductivity of the electrical power supply network does not allow the AC frequency phase to change discontinuously. Implemented technology extracts the harmonic and evaluates its phase, so all unexpected alterations could be clearly seen.

The methods works with any narrowband harmonic in the signal as well.



HISTOGRAM OF SAMPLES

Histogram of samples reveals signal attenuation due to the rounding algorithm features.

Histogram asymmetry and autocorrelation are very important while detecting signal manipulation traces.

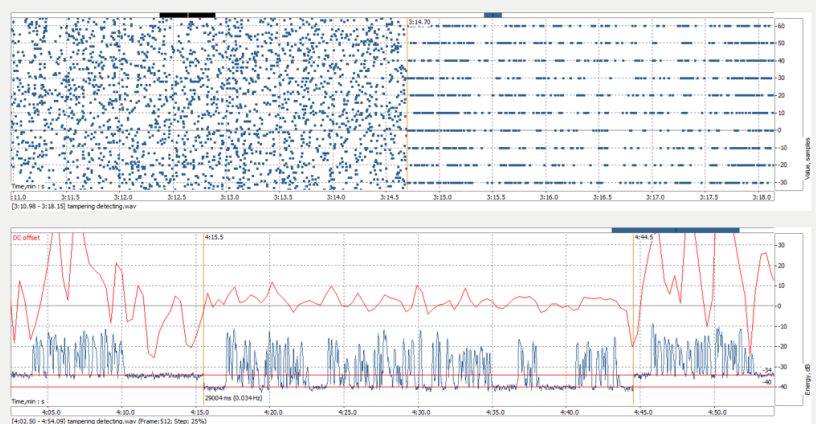
Implemented tools are very specific and cannot be found in traditional audio editing applications, which gives more opportunities to detect signal manipulations.

LEVELOGRAM and DC OFFSET

Levelogram depicts signal fragments that were amplified, compressed or merged.

DC Offset graph reflects the samples distribution center time behaviour.

Technical features reveal breaks that cannot be heard or seen with traditional investigation methods.

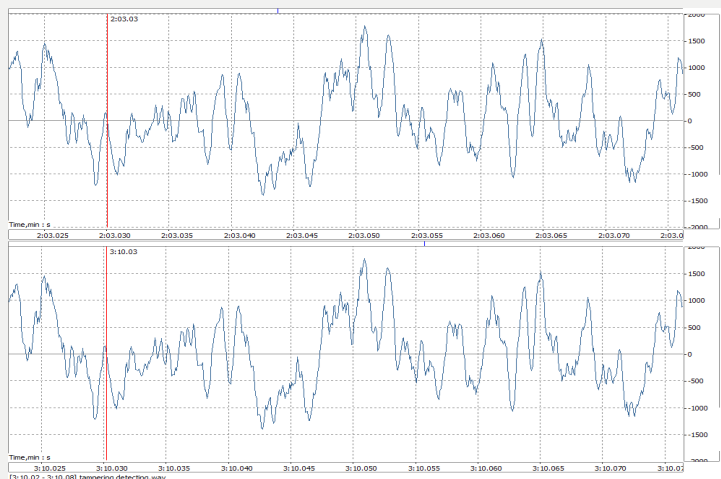
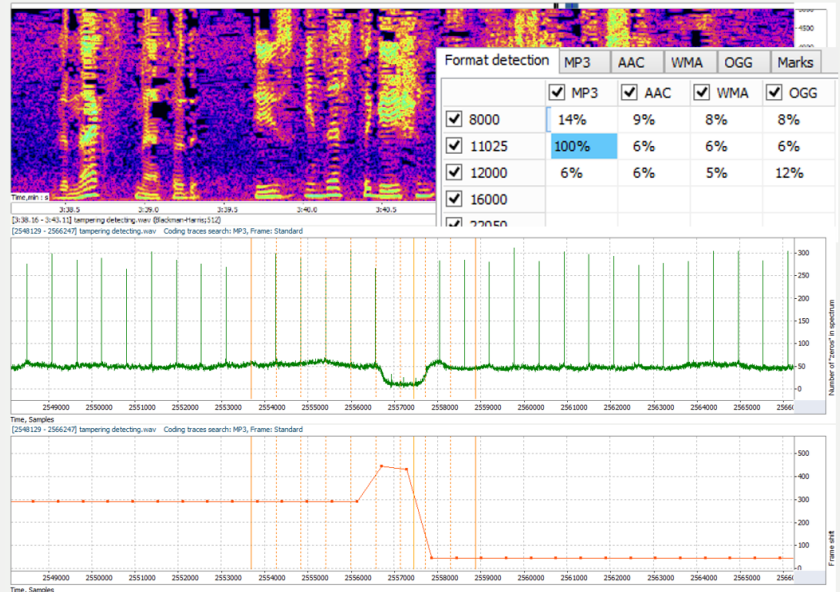


CODING DETECTION and CODEC FRAMES ANALYSIS

Psychoacoustic (MP3, WMA, AAC, OGG) coding procedures leaves traces in signal spectral features and can be restored back even if implied several times.

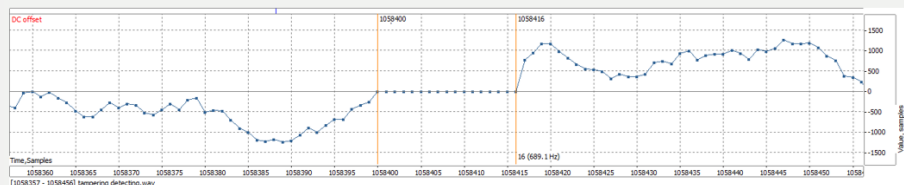
The order of extracted codec frame borders approves signal continuity.

This proprietary unique technology was developed during real cases investigation.



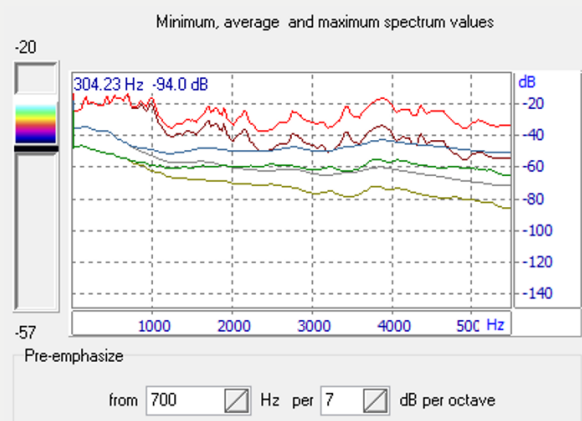
"PAUSE" SEARCH

Consequent samples of matching value can be missed during visual and audial investigation, but is automatically found by TD.



PRECISE SPECTROGRAM RECALCULATION and VIEW NORMALIZATION

A lot of attention is paid to the accuracy of calculations and signal representation. Spectrogram is recalculated in case frequency-to-pixel ratio changes.



MATCHING FRAGMENTS SEARCH

Unique autocorrelation technology that detects signal fraud made by stamping the same signal fragment instead the original audio.

Matching signal fragments spotting means that one and the same signal fragment was used several times to edit the audio.

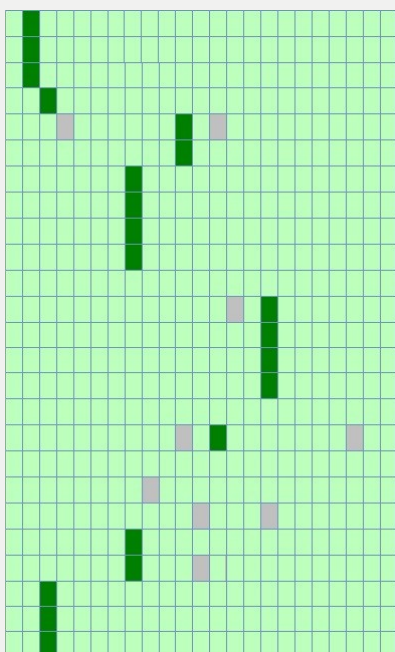
It is a definite feature of editing, that cannot be found by other means.

ACU-Expert HEX is a specialized application software (add-on or standalone) focused on detailed media file structure analysis for forensic audio/video evidence authenticity approval. The main idea of the approach is the check of the file header structure match to file format and accurate parsing of file contents with service fields and frames recognition.

Automatic detection of codec traces and other definite markers of codec library used for audio conversion reveal the exact way the audio was created or modified.

Automatic calculation of fields size and its difference to listed size can help to establish the exact recording device or reveal manipulation.

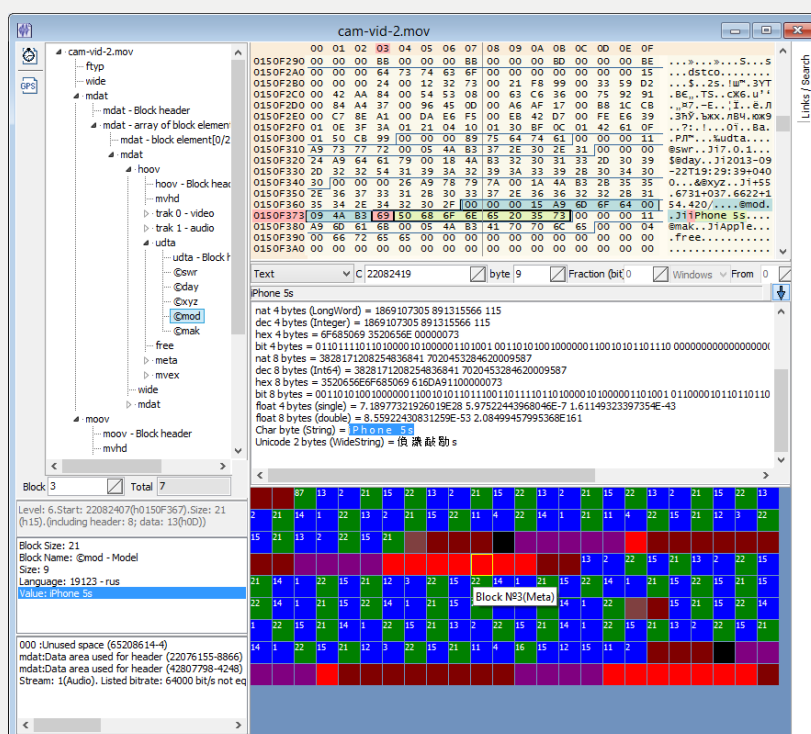
Every codec has its own peculiarities that are reflected in frame header properties. Frames headers parsing allows to check the frame sequences and establish the particular device or coder using a special tool – frame allocation map.



- HEX representation with different variants of content interpretation;
- Comparison of declared file format structure to format standards and format individual features;
- Automatic search for codec types features (LAME, etc.);
- Individual header parsing according to different codec manufacturers;
- By-bit comparison of original and experimental file headers;
- Extraction of GPS data;
- Accurate frame allocation mapping according to selected frame features;
- Frame properties extracted over allocation map.

Following file formats structure are inspected:

- RIFF (.wav, .avi)
- ASF (.wma, .wmv)
- MPEG4/QuickTime (QTFF) (.mov, .mp4, .m4a, .m4v, .3gp);
- MPEG1/2/2.5 Layer 3 (mp3);
- AMR (.amr);
- MPEG-PS (.mpg, .mpeg, .vob);
- MPEG-TS (.mts, .m2ts);
- Audio stream of
 - MPEG1/2/2.5 Layer 2/3;
 - Dolby Digital (AC-3).



ACUSTEK TRAINING PROGRAMS AND SERVICES

FORENSIC AUDIO TRAINING

ACUSTEK provides a variety of training courses in audio forensics:

- **Forensic Speaker Voice Identification**
- **Automatic Speaker Recognition for Forensic Applications**
- **Digital Audio Evidence Authenticity Analysis**
- **Speech Enhancement and Noise Reduction**



ADVANTAGE: *Particular training program is submitted to Customer for approval and depend on students' professional level.*

Training is given by practicing professional experts with more than 10 years of experience, including invited University lecturers.

Students obtain deep understanding of speech production acoustics and get stable operating skills and practical techniques of forensic audio analysis.

Training qualification have been approved in more than a hundred training courses on forensic audio held in different countries worldwide such as (USA, Germany, Italy, Turkey, Morocco, Hungary, Serbia, Latvia, Georgia, Russia, Saudi Arabia, Pakistan, India, China, Mexico and South America, etc.).

AUDIO INVESTIGATION SERVICES

ACUSTEK provides forensic audio services and court testimony worldwide. All investigation methods are tested by ACUSTEK experts before being implemented into final solution.

- **Speaker identification** of a person in audio recording,
- **Authentication** of a single audio recording,
- Detection of **audio copy** for a given recording,
- Detection of **audio-video match**,
- Identification of audio recording **equipment**,
- Noise reduction and **speech enhancement**,
- Analysis of **audio environment** and recording conditions,
- **Text decoding** for a given recording.



ACUSTEK

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