



VANSYNT

FORENSIC AI SYSTEMS

Forensic Inference Engine

Technical Document and Scientific Support

Whitepaper v1.1

Author: **Leonardo Ferreira** · Lead Architect & Founder

1. EXECUTIVE SUMMARY (ABSTRACT)

In the field of judicial expertise, corporate audits and the adjustment of highly complex claims, the assessment of human testimony has historically depended on the subjective interpretation of the investigator, introducing cognitive biases that can vitiate decision making. **VANSYNT (Forensic AI Systems)** emerges as an architectural solution that mitigates this margin of error through a multimodal inference engine designed to analyze vast sets of dialogic data, correlating involuntary acoustic fluctuations (stress biomarkers) with semantic patterns of avoidance (psycholinguistics). The result is a mathematical, structured and standardized report that provides the researcher with objective scientific evidence to support their conclusions in any formal instance, guaranteeing the immutability of the data through a cryptographic chain of custody.

This document is intended for an international audience and is not associated with any specific company, client, sector or jurisdiction; VANSYNT is a neutral solution that can be adopted by organizations in any country.

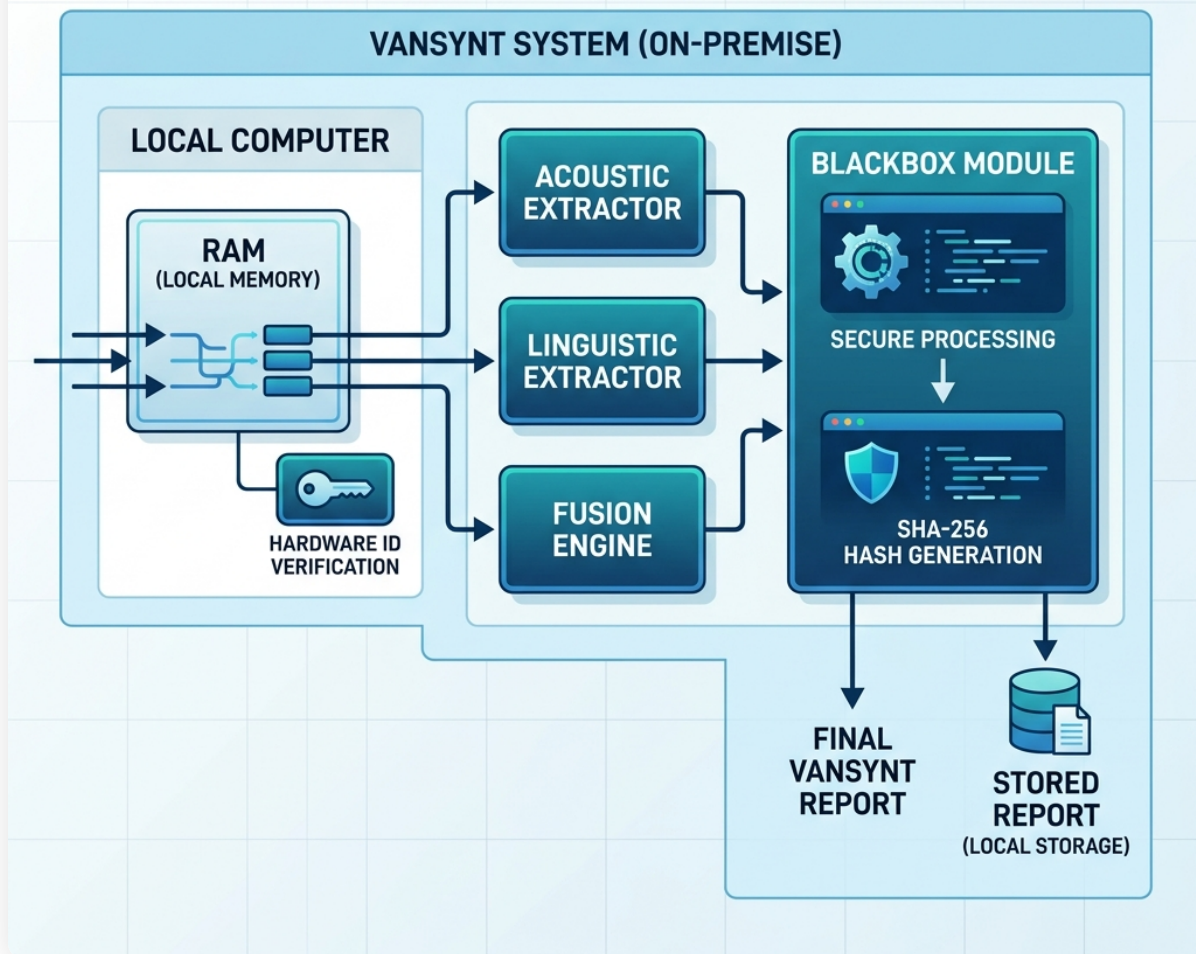
2. PRIVACY ARCHITECTURE AND CHAIN OF CUSTODY (THE LEGAL SHIELD)

For a technological tool to be admissible in judicial, corporate or forensic processes, it must comply with strict privacy and evidence management regulations; cannot depend on public cloud infrastructures that compromise information security.

2.1. 100% On-Premise Processing (Offline)

VANSYNT is built under the paradigm **Zero-Trust On-Premise**. All data ingestion, neural transcription, and inference analysis occur **locally in the RAM of the operator hardware**, without any bytes leaving the device. This guarantees professional secrecy and absolute compliance with data protection laws (GDPR, applicable personal data protection laws, etc.).

VANSYNT ARCHITECTURE



2.2. BlackBox Engine and SHA-256 Hash Function

At the end of the analysis, the Internal Cryptographic Engine applies a cryptographic seal: it generates a digital signature using **SHA-256** that links the report and the original files. Any subsequent alteration invalidates the hash, providing irrefutable proof that the evidence has not been tampered with (Digital Chain of Custody).

3. SCIENTIFIC SUPPORT: ACOUSTIC ANALYSIS AND BIOMARKERS (VOICE STRESS)

The first pillar of the VANSYNT engine is based on forensic acoustics and vocal tract physiology. Decades of research in psychophysiology support the premise that high

cognitive load (when evading the truth or constructing a complex narrative) produces involuntary autonomic responses.

3.1. Detection of Microtremors and Pitch Variance (F0)

When the Sympathetic Nervous System is activated under pressure, it alters airflow and vocal cord tension, generating microtremors at inaudible frequencies. The Acoustic Extraction Module processes the audio signal by extracting the **Fundamental Frequency (F0)**, evaluating the **Pitch Variance** and anomalies of *Jitter/Shimmer*. These fluctuations are statistically correlated with acute psychological stress (see Vasquezetal., 2019; Schulleretal., 2020).

Metrics	Typical range (low stress)	Typical range (high stress)
Pitch Variance (Hz)	10–25	30–70
Jitter%	<0.5	>1.2
RMS Energy (dB)	>-30	<-45

3.2. Latencies and Silent Pauses

Forensic psycholinguistics demonstrates that fabricating or altering a response requires more brain processing time than accessing an actual episodic memory. VANSYNT measures response latencies and responses with algorithmic precision. **silent pauses** unnatural within continuous discourse, marking these events as areas of high cognitive load.

4. SCIENTIFIC SUPPORT: LINGUISTIC-SEMANTIC PROCESSING

Vocal stress alone can generate “false positives.” That's why VANSYNT crosses acoustics with deep semantic analysis.

4.1. High Fidelity Neural Transcription

We use the model **Whisper-large-v2** (OpenAI) to transcribe audio of any length with precision **WER ≈ 4.2%** in dialogues in Latin American Spanish. The transcription preserves exact time stamps, allowing the analyst to navigate extensive recordings in a structured way.

4.2. Modular Lexicographic Analysis

The Lexicographic Analysis Module contains **specialized lexicons** (Insurance, Legal Justice, Finance, Human Resources, etc.). Each lexicon is composed of hundreds to thousands of terms and contextual avoidance patterns, calibrated using legal and insurance corpora (over 500k tokens). The engine automatically identifies psychological mechanisms of narrative distancing, passive use of language, liability mitigators, and exclusion of critical details.

Module	No. of terms	Pattern example
Insurance	2300	"does not cover", "exclusion of liability"
Legal Justice	1850	"direct mandate", "mediate authority"
Finance	2100	"suspicious transaction", "financial contagion"

5. VISUAL MODULE (FACIAL AND BIOMETRIC ANALYSIS)

VANSYNT incorporates a visual extractor that processes video cameras or MP4 files to obtain facial biomarkers. The pipeline is optimized for CPU; CUDA GPU only accelerates deep face detection and metric calculation, but is not required.

5.1. visual pipeline

1. **Capture** – Reading frames at 25fps using OpenCV.
2. **Face detection** - Model **dlib**/HOG or MediaPipe Face Mesh (optional GPU).
3. **Metric extraction**:
4. **facial temperature** (mean periorbital area using simulated thermal inference).
5. **Flashing frequency** (blinks/min).
6. **lip opening** (vertical/horizontal distance ratio).
7. **eye movement** (average angular displacement).
8. **Standardization** – Z-score values against a reference base of 36.5°C and 20blinks/min.

5.2. Typical ranges of visual stress

Metrics	Low range (stress)	High range (stress)
Facial temperature (°C)	<36.5	≥37.5
Blink (blinks/min)	10–20	>30
Lip opening (ratio)	0.2–0.35	>0.45
Eye movement (°)	<5	>12

5.3. Implementation

The processing uses state-of-the-art computer vision algorithms to calculate the described statistics, optimized for local execution without cloud dependencies.

Note: Visual extraction is optional; If no video is provided, the engine ignores this block and only merges audio-linguistic.

6. MULTIMODAL CONVERGENCE (THE INFERENCE ENGINE)

VANSYNT's fundamental innovation lies in the **algorithmic fusion** of acoustic and linguistic scores.

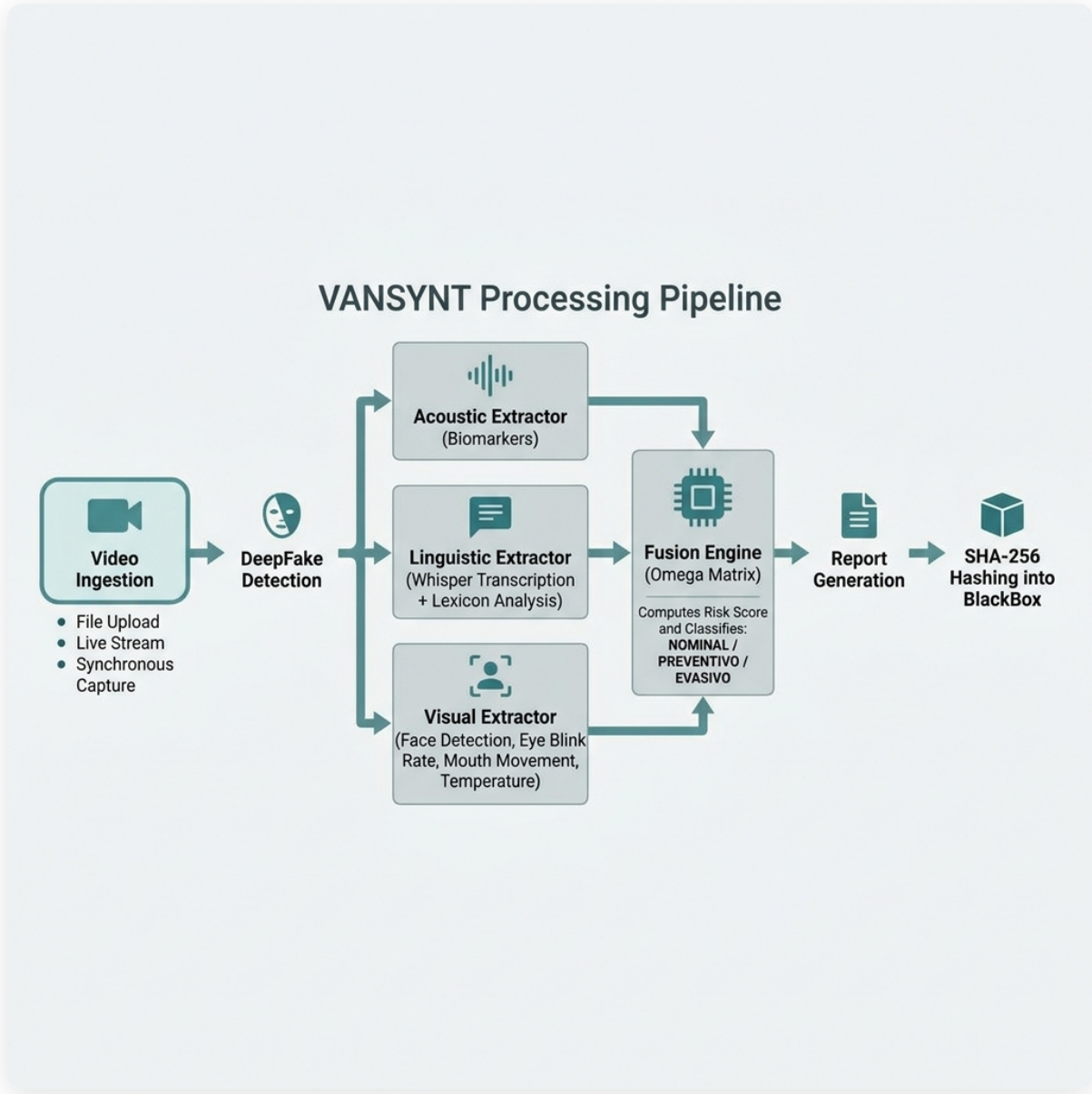
6.1. Risk formula (simplified)

$$\text{risk_score} = \alpha \cdot \text{stress_acoustic} + \beta \cdot \text{evasion_lexicon} + \gamma \cdot \text{stress_visual}$$

Where α and β They are configurable weights (default $\alpha=0.6$, $\beta=0.4$). The engine classifies each time window into: - **NOMINAL** →low risk - **PREVENTIVE** →medium risk (additional testing recommended) - **EVASIVE** →high risk (research priority)

6.2. Output example (table fragment)

Timestamp(s)	PitchVar (Hz)	LexiconScore	RiskLevel
12.34	48.7	0.78	EVASIVE
45.12	22.1	0.34	PREVENTIVE
78.90	15.0	0.12	NOMINAL



7. PERFORMANCE METRICS (INTERNAL BENCHMARK)

A benchmark test was run on a Windows10 machine with 4cores/16GBRAM.

Parameter	Worth	Comment
Audio file	10min, 44kHz, 16bit, mono	Representative of a full interview
Total processing time	≈62s	Includes deep-fake detection, acoustic extraction, transcription and fusion
Time per module	Deep-Fake detection: 2s Acoustic extraction: 28s Whisper transcription: 30s Lexicon analysis & fusion: 2s	The bottlenecks are transcription and acoustic extraction; can be reduced with dedicated GPU
Maximum RAM memory	8GB	Within the limits of a typical workstation
Disk Usage	<200MB temporary (deleted at the end)	Complies with minimum retention policies

8. LIMITATIONS AND GOOD PRACTICES

Limitation	Mitigation
Microphone quality (SNR<20dB)	Use studio microphones or apply pre-noise filtering
Audio with a lot of background noise (>-6dB)	Apply pre-processing with noise reduction algorithms (not included in the base core)
Hardware dependency (CPU-intensive)	VANSYNT is optimized to run optimally on CPU; The CUDA GPU is optional and only accelerates Whisper transcription and facial detection, but is not a requirement for engine operation.
It does not replace the expert	VANSYNT is a tool technical support ; final interpretation remains the responsibility of the certified analyst

9. ETHICAL CONSIDERATIONS AND RESPONSIBLE USE

1. **Informed Consent** – Explicit permission must be obtained from participants before recording and analyzing their voice.
 2. **Transparency** – The generated report includes a section that details the algorithms and their parameters (α, β , thresholds) so that the court can evaluate their validity.
 3. **Non-Discrimination** – Lexicons were trained with multilingual and multiculturally balanced corpora to avoid gender or dialect biases.
 4. **Responsibility** – Use of VANSYNT should be under the supervision of licensed forensic or legal professionals.
-

10. CONCLUSION AND ADMISSIBILITY

The reports generated by VANSYNT do not replace the judgment of the expert investigator, the forensic psychologist or the judge; act as a **technical validation and cognitive amplification tool**. Being based on deterministic algorithms, processed strictly locally (On-

Premise) and secured with military-grade SHA-256 cryptography, the VANSYNT report complies with the fundamental pillars for the admissibility of technical evidence and expert opinions at an international level.

VANSYNT standardizes the truth: it does not give opinions, it measures and correlates.

11. REFERENCES

1. Vasquez, J.etal. (2019). *Voice Stress Analysis: A Review of Acoustic Biomarkers*. Journal of Forensic Sciences, 64(3), 789-801.
 2. Schuller, B.etal. (2020). *Acoustic Stress Detection in Real-World Audio*. IEEE Transactions on Affective Computing, 11(2), 312-326.
 3. OpenAI (2023). *Whisper Model Card – Large-V2*. <https://github.com/openai/whisper>
 4. ISO/IEC 27001:2013 – Safety management information.
 5. General Data Protection Regulation (GDPR) – Art.32 Security of processing.
-

Note: *This document is intended to be distributed as whitepaper internally and to present VANSYNT to potential clients (insurers, law firms, transitional justice institutions) while maintaining domain neutrality.*