

I. PREPROCESSING & ALIGNMENT

YuNet 5-Point Alignment

Real-Time ONNX Face Detection
LMEDS Similarity Transform (s, θ, t)
Expansion: $s_f = 1.50 \times$ (Ear-to-Ear)

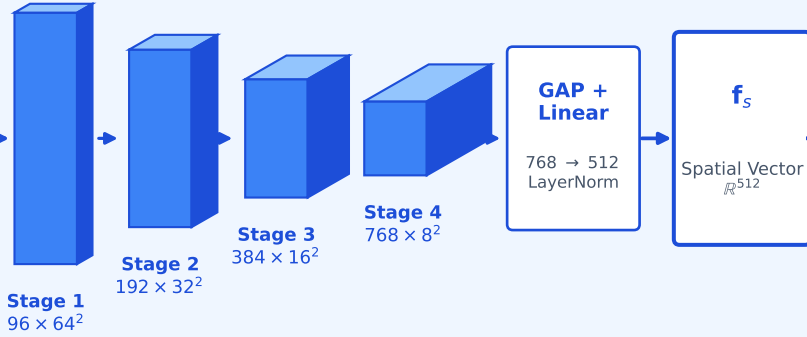
Hann Edge Tapering

Outer Boundary Windowing
 $H_{\text{taper}} = 12$ pixels Transition Band
Suppresses Cartesian Phase Leakage

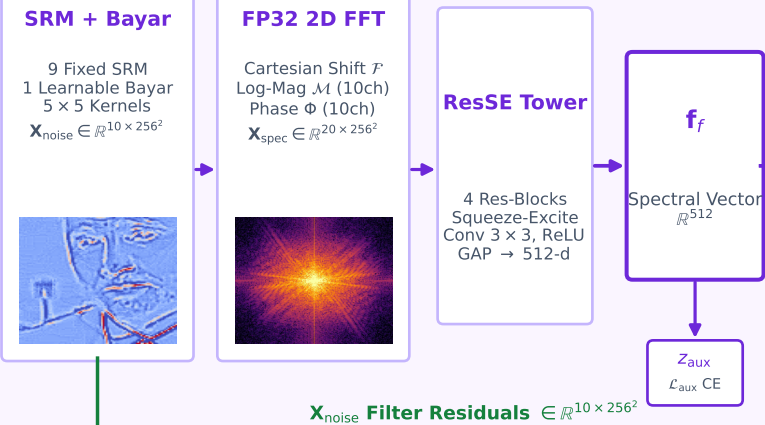


Input Face Crop I
 $\mathbb{R}^{3 \times 256 \times 256}$

II-A. SPATIAL STREAM: ConvNeXt-Small (49.8M)



II-B. SPECTRAL STREAM: ResSE Tower (2.99M)

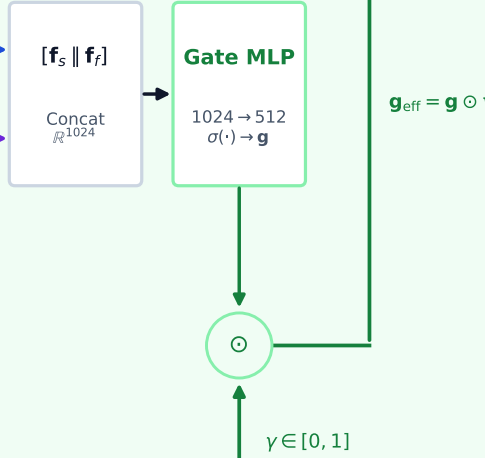


III. SNR-ADAPTIVE GATED FUSION

Complementary Feature Fusion

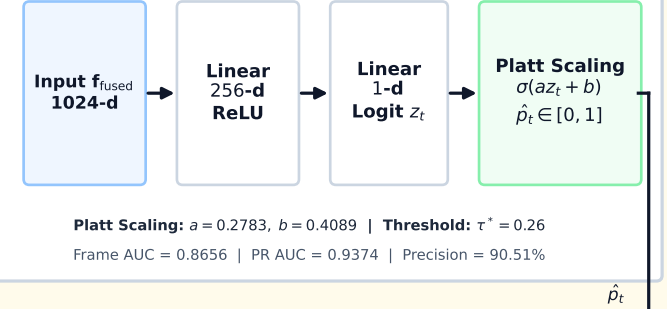
$$\mathbf{f}_{\text{fused}} = [(1 - \mathbf{g}_{\text{eff}}) \odot \mathbf{f}_s \parallel \mathbf{g}_{\text{eff}} \odot \mathbf{f}_f] \in \mathbb{R}^{1024}$$

$$\mathbf{e}_t = (1 - \mathbf{g}_{\text{eff}}) \odot \mathbf{f}_s + \mathbf{g}_{\text{eff}} \odot \mathbf{f}_f \in \mathbb{R}^{512}$$

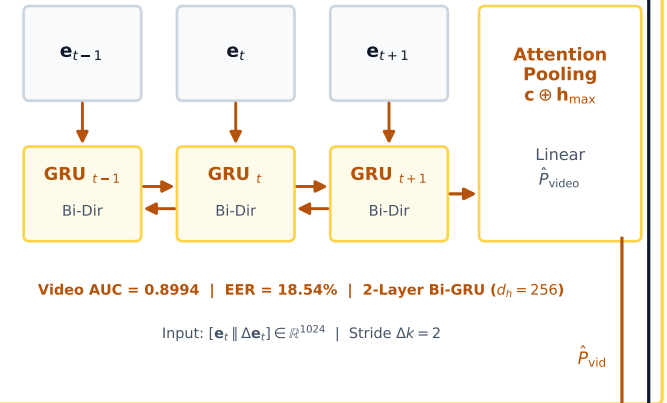


IV. FORENSIC DECISION HEADS & TRIAGE

[BRANCH A] Single-Frame Classifier



[BRANCH B] Spatiotemporal Video Bi-GRU Head



Zone 1: Clearance
 $\hat{p} < 0.40$ (46.3%)
Auto-Dismissal

Zone 2: Review
[0.40, 0.60] (5.1%)
Expert Triage

Zone 3: Confirmed
 $\hat{p} \geq 0.60$ (48.6%)
Auto-Interdict