In-Depth Technical Research Report: Fully Local On-Vehicle AI System for Driver State Detection

This report presents a deep technical research study and system design for a fully local, on-vehicle AI system capable of detecting drunk, drowsy, and asleep drivers using multimodal edge intelligence.

1. Background & Motivation

India faces a high rate of road fatalities due to alcohol impairment and fatigue. A local AI system ensures low latency, privacy, and deterministic safety decisions.

2. Driving Behavior Analysis

1. Steering entropy and overcorrection patterns
2. Lane instability via yaw and steering correlation
3. Harsh braking and throttle oscillations

3. Facial & Behavioral Analysis

1. PERCLOS and eye closure duration
2. Head pose drift and nodding
3. Yawning and gaze deviation

4. AI & ML Architecture

Hybrid CNN + Tree-based models provide perception accuracy and explainability.

5. Hardware Architecture

Tier	Compute	Purpose
Prototype	Jetson Nano / Orin Nano	Edge AI inference
Prototype	Raspberry Pi + Coral TPU	Low power vision
Production	Snapdragon Auto	Automotive-grade deployment

6. Security & Ethics

Privacy-by-design, local processing, secure boot, and Indian legal compliance are core principles.

7. Validation & Future Work

Future work includes federated learning, personalization, and V2X integration.