



AI-Driven Driver Assistance for Electric Vehicles

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Level-1 driver-assistance systems aim to enhance driving safety and comfort while keeping the human driver responsible for supervision and control. Camera-centric Advanced Driver Assistance System prototypes are attractive due to low cost and rich semantic information, but practical deployment is limited by illumination variability, obstruction, domain shifts, and real-time constraints, especially when multiple perception tasks run concurrently. This paper presents a modular ROS 2-based Level-1 driver-assistance prototype for Electric Vehicle (EV) platforms that integrates (i) real-time camera perception for road-object detection, traffic sign/light detection, and lane detection, (ii) a multi-agent decision fusion node (“Brain”) that stabilizes probabilistic outputs using temporal voting, confidence hysteresis, and rule-based arbitration, and (iii) advisory command publishing through a Controller Area Network (CAN) interface. A hybrid lane subsystem combines semantic segmentation (YOLOv8n-seg) with classical geometry (BEV transform, polynomial fitting, smoothing) to produce interpretable lane curvature and lateral offset suitable for lane-keeping assistance. Experiments in a webcam bench mode and a simulation-ready mode evaluate speed-accuracy trade-offs, end-to-end latency, jitter, and decision stability under varying scene complexity and lighting. Bench tests on an Intel Core i9 (32 GB RAM, RTX 4090) sustained 1280×720 at 30 FPS in a modular ROS 2 pipeline, with YOLOv11 traffic light detection achieving $mAP@0.5 = 0.95$ and $mAP@0.5:0.95 = 0.69$. Lane perception using a ResNet backbone (CULane subset) achieved $F1 = 60.84\%$ (Precision 70.60%, Recall 53.45%, Mask $mAP@0.5 = 52.66\%$). The findings highlight engineering considerations for Sri Lankan road contexts and motivate future work on domain expansion and repeatable scenario replay using simulation.

Keywords: Level-1 ADAS, Camera-only perception, ROS 2, Lane segmentation, CAN bus interface