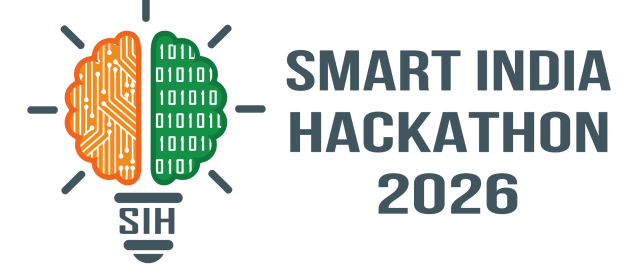


SMART INDIA HACKATHON 2026



- **Problem Statement ID – 26037**
- **Problem Statement Title-** Adaptive Path Planning and Collision Avoidance for Autonomous Vehicles on Unstructured Indian Roads
- **Theme-** Smart Vehicles
- **PS Category-** Software
- **Team ID-** 26RBU143
- **Team Name-** ZeroIQ's



For Demo and Detailed Info

For Demo and detailed Info visit Idea website : www.collisioni.tech

Collision Intelligence (C-I): Real-Time Adaptive Navigation Framework for Unstructured Indian Environments

What is C-I ?

Camera, LiDAR, and radar fusion maps drivable free space while deep learning predicts chaotic mixed traffic. Hybrid A* and NLMPC instantly replan paths, feeding straight into Simulink vehicle dynamics.

Innovation and Uniqueness

- **Graded traversability, not binary free space:** LiDAR residuals assign costs to the road surface, letting the planner steer around potholes instead of simply stopping or missing them.
- **Real imagery → runnable scenarios:** Field images become simulation scenarios using segmentation for drivable surfaces and detection for Indian road agents.

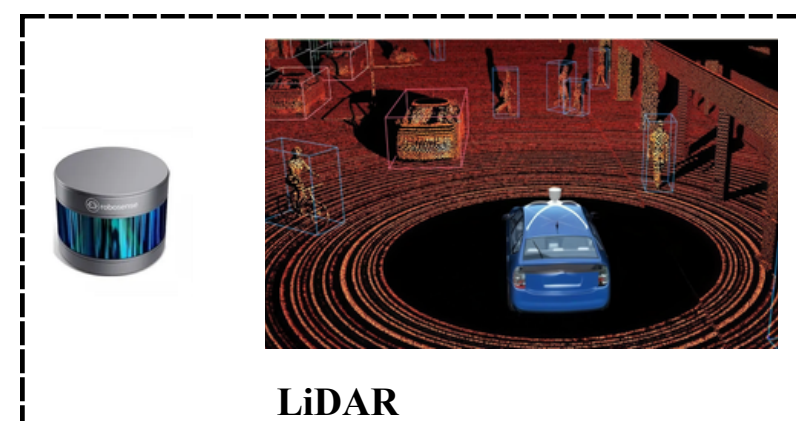
Proposed Solution:

Gaps in existing solutions

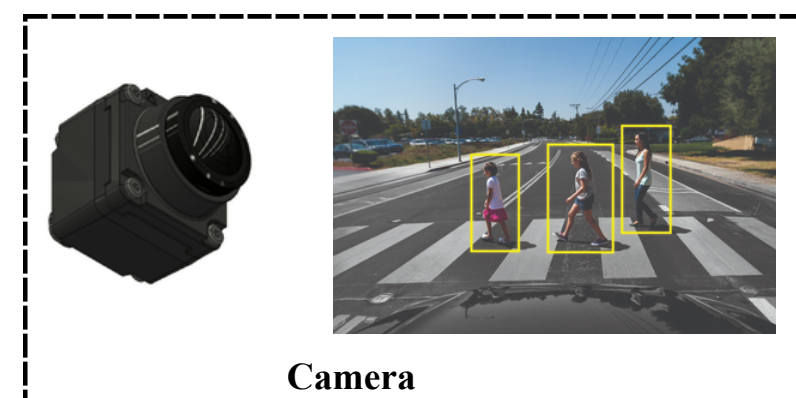
- Fail in unorganized, unstructured environments
- Depend heavily on clear lane markings
- Ignore unpredictable local driving behaviors

How it addresses the problem

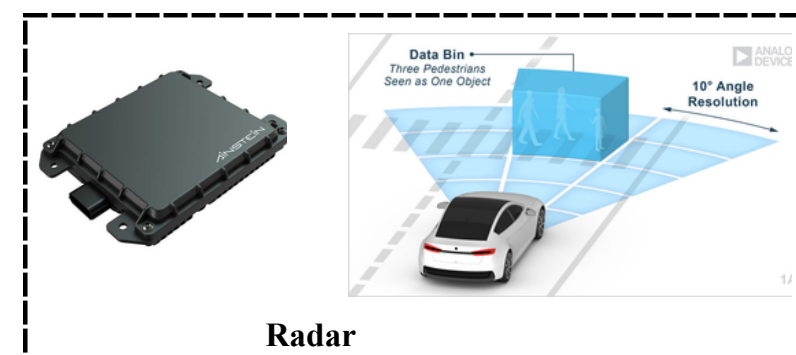
- Replans in real time
- Plans in free space, not lanes
- No single point of sensor failure
- Doesn't freeze in dense traffic



LiDAR

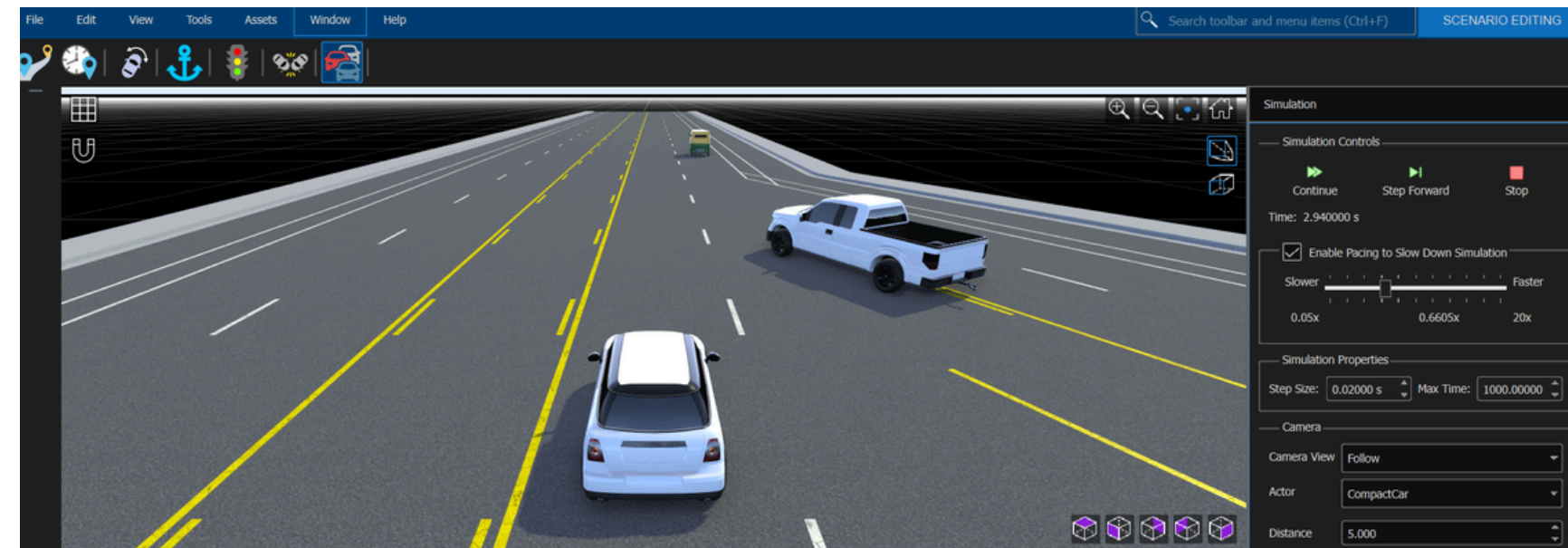


Camera

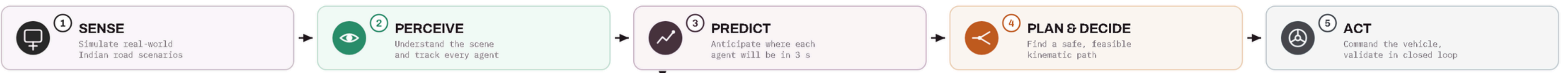


Radar

For Demo and detailed Info visit Idea website :



TECHNICAL APPROACH



FEASIBILITY

Toolchain is ready

Existing tools support detection, prediction and model training.

Training data exists

IDD provides labeled Indian traffic data for required agents.

Method is published

Hybrid A*, RSS and PointPillars are proven, peer-reviewed methods.

CHALLENGES & RISKS

Unpredictable agents

Cattle, pedestrians and two-wheelers do not follow standard motion models.

Replanning latency

High compute load can slow real-time replanning in dense scenes.

Sensor degradation

Dust, glare and monsoon rain reduce camera and LiDAR reliability.

Generalising across scenes

One model must perform well in both rural and urban environments.

MITIGATION STRATEGIES

Hybrid prediction + safety override

Use a learned GRU model with an IMM fallback; Stateflow enforces emergency stop and yield.

Seed-and-refine split

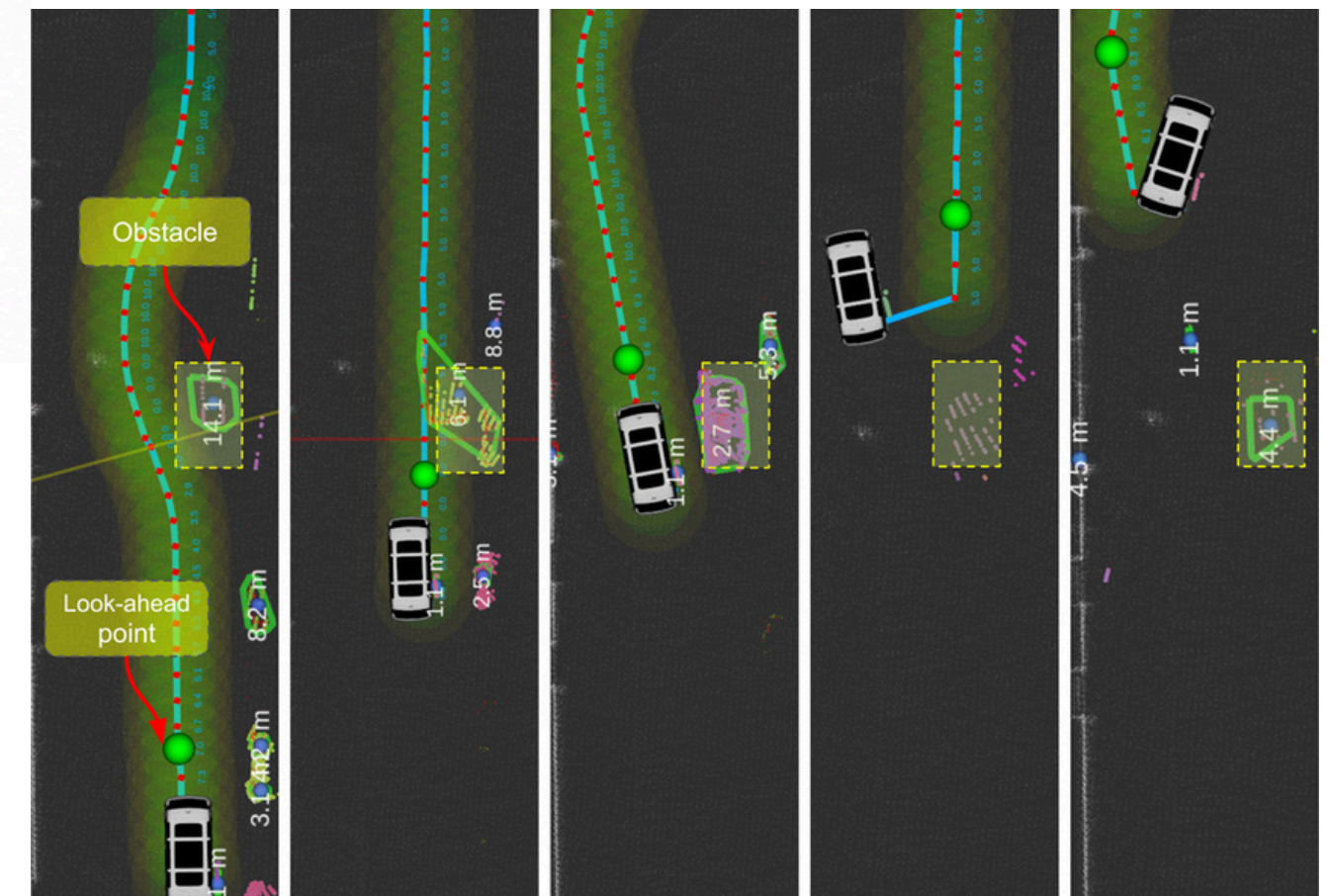
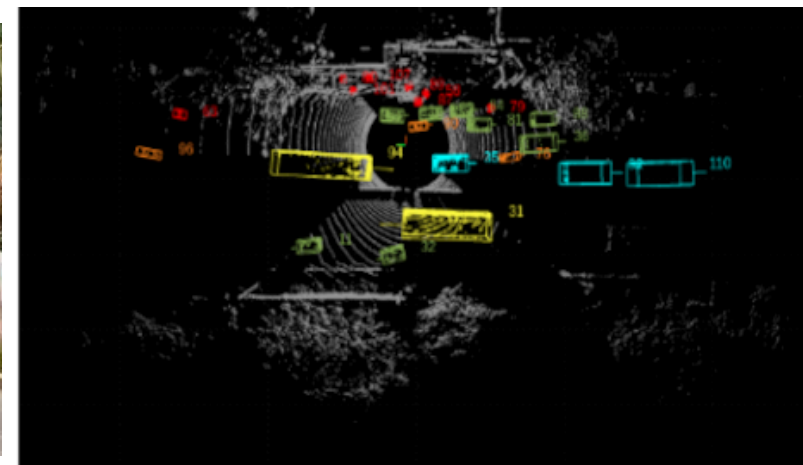
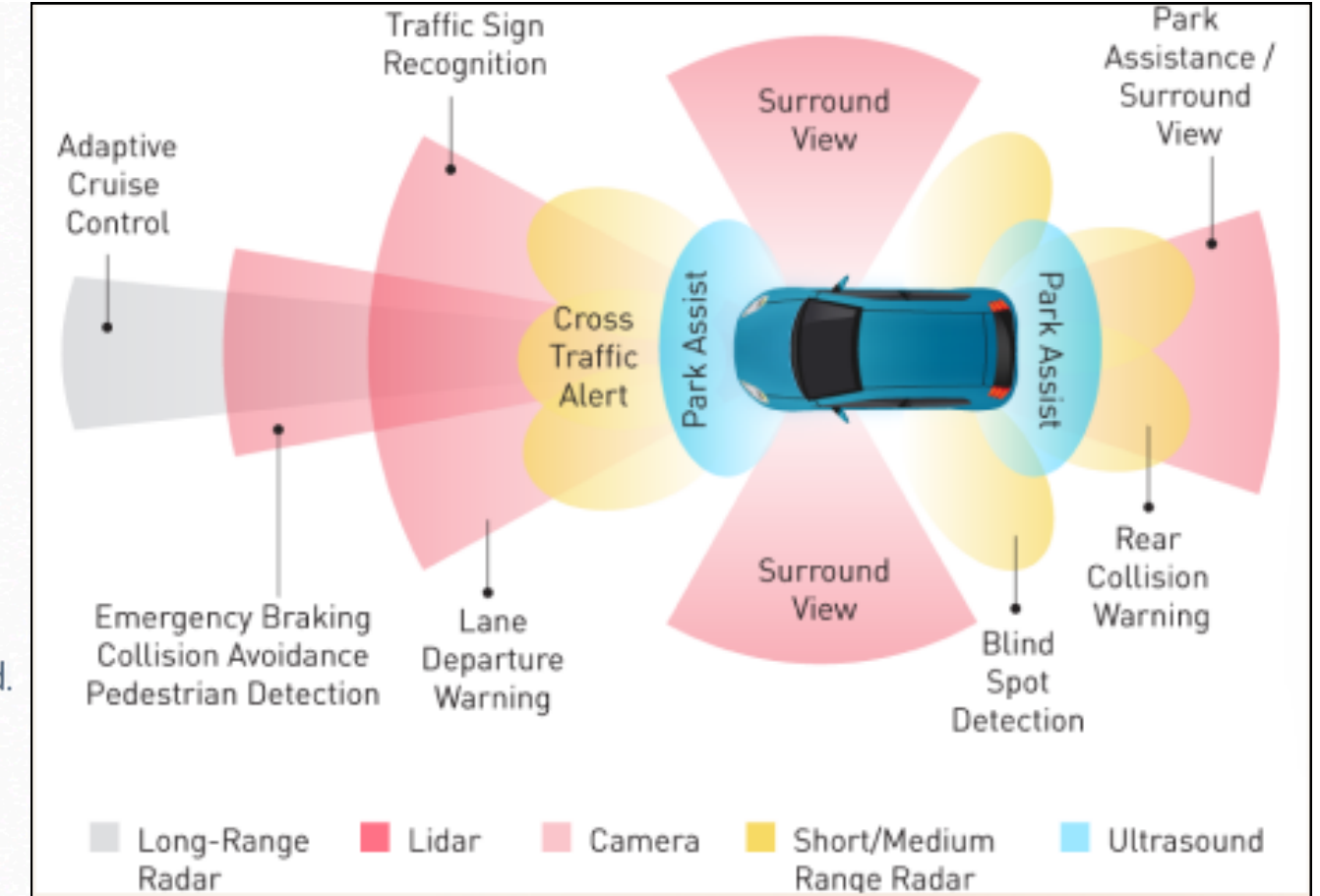
Get a fast initial plan (~40 ms) with Hybrid A*, then refine with NL-MPC (~30 ms); use a pre-computed braking corridor if needed.

Uncorrelated redundancy

Add radar (RF) alongside optical sensors to maintain perception during visual degradation.

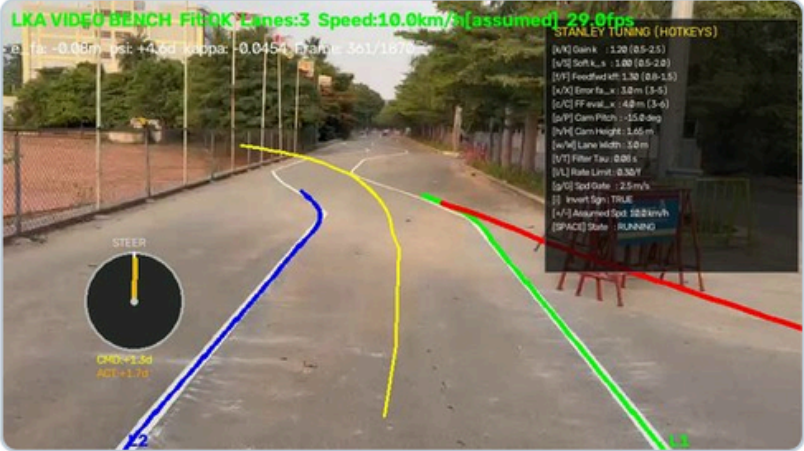
Incremental validation

Test individual scenarios, then run a Monte Carlo sweep to identify failure limits.



Dimension	Benefit	Who Gains	Practical Bottleneck
Environmental	Smooth NLMPC replanning cuts harsh-braking events - RMS lateral jerk held under 0.9 m/s ³ - lowering fuel burn per km.	Fleet operators & environment	Gains only hold if replanning stays real-time in dense traffic; heavy compute load can force conservative, less efficient paths.
Social & Safety	Wide, honest uncertainty bounds around pedestrians, two-wheelers and cattle - not confident guesses.	Vulnerable road users	Predictor is trained on IDD agent classes; rare or unseen agents fall back to a lower-fidelity IMM kinematic model.
Economic	Simulation-first validation tests high-risk cases (e.g. a cattle crossing) at zero real-world cost or risk.	OEMs, suppliers, insurers	Sim-to-real gap remains - RoadRunner scenes still need cross-checking against real Indian road data before field trials.
Adoption Pathway	Perception + prediction stack doubles as an AEB system; 5 parameterised scenarios give regulators a testable pass/fail bar.	Regulators, ADAS makers, fleets	Realistic near-term scope is constrained sites - ports, mines, campuses; open-road deployment remains a later milestone.

BUILD IN PROGRESS - VISUAL EVIDENCE



Stanley LKA, closed loop on campus
lane tracking + steering at 10 km/h



Instrumented test platform
AEB runs at the validation site

Why It Matters: Together, these four benefits build a practical adoption case - an efficiency gain fleets feel immediately, a safety case regulators can test, and a validated foundation OEMs can build on, without waiting for perfect infrastructure or unlimited compute.

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