DriveGuard

Low-Cost Smart-Safety Retrofit System for Older Cars

Final Pitch Deck | Group 16

AI driver monitoring

BLE parking sensors

Wi-Fi rear camera

Retrofit safety kit that combines smartphone-based AI, ultrasonic sensing and a rear camera to bring ADAS-like support to existing vehicles.

PROBLEM

The problem: older vehicles lack modern safety support

Safety gap

Many older vehicles do not include driver monitoring, parking assistance or modern warning interfaces.

Human factors

Fatigue, distraction and reduced visibility increase risk during both driving and low-speed parking manoeuvres.

Affordability gap

Replacing the vehicle is not realistic for many households; a modular retrofit solution is a more accessible path.

Solution: a modular safety retrofit kit

Smartphone as the central unit

Android app for UI, mode logic, GPS/IMU context and on-device AI processing.

ESP32 + 5 ultrasonic sensors

Front/rear obstacle sensing with filtered distance telemetry sent over BLE.

Rear Wi-Fi camera

AMiO/W-CAR camera used in parking mode as an external video source.

Alerts and mode management

Visual, audio and haptic feedback, with automatic switching between driving and parking contexts.

TARGET AUDIENCE

Target audience and value proposition

1 **Drivers of older cars**

Adds safety support without replacing the vehicle.

2 **Families and caregivers**

Supports safer independence for vulnerable or elderly drivers.

3 **Driving schools and fleets**

Low-cost kit for training, awareness and retrofit demonstrations.

Core value proposition

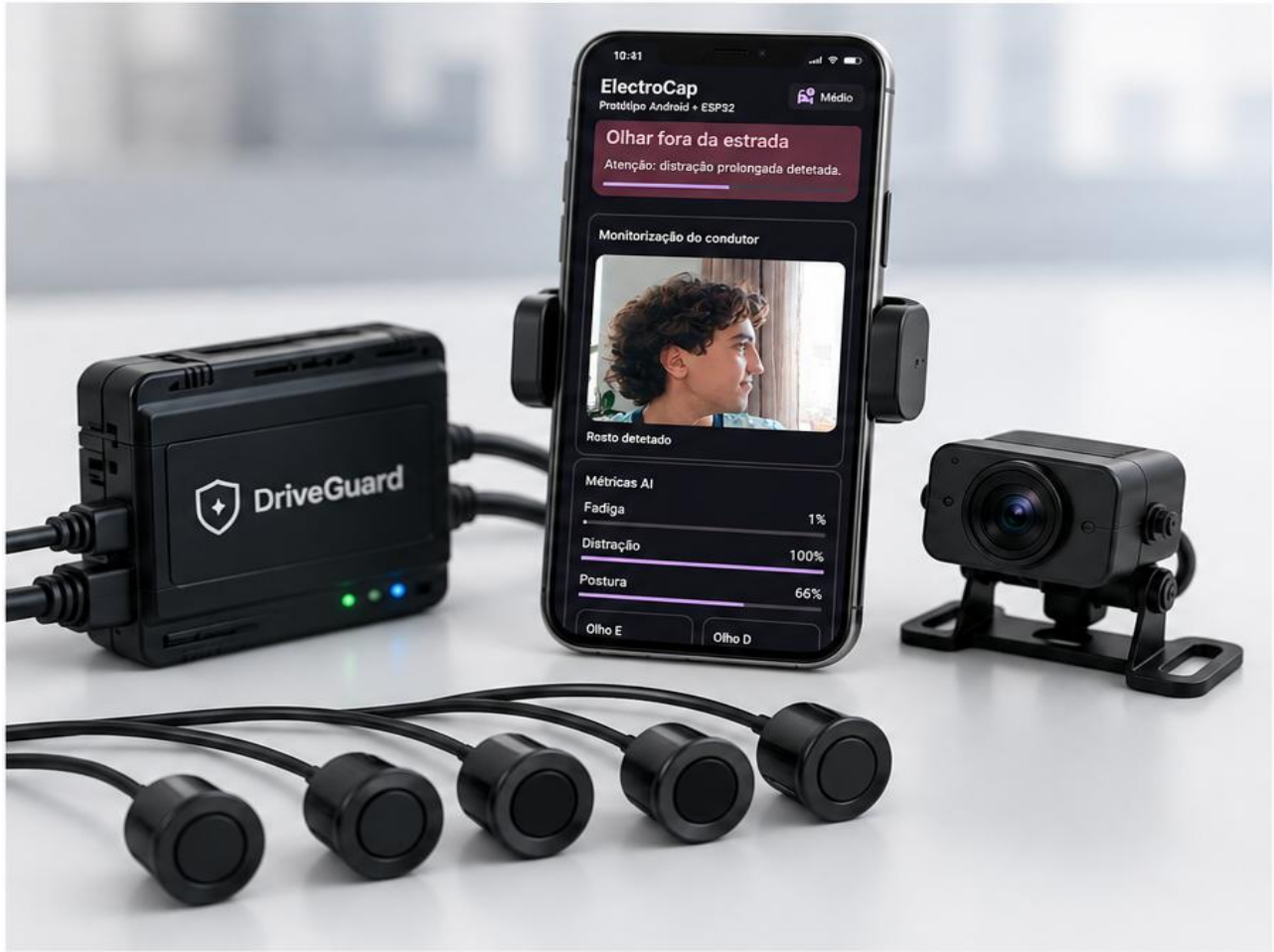
Retrofittable: no permanent vehicle modification required for the prototype.
Low-cost: uses commodity components and the driver's existing smartphone.
Modular: driver monitoring, parking sensors and camera can evolve independently.
Accessible: simple interface designed for real driving and parking contexts.

5 ultrasonic sensors

2 operating modes

1 central app

Positioning against existing alternatives



Modern ADAS vehicles

Excellent integration High purchase cost
Not available in older cars

Smartphone-only apps

Low hardware cost Phone placement affects reliability
No obstacle sensing

Wearables

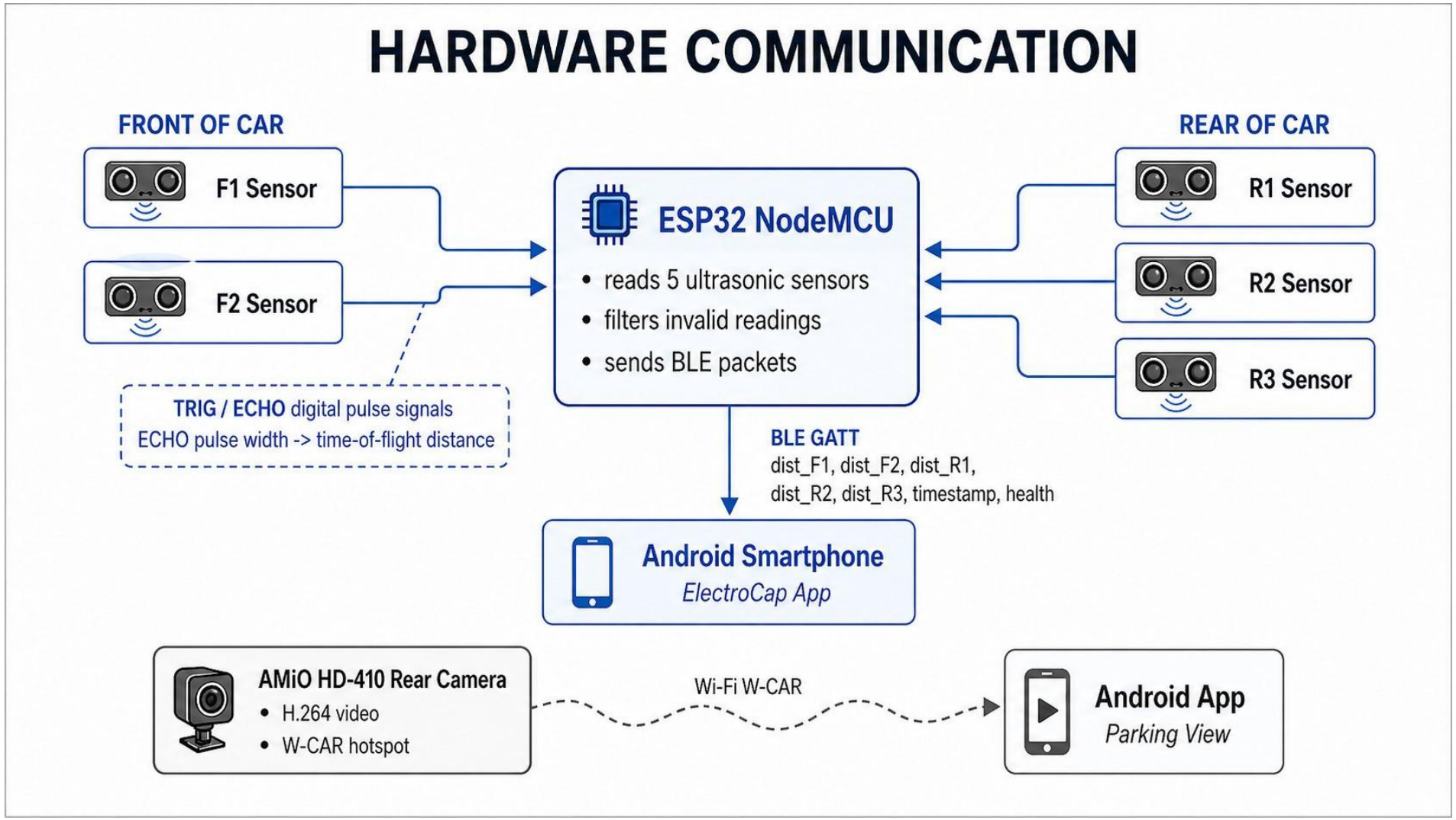
Physiological signals
Requires adoption and charging Indirect driving context

DriveGuard

Retrofit kit
AI + sensors + camera
Low-cost modular architecture

Positioning: DriveGuard aims to provide a practical middle ground: more context-aware than a smartphone-only app, but far cheaper and easier to deploy than replacing the car.

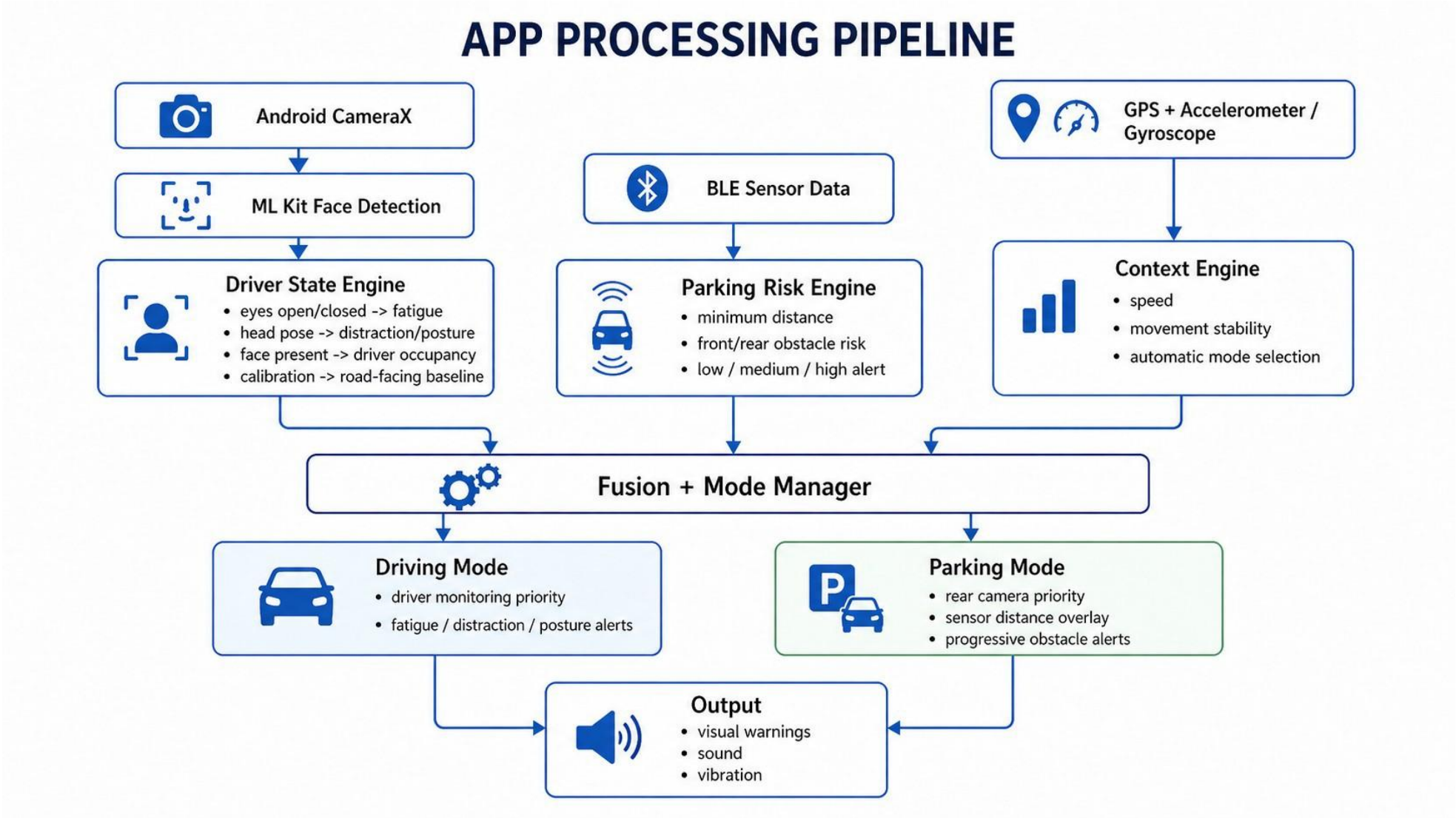
Proposed solution architecture - hardware communication



Key technical choice: BLE carries sensor telemetry while Wi-Fi remains available for the W-CAR rear camera network.

ARCHITECTURE

Android app processing pipeline



AI IMPLEMENTATION

Driver monitoring: from model outputs to risk scores

On-device AI model

Google ML Kit Face Detection
CameraX frame analysis
Runs locally on the phone

Raw outputs

Face presence
Eye open probability
Head yaw, pitch and roll

Custom scoring layer

Fatigue score
Distraction score
Posture score

Road-facing calibration

Because the phone is mounted sideways/centrally in the car, "focused on the road" is not the same as "looking at the phone". The app records a 3-second baseline of yaw, pitch and roll while the driver looks forward. Distraction is then computed from deviation relative to that calibrated road pose.

0-100
normalized risk scores

3s
road-pose calibration

local
no cloud dependency

Parking assistance: distance sensing and risk thresholds

Sensor layout

2 front sensors: F1, F2
3 rear sensors: R1, R2, R3
JSN-SR04T ultrasonic modules

ESP32 firmware

TRIG/ECHO pulse timing
Invalid readings filtered
Distances aggregated

BLE telemetry

dist_F1...dist_R3
timestamp
health/status

Risk levels use the minimum valid distance across all sensors

Safe	Low	Medium	High	Critical
> 120 cm	81-120 cm	46-80 cm	26-45 cm	<= 25 cm

Alert output escalates visually, acoustically and haptically as the obstacle distance decreases.

RESULTS

Testing and evaluation plan

Driver-state detection

Accuracy under normal conditions
False positives per hour
Latency from event to alert

System performance

CPU/battery consumption
Device temperature rise
App stability during operation

Sensor reliability

BLE packet loss/dropouts
Distance error vs reference
Parking alert response time

Planned validation protocol

Controlled driving/parking scenarios with the phone fixed in the prototype position.
Simulated fatigue and distraction events to tune thresholds and reduce false alarms.
Static obstacle-distance tests comparing ultrasonic readings against measured distances.
End-to-end demo tests: mode switching, alert escalation and clean UI operation.

Costs and benefits

Prototype bill of materials from supplied cost sheet

Component	Qty	Unit cost	Total
ESP32 NodeMCU	1	10.85 EUR	10.85 EUR
AMiO HD-410 Wi-Fi camera	1	32.55 EUR	32.55 EUR
Breadboard	1	3.99 EUR	3.99 EUR
Jumper wires kit	1	3.00 EUR	3.00 EUR
LM2596 step-down converter	1	3.44 EUR	3.44 EUR
JSN-SR04T ultrasonic sensors	5	9.14 EUR	45.70 EUR

Estimated total: 99.53 EUR

Android smartphone excluded from the hardware cost because the prototype assumes use of an existing phone.

Benefits for users

Safer driving behaviour
Improved parking awareness

Benefits for deployment

Modular hardware
Non-invasive retrofit approach

Benefits for development

Adjustable thresholds
On-device processing and privacy

Low-cost retrofit concept: the prototype hardware is designed to remain accessible while combining driver monitoring, BLE sensors and rear-camera support.

Final product

Future Product Vision

Ready-to-install retrofit kit

Universal license-plate frame design
Simple installation on older vehicles
Integrated sensors, camera and electronics

Smart connected safety system

AI-powered driver monitoring
Real-time parking assistance
Mobile app with alerts and vehicle insights

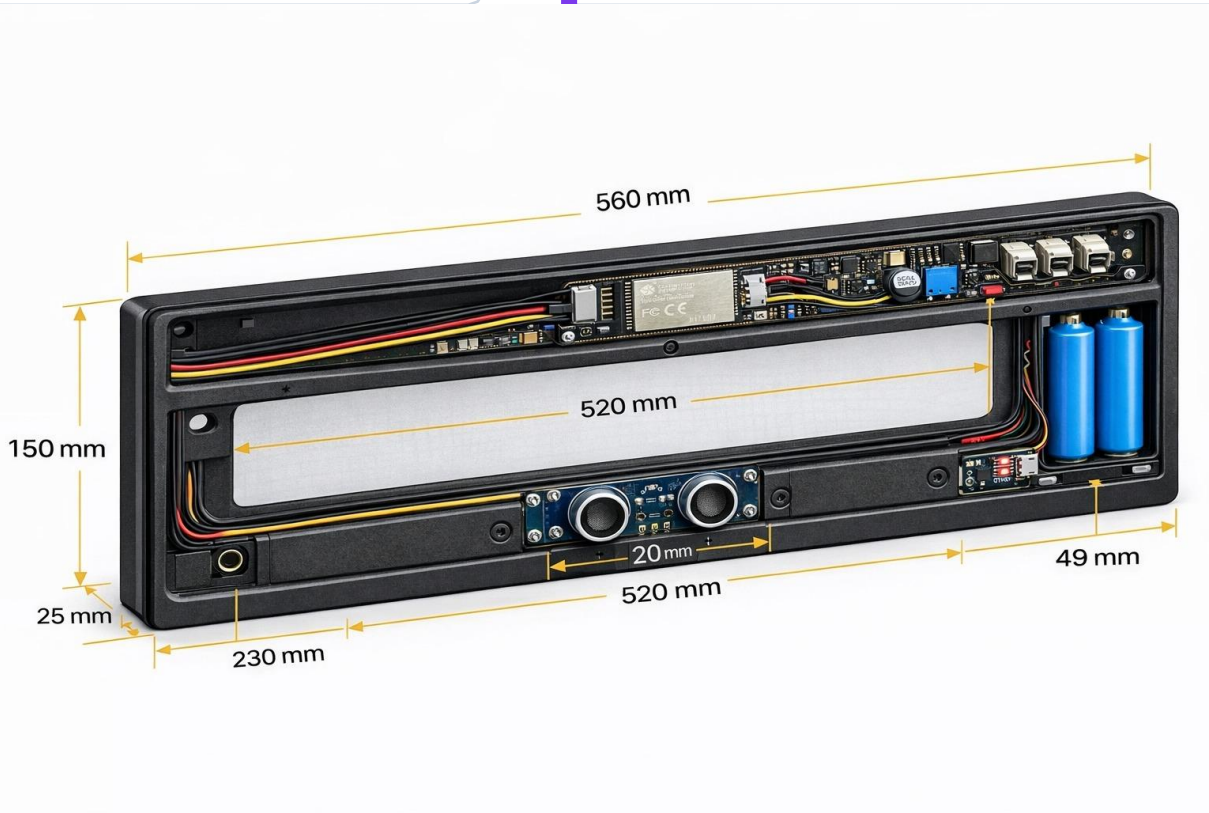
Market-ready design

Weather-resistant enclosure
Optimized power consumption
Scalable low-cost manufacturing

Future development roadmap

If developed beyond the prototype stage, DriveGuard would evolve into a commercial retrofit safety system for older vehicles. The final product would integrate sensors, a rear camera and embedded electronics into a compact license-plate frame.

Future work would focus on improving reliability, refining AI features and validating the system through real-world testing, creating an affordable and accessible safety solution for older cars.



TEAM

Team and individual contributions

Tomás Soares

System architecture, Kotlin/MVVM integration, app architecture

Martim Basso

ML Kit integration, driver monitoring, model optimization

Gabriel Rodrigues

ESP32 communicati on, sensor acquisition and filtering

Gabriel Domingos

App interface design, alerts and accessibility adjustments

Pedro Carvalhosa

Risk score algorithm, sensor fusion and alert escalation

António Mota

Testing strategy, validation metrics and field-test planning

Working model: parallel development of Android app, AI pipeline, ESP32 firmware, sensor fusion and validation.

CLOSING

Project links

Access the supporting material for the final evaluation and ElectroDay demonstration.

DriveGuard demonstrates a practical path to make existing cars smarter and safer through a low-cost, modular retrofit kit.