A machine learning based rolling resistance prediction model for Electric Vehicles

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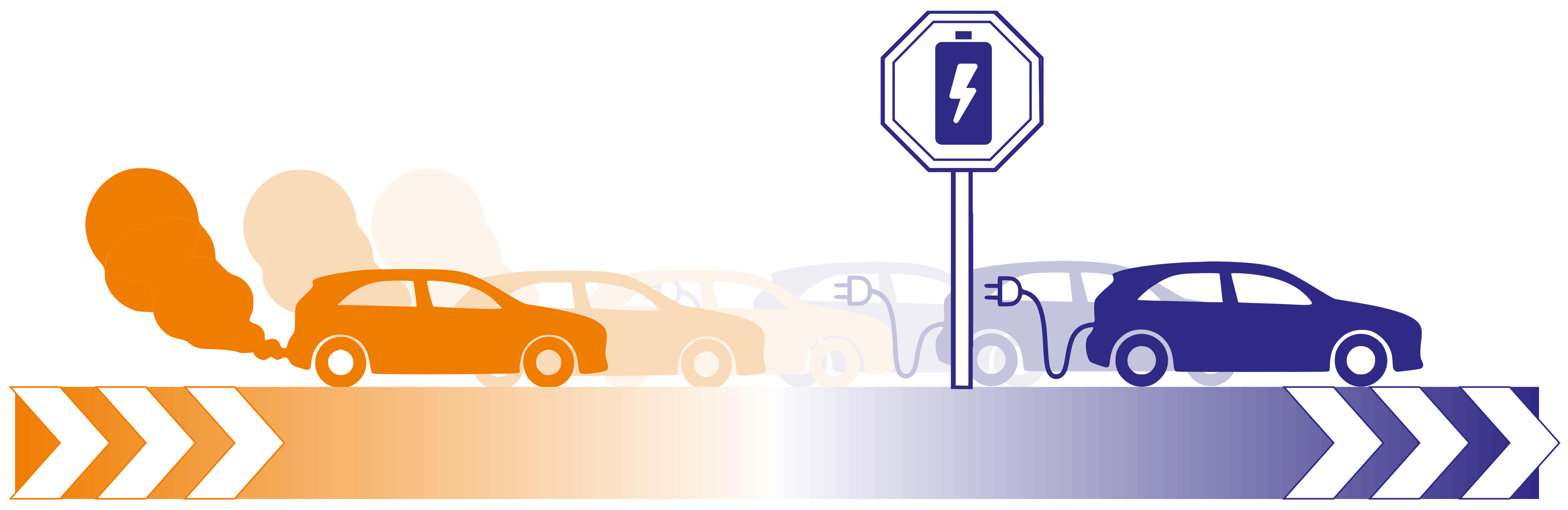
Introduction



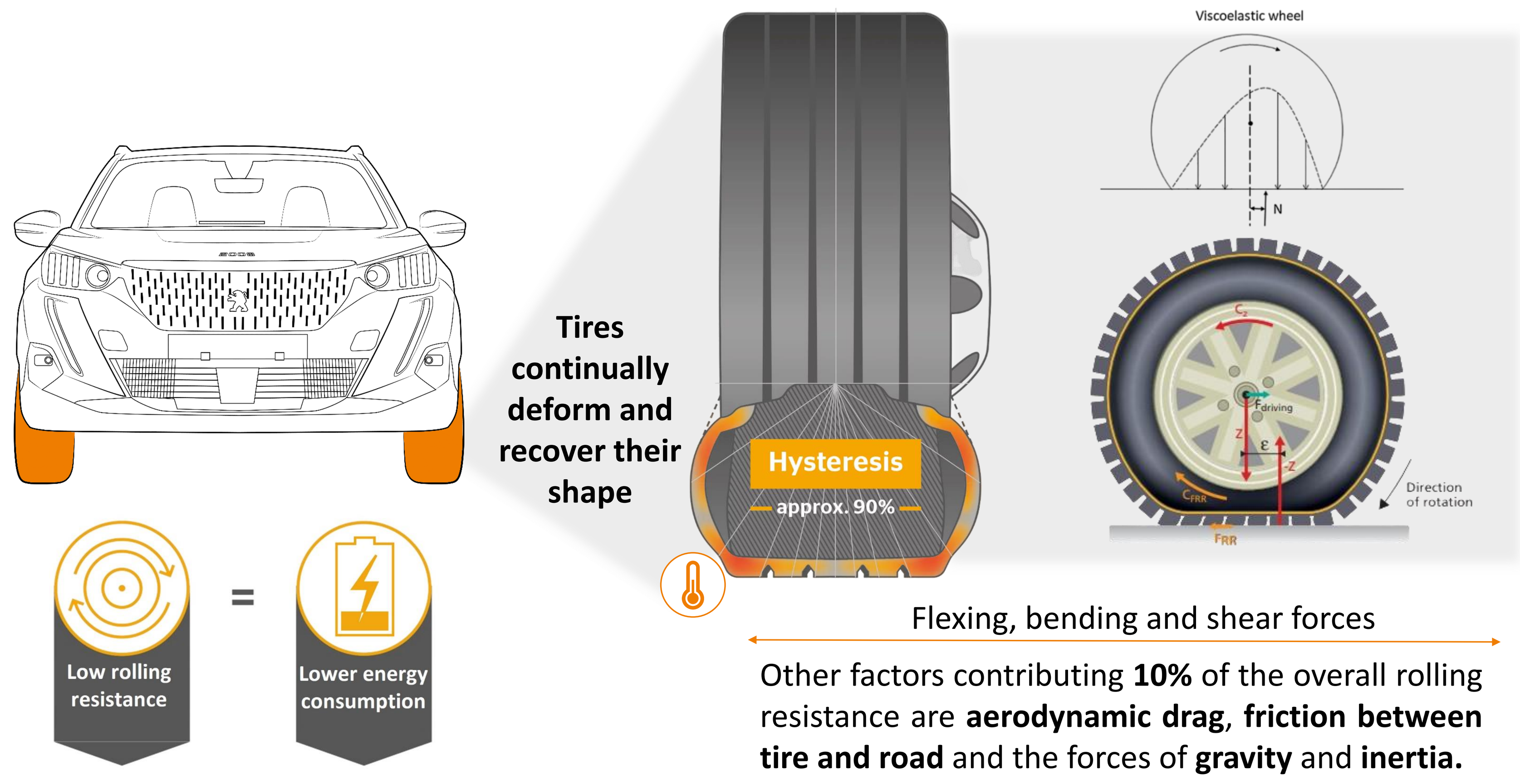
- **Rolling Resistance** accounts for up to **30%** of a vehicle's energy consumption [1].

Key Factors [2]

- **Pavement**'s structural and functional characteristics (roughness, texture, stiffness, temperature).
- **Tires**' structural and performance properties (tread characteristics, temperature, pressure).
- **Vehicle**'s structural and performance properties (suspensions, load, load distribution, speed).

What is Rolling Resistance?

- The energy consumed by a tire per unit of distance covered [3].



Other factors contributing **10%** of the overall rolling resistance are **aerodynamic drag**, **friction between tire and road** and the forces of **gravity** and **inertia.**

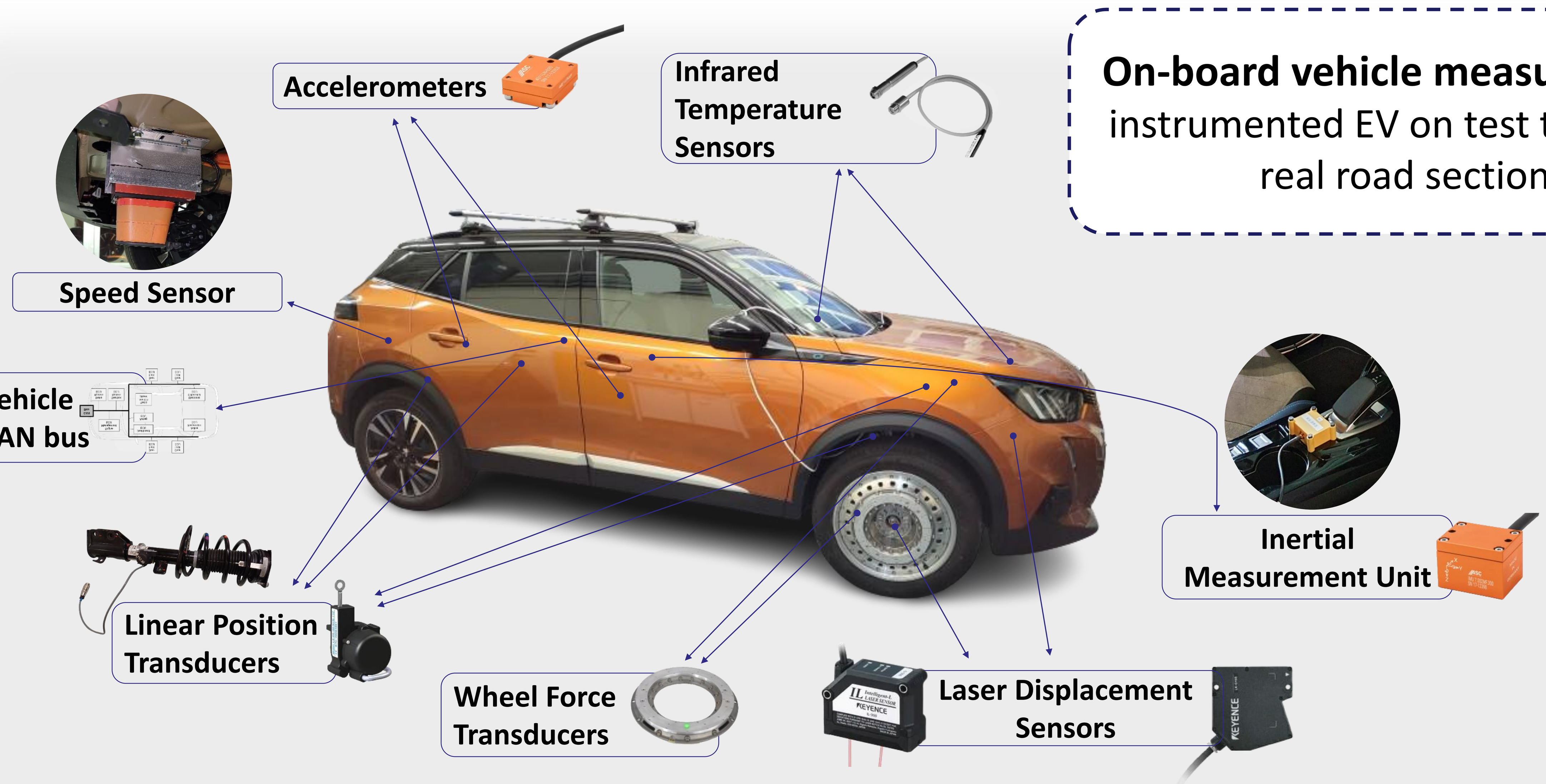
Knowledge GAP

- Few studies on rolling resistance concerning Electric Vehicles (EVs).
- Effect of increased EVs' torque and weight on rolling resistance.
- No models available to estimate rolling resistance for EVs.

Objectives

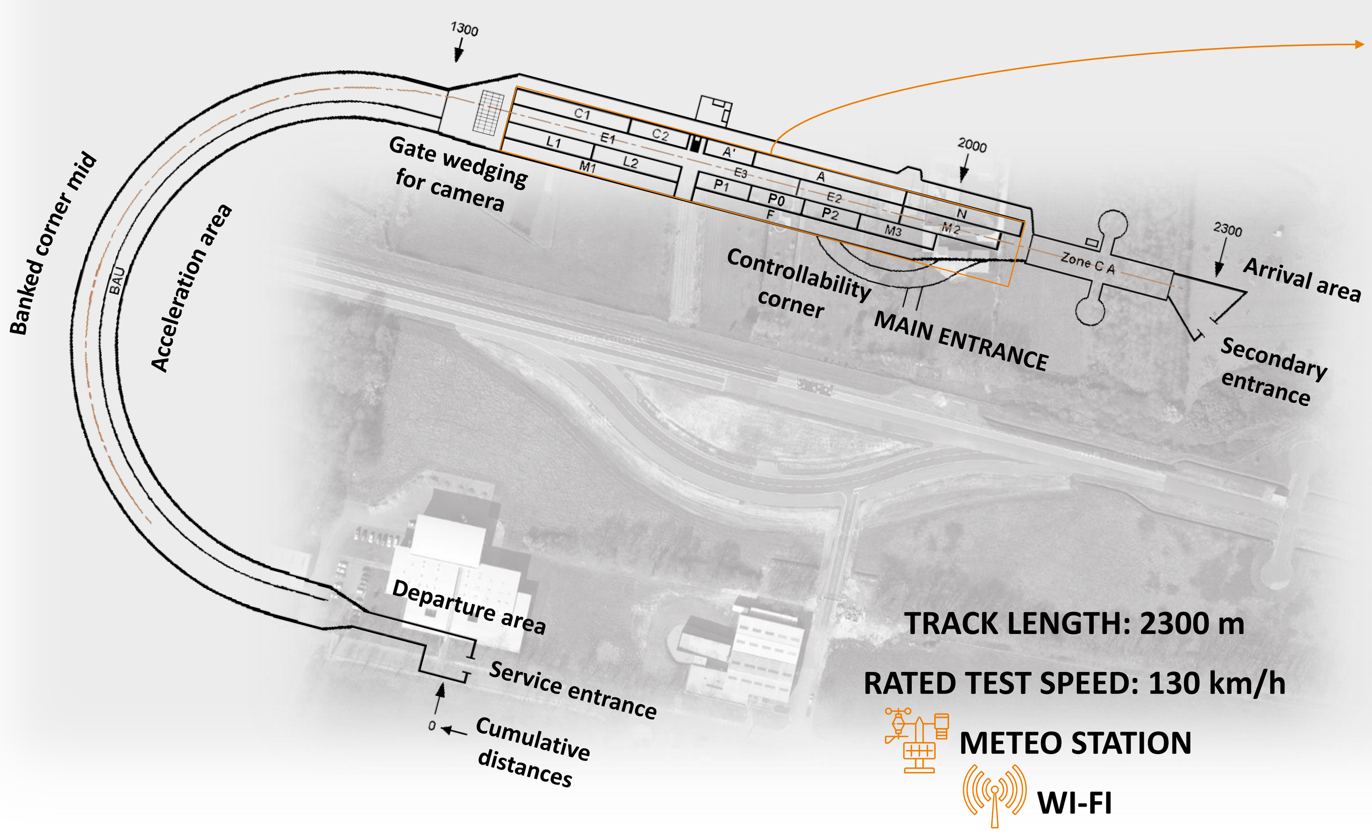
- To develop a data-driven rolling resistance prediction model for EVs.
- To assess the potential of Machine Learning for rolling resistance estimations.

Methodology



On-board vehicle measurements: instrumented EV on test tracks and real road sections

- Rolling resistance forces in the tire-road contact area
- Tires temperature and deformation, suspensions behavior
- Pavement characteristics (IRI, MPD)
- Vehicle speeds and accelerations



TEST BOARDS AREA: 700 m

A'	Coarse surface dressing 8/10
A	Porous asphalt concrete 0/6
N	Porous cement concrete
E1	Dense asphalt concrete 0/10 (new)
E2	Dense asphalt concrete (old)
M2	Very thin asphalt concrete 0/6, cl.2
L1	Epoxy resin (smooth)
L2	Sand asphalt 0/4
M1	Very thin asphalt concrete 0/10, cl.1
F	Colgrip surface dressing 1/3 bauxite

Training of a Machine Learning model: multi-step approach

DATA MINING

DATA COLLECTION

Test plans including variations in:
- Vehicle speed.
- Road pavement sections.
- Tire inflation pressure.

DATA PREPARATION
- Data filtering.
- Data cleansing.
- Data transforming.
- Data reduction.
- Data splitting.

MODEL DEVELOPMENT

MODEL TRAINING
- Algorithm selection.
- Learning through training dataset.

MODEL EVALUATION
- Validation through testing dataset.

MODEL IMPROVEMENT
- Tuning algorithm parameters.
- Monitoring and maintenance.

Expected Outcomes

- Outdoor testing procedure to measure rolling resistance for EVs.
- Rolling resistance prediction model based on vehicle's dynamic states, tire features and pavement characteristics data.

References

[1] U. Sandberg, U. Hammarström, R. Karlsson, J. A. Ejsmont and A. Bergiers, "MIRIAM: Rolling resistance-Basic information and State-of-the-Art on measurement methods". 2011.

[2] Cerezo V., Santos J., Bouteldja M., Potier X. "Relationship between driving conditions, pavement characteristics and rolling resistance". In : The 9th Symposium on Pavement Surface Characteristics (SURF2022). Milano, Italy, 2022.

[3] Michelin, "Le pneu Résistance au roulement," 2003.

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