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Multi-Objective and Muti-Scenarios Control Methodology:
Application to Car Lateral Control Synthesis

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Financement

Thèse Cifre ANRT
Renault – IMT Atlantique

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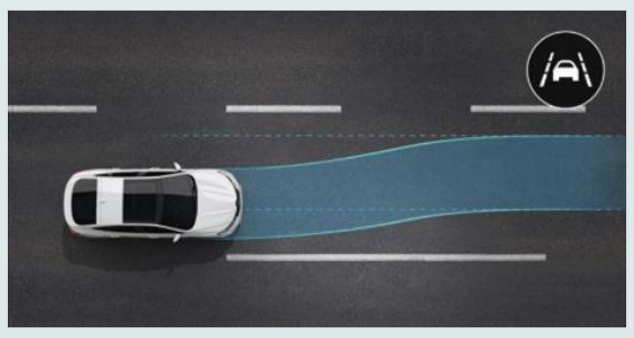
Contexte

The Tuning of ADAS's Control Laws

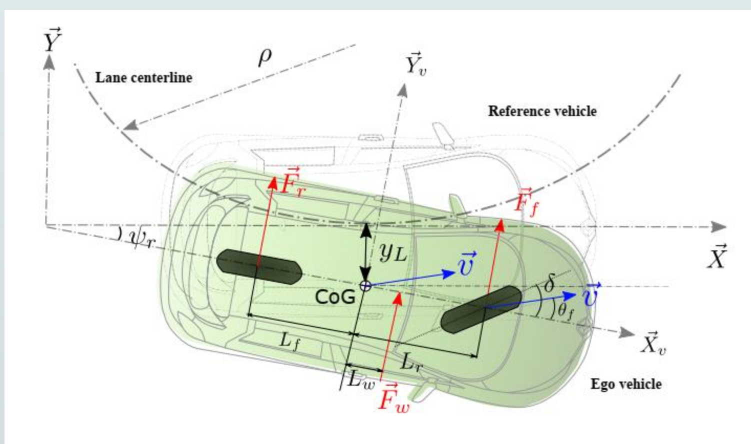
- **Ensure safe and efficient behavior:** for public acceptance
- **Tuning criteria:** efficiency, comfort, safety, consumption, stability robustness
  - What is the right trade-off ?
- **1 tuning:** for each vehicle and each configuration
  - Long process

Methodology

LCA: Lane Centering Assistance



Vehicle model



Service

- Conversion of service's specifications to criteria usable by an optimization algorithm

Comfort
- Lateral Jerk
- Steering Jerk

Performance and Robustness
- Lateral Error
- Robustness Margin

Synthesis Algorithms

- Multi-objective and multi-model optimization in a framework
- No analytical solution
- Non-convex and non -smooth problem

Use of Non-Smooth Algorithms

Non-convex: local minimums

Non-smooth: the gradient does not exist at every point, leading to difficulties in defining the descent direction.

Objectives

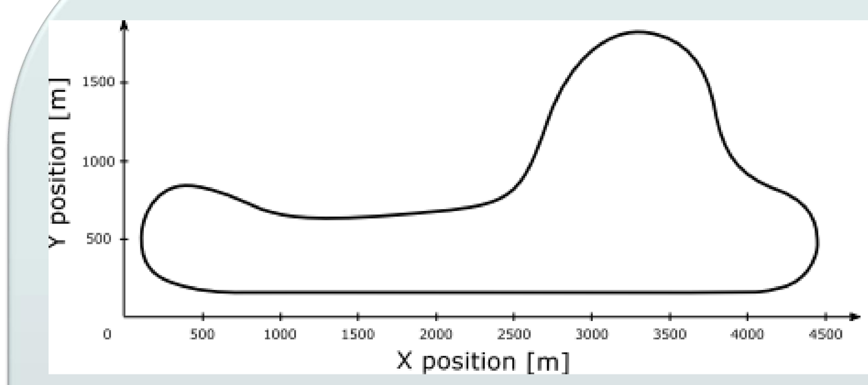
Reduce time of ADAS tuning

- Give the designers a 1st synthesis insuring a certain level of stability and performance.
- Establish linkage between tuning parameters and performance criteria to facilitate understanding of calibration and retouching.
- Design a generic method to quickly adapt to different configurations and models.

Optimize the performance

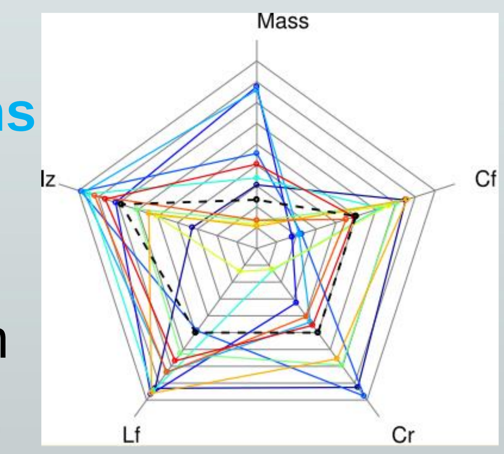
- Use of multi-objective optimization algorithms based on simple criteria.
- Manage more nominal cases for a controller (to limit the size of the embedded software).

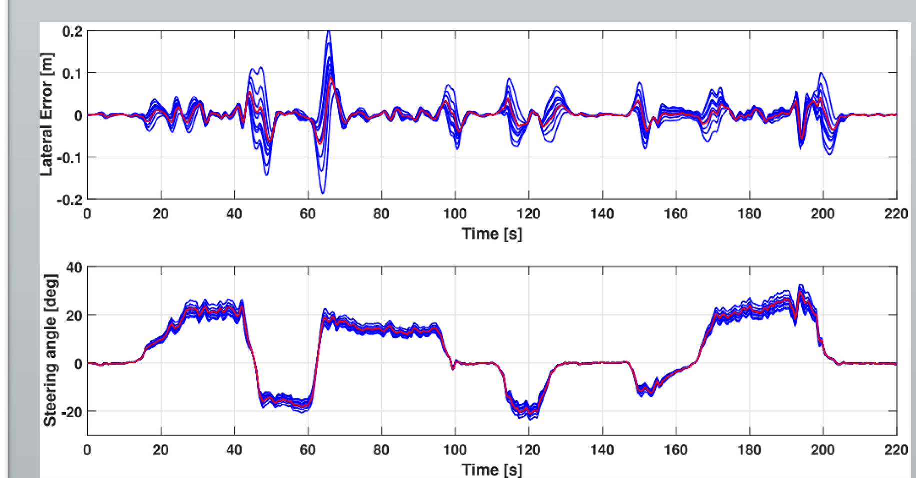
Results



- **Simulations based on real tracks**

- **Dispersion of uncertain parameters for the simulations**
  The black dashed line represents the nominal values. Each parameter varies between +/- 20% from its nominal value.





- Lateral error
- steering angle
- 10 random sets of uncertain parameters (blue) and of the nominal one (red).

Conclusion

A methodology to design a LCA, which structure is constrained according to engineering specifications is presented. Convenient indicators, closely linked to practical specifications are used in the optimization process in order to keep a physical signification. What we call a multi-scenarios approach is to consider performance with regard to different cases of use, *e.g.* curves or gusts of wind. Finally, parametric uncertainties are explicitly taken into account by using multi-model synthesis.

13 Octobre 2022 Colloque IMT « Les sciences de l'information au service des nouvelles mobilités »