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Accident avoidance by active intervention for Intelligent Vehicles

Driver Steering Override (DSO) Strategies for Steering based Active Safety Systems

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Presentation Outline

- Introduction
- DSO Strategy Objectives
- Description of DSO Strategies
- Results
- Conclusions

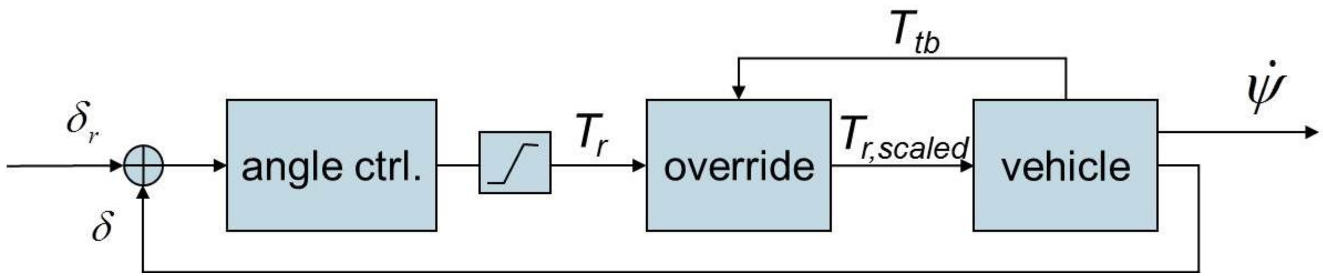
Introduction

- A Driver Steering Override (DSO) strategy evaluates the driver's interaction with the autonomous steering system and modulates accordingly the level of intervention.
- This paper evaluates two different DSO strategies.
- The paper focuses on one type of Lane Keeping Aid (LKA) system for prevention of undesired lane departures (using an EPAS).

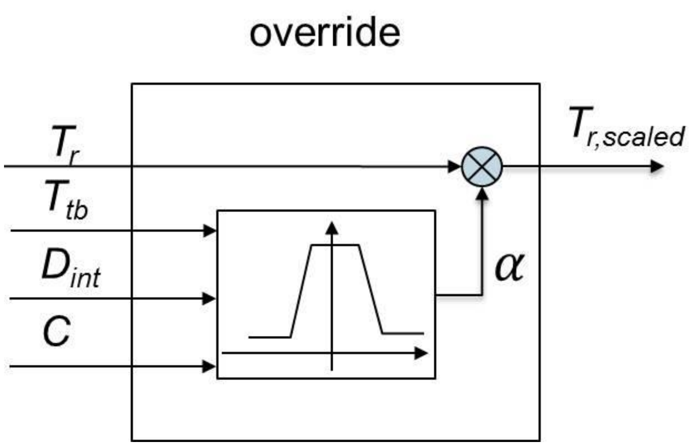
Driver Steering Override (DSO) Strategy Objectives

- A DSO strategy needs to:
  - Assure system benefit whenever the LKA intervention is required, and also
  - Make the system behaviour consistent to a set of scenarios (e.g. driving on the outside of a curve and on straight roads)
- …..while:
  - Dealing with specific situations (curve cutting, obstacle avoidance involving lane departure).
  - Offering acceptable “steering feel”.
  - Dealing with effects of autonomous steering due to faulty sensor data.

Description of Studied DSO Strategies

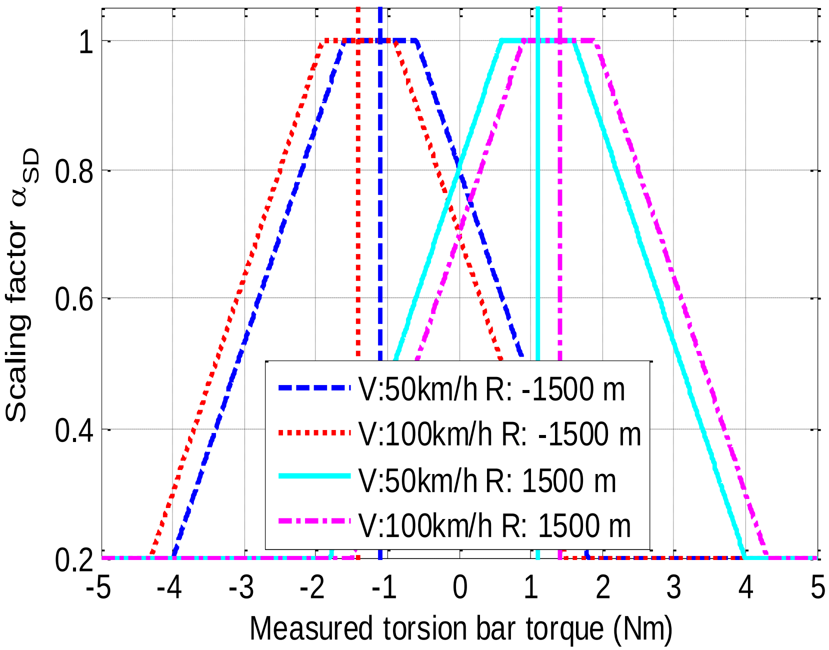


- The DSO-algorithm calculates a scaling factor (α).
- A torque saturation block is needed for scaling to have effect.
- D_{int} and curvature (C) is used to determine in- or outside of a curve.
- T_{tb} is measured torsion bar torque.



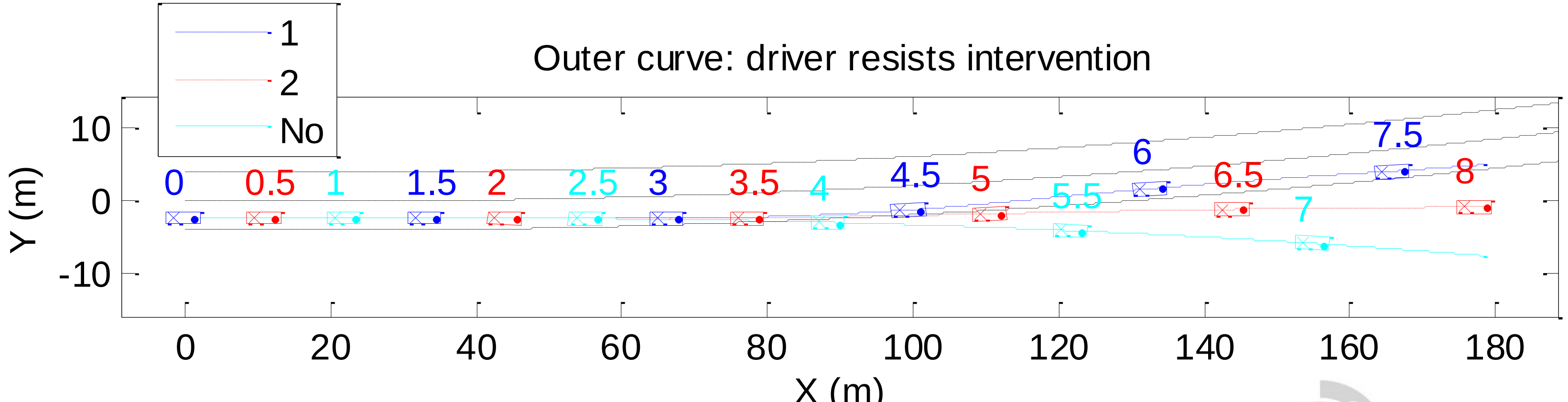
DSO Strategy - No. 2

- Similar "fundamental scaling".
- Added fade out functionality.
- Override scaling is given by:
  - $\alpha = \alpha_{SD} * \alpha_{FO}$
- Intervention logic is determined by 8 states distinguishing between (decision classes):
  - *Inner* our *outer* side of curve.
  - Driver is using *less* or *more* torque than expected to negotiate the curve.
  - Driver is *resisting* or *complies* with intervention.



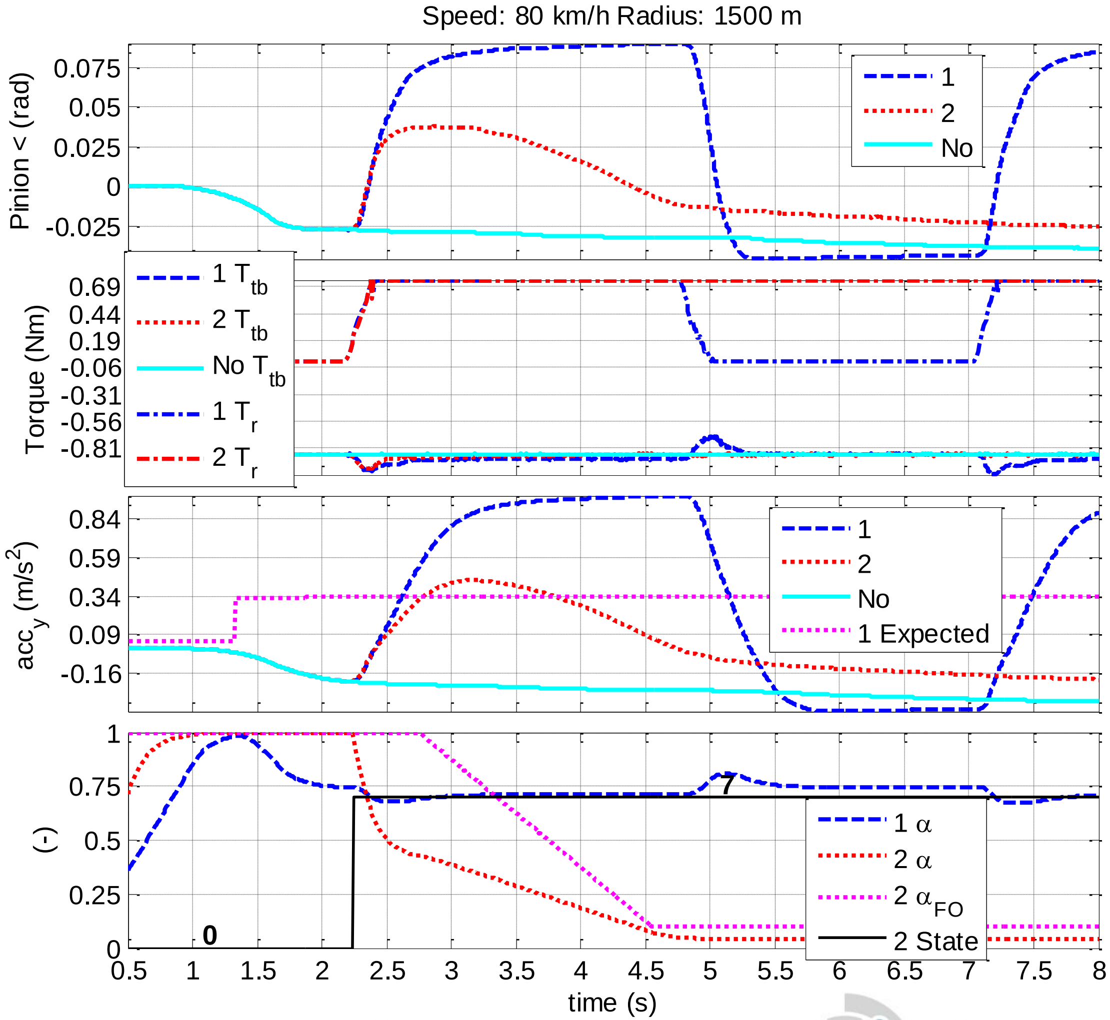
Simulation Results

- Three different scenarios has been simulated in “Volvo Car’s Traffic Simulator” in Matlab/Simulink (a 7DOF Volvo S60, non-linear tires, and sophisticated EPAS system model).
- One scenario is presented here where the driver is:
  - driving at the outside of a curve
  - resisting the intervention (i.e. steering outwards)
  - Driver is steering less than expected.
- No.2’s state decision: scale down and fade-out the intervention (driver wants to steer outwards)

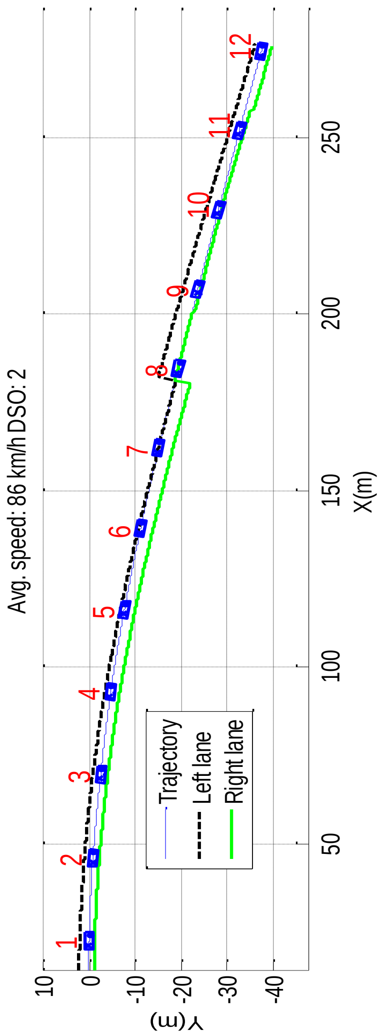


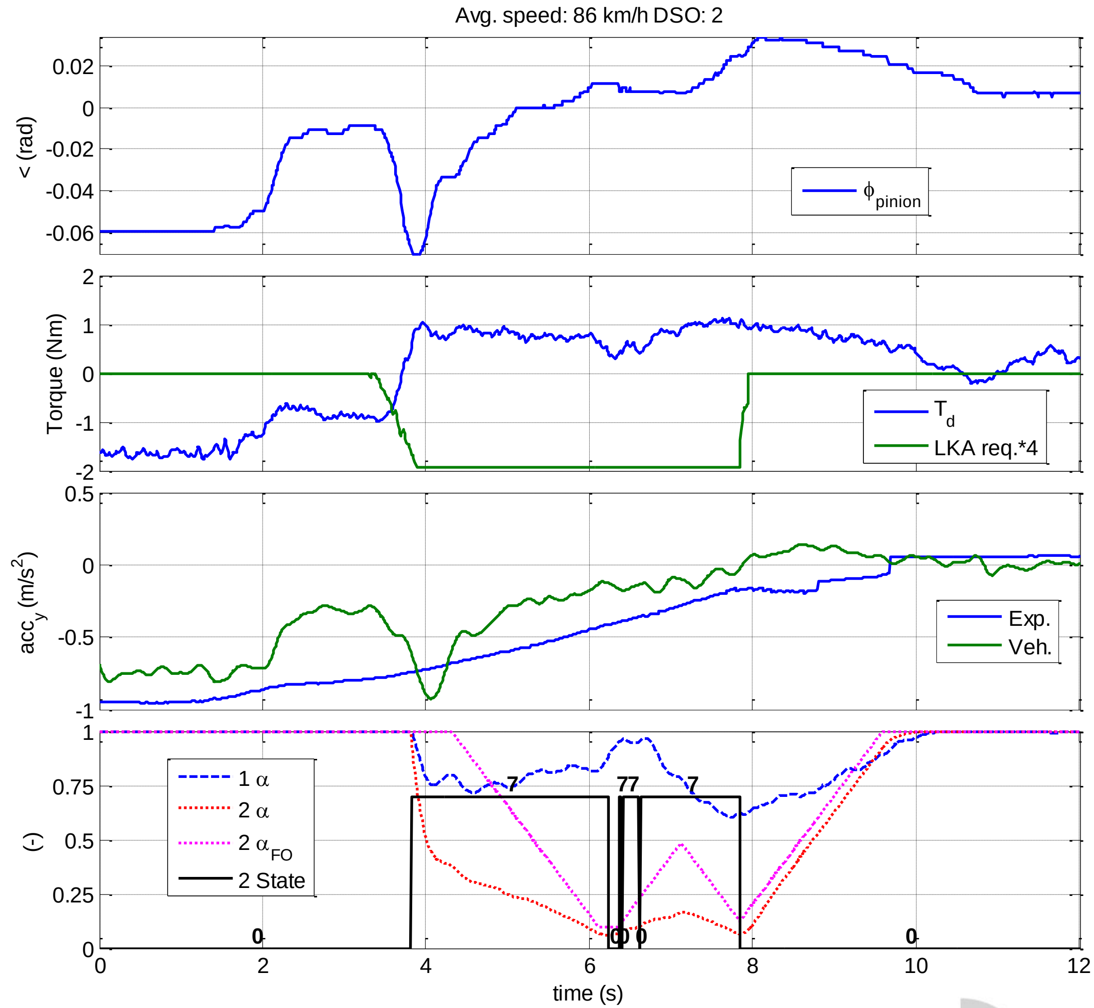
Simulation Results

- Figure compares the effects of:
  - No.1 vs.
  - No. 2 vs.
  - "no LKA"
- The main difference is due to the fade out logics (driver is resisting persistently).
- Strategy has clear impact on vehicle trajectory.



Experimental Data





Conclusions

- Both strategies cope with the DSO strategy objectives, manifested for example by:
  - Keeping the vehicle near the intended path when the driver is not “deliberately resisting”.
  - Providing steering feedback without discontinuities during driver/system interactions
  - Handling specific situations like deliberate curve cutting etc.
- The override strategy has a decisive influence on the LKA benefits, depicting therefore the need for careful design and rigorous testing
  - Balancing between “performance” (No.1) and “comfort” (No. 2) is necessary.

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Thank you.

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SEVENTH FRAMEWORK PROGRAMME

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