Motion control for autonomous semi-trailer trucks on low-friction roads

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Motivation & Research goals

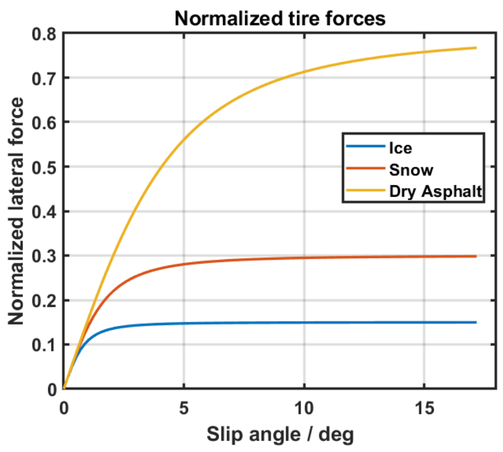
Autonomous driving of semi-trailer trucks in northern countries need to handle challenging weather- and road conditions. Snow and icy roads especially can cause

- Longer acceleration and deceleration distances
- Increased risk of jackknifing
- Increased risk of trailer swing

The aim of this project is to investigate and develop methods for motion control that enable safe and performant operation of semi-trailer trucks in these challenging conditions.

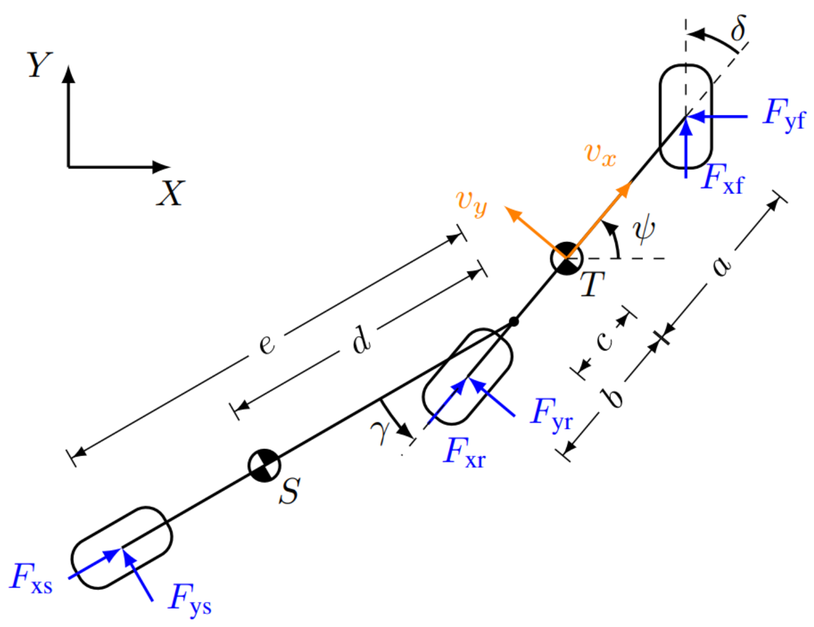
Methods

Snowy and icy roads are challenging because the low friction between tire and road limits the tire forces available for traction and steering. The limits are commonly modelled as a *friction ellipse* or circle. Understanding how the control inputs relate to tire force limitations is critical.



In our work we leverage model predictive control, allowing us to:

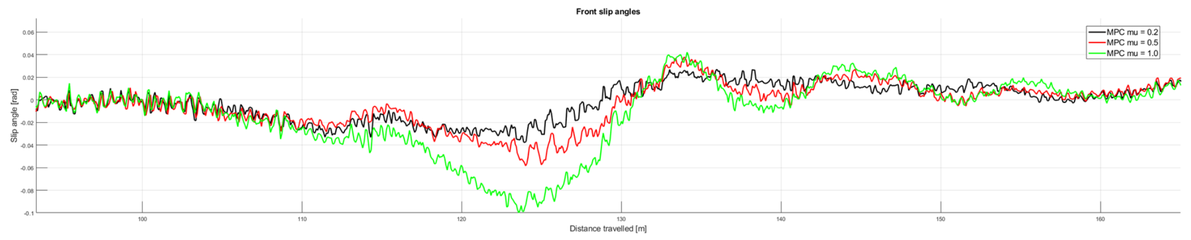
- Predict and optimize the vehicle motion, using models that capture the complex behavior of semi-trailer trucks.
- Incorporate safety constraints that ensure model validity and keep the vehicle in a safe range of operation.



Testing

In winter/spring 2024 we conducted initial experiments with a rigid truck at winter test tracks in northern Sweden. For motion control, a friction-aware MPC for lateral control was tested.

By introducing a friction-scaled slip angle penalization term in the MPC cost function, we could drive on ice.



AllDrive

The AllDrive project is a collaboration between industry and academia, with the goal of performing **autonomous driving** on **low friction roads**. The project is separated into three focus areas, with one PhD project each:

- Friction estimation and sensor fusion (LTU)
- Friction aware motion planning (KTH)
- Friction aware motion control (KTH)

The participants in the project from the industry side are Scania and Klimator, and from the academic side, KTH and LTU. The project is funded by Vinnova through the Strategic Vehicle Research and Innovation fund (FFI), Scania and Klimator.

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