Estimation of Tire Forces and Torques via Nonlinear Suspension Models and Optimal Control

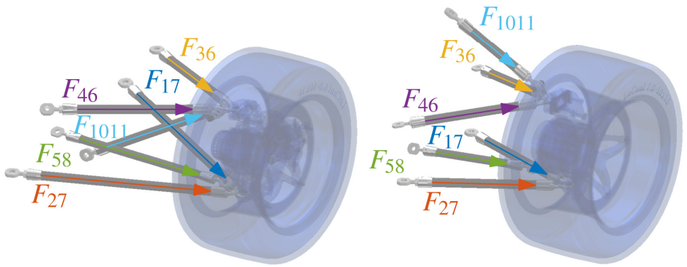
Motivation

Scaling tire loads to real operating conditions

Image courtesy of E-Agle Trento Racing Team

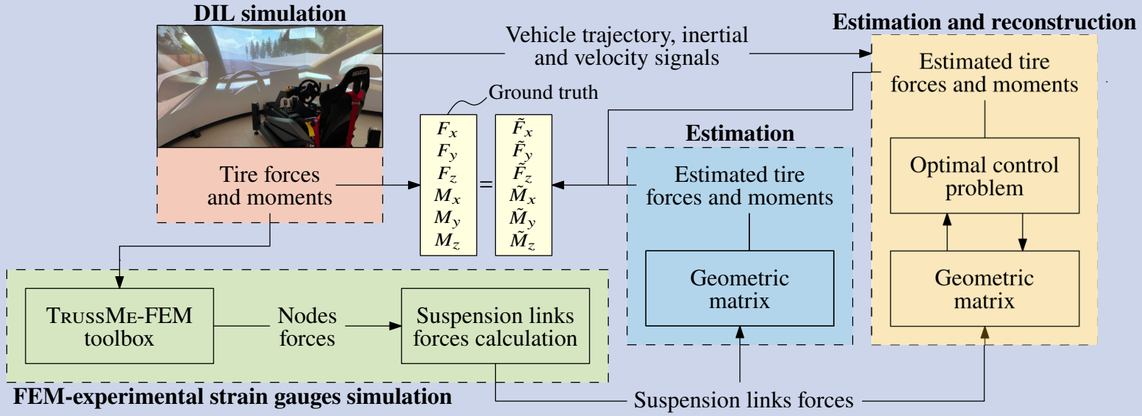
Accurate tire loads estimation require expensive sensors and thorough testing

Tire Forces and Moments



Can we estimate tire *forces* and *torques* using only strain gauges data? Can we estimate tire loads even with *missing* or *corrupted* sensors signals?

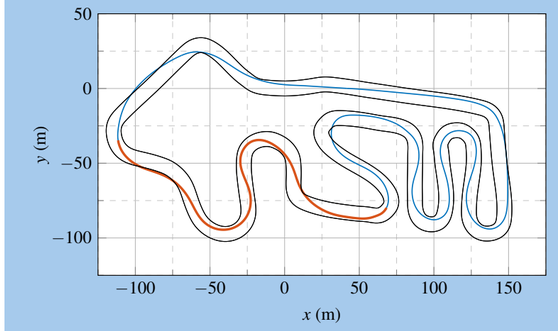
Proposed Methodology

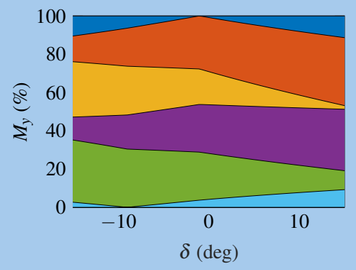


- ✓ *Symbolic* modeling ensures efficiency and code consistency
- ✓ *Nonlinear* suspension model with asymmetric tension-compression behavior
- ✓ Geometric matrix with *steering angle* and *suspension travel* influences
- ✓ *Optimal control* compensates for sensor faults or corrupted data

Results

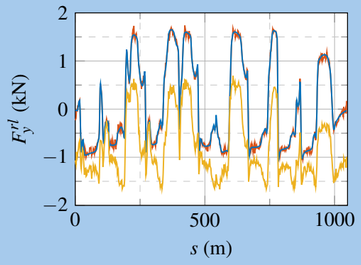
Validation on a DIL simulator with a high-fidelity multi-body vehicle model

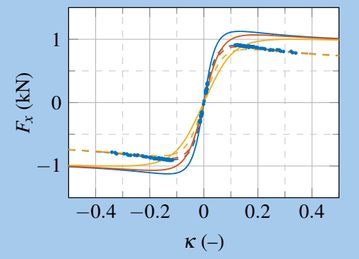




Insights into contributions of the suspension links internal reactions to the tire loads

Good estimation of tire forces and moments with optimal reconstruction of corrupted signals





Tire forces and moments scaling factors

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