Novel Chassis Concept for Omnidirectional Driving Maneuvers

Challenges in modelling suspensions with wheel individual steering system
Agenda

1. Overview Project OmniSteer
2. Novel Chassis Concept in Project OmniSteer
3. Modeling Novel Chassis Concept
4. Application of the Model
5. Summary
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Overview Project OmniSteer

- **Omni** prefix stands for:
  - orthogonal
  - multi-directional
  - non-linear

- The target of the OmniSteer project is to develop a **mechatronic** system for the longitudinal and lateral guidance of a vehicle, which ensures the functional safety. This intention is enabled by the **electrification** of the power train and the facility to **integrate the power units into the wheels**.
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Novel Chassis Concept in Project OmniSteer

- Omnidirectional driving maneuvers
  - Requirements:
    - 4 individually steerable wheels
    - 90 degree in both directions

- Several concepts known from literature, but not applicable for passenger cars
  - novel concept needed

Source: National Aeronautics and Space Administration, 2016
Novel Chassis Concept in Project OmniSteer

- Omnidirectional driving maneuvers
  → Requirements:
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  - 90 degree in both directions

- Several concepts known from literature, but not applicable for passenger cars
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- Features of novel Chassis Concept:
  - Steering wishbones
  - Curved wishbones
  - Height offset of wishbones
Novel Chassis Concept in Project OmniSteer

Why do we need a model?
- Estimating forces and moments within the suspension and steering system to support the mechanical design
- Gaining the knowledge of vehicle dynamic behavior in omnidirectional driving maneuvers
- Serving as reference model to test different kinds of control algorithms

Challenge in modeling
- Novel chassis concept was not predefined in the library in the most commercial vehicle dynamics softwares
- Steering system could no longer be controlled by the steering track rod
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Modelling Novel Chassis Concept

- Vehicle model in CarMaker as foundation
- Modelling Suspension and steering as a Multi-Body model in Matlab/Simscape Toolbox
- Connection CarMaker model and Suspension model through SKC-File and CM4SL-Environment
Modelling Novel Chassis Concept

Analysis

Multibody model

Topology model

Implementation in Simscape
Modelling Novel Chassis Concept

Suspension multibody model

Suspension System

Steering System

Suspension kinematics

SKC-File

CarMaker for Simulink

Suspension System

Steering System

Suspension Torque

Steering Angle

Steer.<Pos>.q
Modelling Novel Chassis Concept

Driving Maneuver: Parking on the other side of street
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Application of the Model

Simulation environment to test odometry-based localization algorithm
Application of the Model

Comparison of different odometry-based localization algorithms during parking maneuver
Application of the Model

Comparison of different odometry-based localization algorithms during parking maneuver
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Summary

- Novel chassis concept is needed for the omnidirectional driving maneuvers
- Modeling method of novel chassis concept with help of CarMaker and Simscape was introduced
- Application this model in development of odometry based localization algorithm
Thank you for your attention!