Applicability of a Mid-to-End Reinforcement Learning Approach to On-Road Autonomous Driving for Truck & Trailer Systems

*Remarks to the title:*

* by “mid-to-end” we mean instead of using raw sensor data like camera images, we’ll use vectorized inputs like lane marker points and free space with spline representation.
* the specific type of reinforcement learning, e.g., value-based, policy-based, actor-critic, etc., may be added to the title after the paper is finished

Key Words: Reinforcement learning (RL), Truck & trailer system, Large dimension, Heavy-duty vehicle, Vectorized input, Self-created simulation environment, Free space, Structured road driving, Autonomous driving

# Problem Description

When deploying autonomous driving on truck & trailer systems, a new challenge arises: how to keep both the tractor and the trailer within the lane markings as much as possible without hitting any surrounding objects, especially when making sharp turns. The large dimension and the articulated structure of these systems impose additional constraints on the planning and control part of the autonomous driving SW.

*“The research on path planning for tractor-trailer vehicles has mainly been focusing on off-road scenarios… or low curvature roads… only a limited amount of work considers this critical problem (on-road path planning) for articulated vehicles, which requires tailored solutions to comply with the large vehicle dimensions.”* (Oliveira, 2020). A preliminary literature research has uncovered 6 such papers, all of which employ optimization-based approaches (formulating and solving the motion planning problem as an optimal control problem). While yielding optimal solution, one drawback of this kind of approaches lies in its high computational burden when solving the complex numerical problem. Out of this motivation, the target of this thesis is to investigate the applicability of an AI-based approach for motion planning (and control) for the truck & trailer system. More specifically, the goal is to design and train an Reinforcement Learning agent in a suitable simulation environment to be able to drive a truck & trailer system like an expert driver.

# Proposed Research Direction

The following expectations are set on the thesis:

1. A basic literature research in the field of AI-based motion planning approaches with focus on Reinforcement Learning methods has been conducted
2. A decision on a specific RL approach has been derived based on the literature research and relevant decision criteria
3. A suitable simulation environment for the training has been chosen and created (e.g. in OpenAI Gym)

* Using the standard interface defined for the gym library
* The feedback state from this environment could be in two flavors (or just one, depending on the time):
  + Rasterized image, or
  + Vectorized environment model, e.g., lane marker points, free space in spline format. The advantage of this is that the trained policy can be directly deployed to handle real environment

1. ARL agent has been designed and trained to drive in the simulation environment
2. The performance of the RL approach has been evaluated
3. Conclusions regarding the general applicability of RL to the tractor-trailer motion planning problem have been drawn