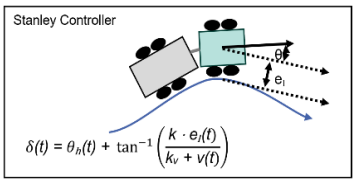
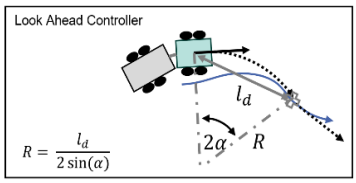
Institute of Vehicle System Technology
Institute of Mobile Machines
Prof. Dr.-Ing. Marcus Geimer

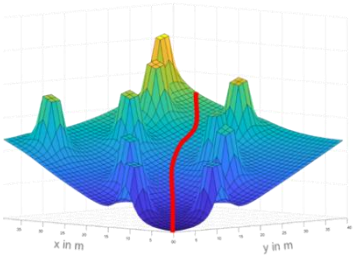
Bachelor- / Masterarbeit

Reinforcement Learning-Based Adaptive Steering Control for Autonomous Driving of Large-Scale Articulated Vehicles

With the increasing deployment of autonomous control in large-scale articulated vehicles, classical path tracking algorithms such as Stanley and Pure Pursuit are widely used due to their simplicity and effectiveness. However, their performance heavily depends on hand-tuned parameters, which are difficult to adapt dynamically across different driving scenarios—e.g., tight turns, long straights, or complex off-road terrain. In the current implementation, our hybrid Stanley + Pure Pursuit controller achieves stable tracking performance but lacks the ability to adjust control gains in real time based on vehicle state and environment context.







This thesis aims to address this limitation by developing a reinforcement learning-based agent that learns to dynamically adapt controller parameters for optimal path tracking performance. The work will build upon our existing simulation framework for autonomous articulated forestry machinery and extend it to support closed-loop training with standard RL algorithms. Students are encouraged to experiment with efficient policy learning methods (e.g., PPO, TD3), and to explore generalization across scenarios such as varying terrain types or driving directions.

Planned Tasks:

- Literature review on reinforcement learning for control, especially in low-speed autonomous driving of large-scale articulated vehicles
- Familiarization with current Stanley + Pure Pursuit control framework
- Extension of the simulation environment for closed-loop training and evaluation
- Implementation and training of reinforcement learning agents (e.g., PPO, TD3) for dynamic gain tuning
- Evaluation of tracking performance across diverse driving scenarios (e.g., sharp turns, uneven terrain)
- Documentation and presentation of results with publication as a potential goal

Type of thesis:

- Focus: Reinforcement Learning for Adaptive Path Tracking
- Fields: Control Systems, Reinforcement Learning, Robotics Simulation

Start and Duration:

- Start: To be agreed upon
- Duration: 3-6 months

Prerequisites:

- Solid understanding of reinforcement learning concepts and algorithms
- Practical experience with Python, ROS 2 and Ignition Gazebo
- Strong self-motivation and good scientific writing skills in English or German
- C++ experience for writing custom nodes or plugins is beneficial

If you are interested in this topic, feel free to get in touch. The scope of the work can be adapted or extended based on your individual strengths and interests.

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