



BACHELOR/MASTER THESIS

Closed-Loop Simulation for Concept Proof of Control Models

The goal of this thesis is to design and implement a closed-loop simulation environment that answers one really important question early in the development process: does a function model work together with a model of our car, before it goes to testing and parameter tuning? The environment connects function models (e.g. traction control, torque distribution or launch control) to the vehicle model through clearly defined interfaces, so that new models can be plugged in with little effort. Standardised scenarios such as acceleration, skidpad or autocross laps are combined with quantitative criteria like wheel slip, lap time or energy consumption. Together, they show whether a concept brings the expected benefit and stays stable when vehicle parameters vary.

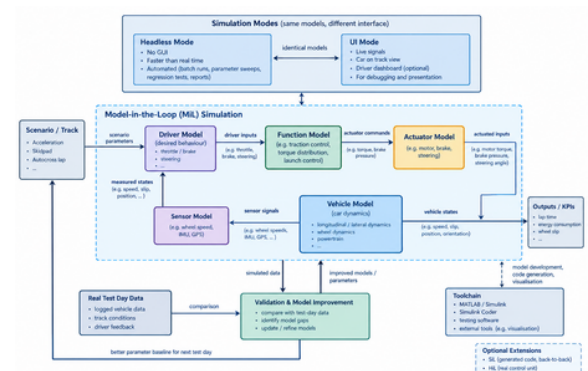
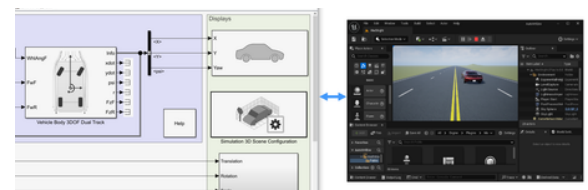
The simulation has to run in two modes. In headless mode it runs without a graphical interface and a UI mode, with a display with live signals, a view of the car on the track and possibly the driver's dashboard, which helps with debugging and presenting results. Both modes run identical models.

Every model needs validation so it is part of the thesis: which effects must be modelled for a credible concept proof, and how well does the simulation reproduce real measurements? Logged data are compared with the simulated behaviour to show where the model needs improvement. This creates a feedback loop: the simulation prepares the test day with a sensible parameter baseline, and the test day delivers data that improve the simulation.

Model-in-the-loop (MiL) simulation is the core scope of this thesis. If time allows, the environment can be extended to software-in-the-loop (SiL), testing the generated code, and to hardware-in-the-loop (HiL) with the real control unit.

The toolchain is MATLAB/Simulink, Simulink Coder and compatible testing software. The models must be built in MATLAB/Simulink, but the simulation can communicate with other software, for example for visualisation.

The result should be a documented, reusable and expandable simulation platform for the whole team, so that ideas can be checked quickly (within hours). For you as a student, this thesis offers hands-on experience in model-based development, control engineering and test automation, and the chance to make a direct impact on a real racing car.



Tasks:

- Analyse the existing function models, the vehicle model and their interfaces, and define the scenarios (manoeuvres, tracks) and KPIs the simulation must cover
- Build the MiL environment in MATLAB/Simulink: connect the function model under test with the vehicle model, a driver model and, where needed, sensor and actuator models
- Implement headless (batch runs, parameter sweeps, regression tests, reports) and UI mode
- Validate the vehicle model against logged test-day data
- Document the architecture (and write a user guide)

Requirements:

- Enrolled in a Bachelor's or Master's programme in a related Engineering field
- Good knowledge of MATLAB/Simulink; experience with automated testing or code generation is a plus
- Basic knowledge of control engineering and vehicle dynamics, or the willingness to work into it quickly
- Very good communication skills in English or German
- Enthusiasm for motorsport, racing and becoming a team member