



MASTER THESIS

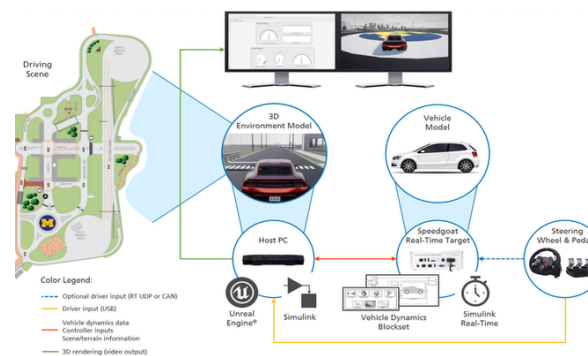
DIL Simulation

The goal of this thesis is to design, implement and validate a Driver-in-the-Loop simulator for our Formula Student car. At its core is a real-time-capable vehicle model that represents the dynamics relevant for driving: longitudinal, lateral and vertical dynamics, suspension kinematics, tyre behaviour, aerodynamic loads and the powertrain of our electric racing car. The model has to be parameterised with real data from our car, such as CAD and measurement data, tyre data and supplier data. It should be balanced between fidelity and computational effort as it will run in real time.

Around this model, the driver interface and the virtual environment need to be built. This includes a steering wheel (ideally with force feedback), pedals, a seat and a display setup, as well as a visualisation of the track and of the car. Track layouts (including the cones) for the dynamic disciplines (acceleration, skidpad, autocross and endurance) can be created from the competition rules and from our own data. Important design questions are latency, update rates and the quality of the feedback that the driver receives, that determine how realistic the simulator feels and how far its results can be trusted.

For the implementation, we expect to use MATLAB/Simulink together with a Speedgoat real-time target machine running Simulink Real-Time. The vehicle model is built in Simulink, compiled via code generation and executed on the Speedgoat with a fixed step size, ensuring the deterministic timing and low latency a driver needs. Speedgoat's I/O modules and interfaces connect the steering wheel and pedals directly to the real-time system and open the way to hardware-in-the-loop tests with the car's real control unit. The track and car visualisation runs on a separate PC that receives the vehicle state via UDP, for example in Unreal Engine or Unity. Since the real-time platform is largely set, the thesis focuses on design decisions within it: balancing model fidelity against the available step size, defining the interfaces between driver hardware, model and visualisation.

The result should be a documented, reusable and expandable simulation platform that supports the team in three ways: driver training and selection ahead of the season, evaluation of setup and design variants from the driver's perspective, and development and testing of control functions. For you as a student, this thesis offers hands-on experience in vehicle dynamics, real-time systems, model-based development and human-machine interaction, and the chance to make a direct impact on a real racing car. You will work closely with the vehicle dynamics, electronics and software departments and be part of a motivated, interdisciplinary team.



Tasks:

- Review the state of the art in driving simulators and vehicle models used in motorsport and Formula Student and define requirements
- Develop and parameterise a real-time-capable vehicle model of our car using CAD, measurement and supplier data
- Implement the simulator, including driver hardware, the virtual track environment and real-time communication between components
- Validate the model (and evaluate the simulator with the team's drivers)
- Document the architecture (and write a user guide) so the model can be maintained and the simulator can be extended

Requirements:

- Enrolled in a Master's programme in a related Engineering field
- Knowledge in MATLAB/Simulink; familiarity with model-based development or Simulink Real-Time is a plus
- Basic knowledge of 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