Institute of Automotive Technology
TUM School of Engineering and Design
Technical University of Munich

Master's Thesis

# Analyzing the Influence of Execution Times on the Performance of a Real-World Autonomous Racing Software Stack

The TUM Autonomous Motorsport team is at the forefront of developing advanced software for autonomous racing vehicles, participating in and winning cutting-edge racing series such as the Indy Autonomous Challenge (IAC) and the Abu Dhabi Autonomous Racing League (A2RL). Pushing the limits of autonomy, performing precise overtaking maneuvers at speeds exceeding 270 km/h - where milliseconds count - requires highly efficient software.

This research project investigates the impact of computational delays within a modular autonomous racing software stack. To ensure reliable evaluations, the software must be tested across diverse scenarios. Given the lack of deterministic frameworks for assessing the overall software performance, the objective is to create a method for identifying critical execution time thresholds in each module. By identifying these thresholds, this research seeks to establish the maximum permissible execution times for real-world algorithms, advancing the evolution of autonomy in highly dynamic scenarios.

**Work packages:**

- Literature research on the impact of computational delays on software performance and optimization strategies
- Development of a simulation environment and identification of key performance metrics for autonomous racing
- Integration and evaluation of the existing autonomous racing software stack
- Analysis of the results and identification of directions for future research

**Requirements:**

- Enthusiasm about software engineering and efficient software design
- Good programming skills in C++ and/or Python
- Ability to collaborate in a team and engage in interdisciplinary research

If you are interested in this project or any other project in the context of autonomous racing, send us (simon.sagmeister@tum.de, marcel.weinmann@tum.de) your CV and grade report.