ZURICH UAS RACING

Simulation and Analysis of Torque Distribution Strategies (Torque Vectoring) for a 4WD Electric Vehicle

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Formula Student (FS)

The internationally highly regarded engineering competition Formula Student (FS) challenges teams of students to design and build a formula racing car and compete against other universities in various disciplines. The various competitions offer an exceptional opportunity for students to apply their academic knowledge in a practical setting.

Introduction Bachelor-Thesis

With the increasing adoption of electric drivetrains, torque vectoring – the active distribution of drive torque between individual wheels – has become a key technology for enhancing handling, stability, and overall vehicle performance.

In a four-wheel-drive (4WD) electric Formula Student car, each wheel can be controlled independently, providing significant opportunities to influence cornering balance, traction, and energy efficiency. Understanding how different torque distribution strategies affect vehicle behavior is essential for developing advanced control systems.

This thesis provides an important step toward future controller development by using simulation-based analysis to study and compare various torque vectoring strategies before implementation on a physical vehicle.

Goal

The goal of this project is to investigate how different torque distribution strategies influence the dynamic behavior of a 4WD electric Formula Student vehicle. By evaluating their effects on handling balance, stability, and lap time, the results will form a validated foundation for future torque vectoring controller design and optimization.

Objectives:

- **Model Setup:** Develop a simplified vehicle dynamics model (e.g., bicycle model extended to four driven wheels) suitable for torque vectoring simulation.
- **Strategy Development:** Implement and compare different torque distribution strategies, such as open-loop, load-based, and yaw-rate-based control.
- **Dynamic Analysis:** Analyse the effects of each strategy on understeer and oversteer characteristics during cornering.
- **Performance Evaluation:** Assess the influence on lap time and vehicle stability through simulation.
- **Documentation:** Summarize all results, model configurations, and findings, and provide recommendations for future controller development.

If you are interested in this project thesis, we kindly ask you to get in touch with us:

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