Safety-Aware Autonomous Racing Takeover Via Sampled-Based MPC and Control Barrier Functions
ME555 Automotive Engineering Design Proposal

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1 Abstract

In the course of autonomous racing,

2 Research Objective

- To develop an autonomous vehicle takeover system for autonomous racing scenarios, with potential application to the Indy Autonomous Challenge, in support of Duke Motorsport.

- To implement Model Predictive Path Integral (MPPI) control [1], a sample-based model predictive control framework, to achieve optimal takeover maneuvers.

- To integrate Control Barrier Function (CBF) [2] constraints within the control architecture to ensure safety guarantees during vehicle operation.

- To incorporate motion prediction based on temporal learning methods to inform MPPI-based trajectory generation.

- To establish simulation environments for validation of the proposed methodology and to facilitate future research and development.

- To integrate the simulation framework with Simulink and conduct experimental validation on two F1TENTH vehicles, subject to time availability.

3 Related Work

References

[1] G. Williams, A. Aldrich, and E. Theodorou, "Model predictive path integral control using covariance variable importance sampling," *arXiv preprint arXiv:1509.01149*, 2015.

[2] A. D. Ames, S. Coogan, M. Egerstedt, G. Notomista, K. Sreenath, and P. Tabuada, "Control barrier functions: Theory and applications," in *2019 18th European control conference (ECC)*. Ieee, 2019, pp. 3420–3431.