Professorship Autonomous Vehicle Systems
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SA/MA

Enhancing Model Predictive Control for Autonomous Vehicle Trajectory Following using Deep Reinforcement Learning

One of the key challenges in autonomous vehicle control is ensuring the vehicle follows a desired trajectory while maintaining stability and safety. The use of Model Predictive Control (MPC) has been widely adopted as an effective method for trajectory following. MPC uses a prediction model of the system to optimize control actions over a finite horizon. However, the performance of MPC is highly dependent on the accuracy of the prediction model used.

The current approach uses a nonlinear dynamic single track model with a Pacejka tire model. But it still can't perfectly model the reality and has structural and parametric uncertainties. The model also needs to be adapted online as its behavior is often affected by several factors such as wear and tear of the vehicle, load change/displacement, changes in road conditions, and environmental factors.

The goal of this thesis is to improve the performance of the model predictive controller by combining it with reinforcement learning (RL) to adapt the prediction model online. RL is a machine learning approach that allows an agent to learn a control policy by interacting with its environment. Combining these two approaches can offer a powerful solution to adapt the prediction model online, handle uncertainty and disturbances that might appear while driving, and improve the closed-loop performance.

Tasks to be completed during the thesis:

- Conduct a state-of-the-art review on the use of RL in MPC
- Formulate the problem of adapting and enhancing the prediction model used in the MPC
- Concept, develop and implement an open-source available RL algorithm to adapt the prediction model online
- Test and evaluate the performance of the proposed approach in simulation and/or experiment
- Compare the performance of the proposed approach with traditional model predictive control methods
- Write a comprehensive thesis report documenting the research, methodology, implementation, and results.

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