Optimal Control Approaches for Online Control of Vehicles

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Abstract: Automatically driven vehicles have to be able to mirror safety, comfort and reaction as if being driven by a skilled driver, even in worst-case scenarios. In order to compete with a skilled driver, an optimal control algorithm in combination with a model-predictive control scheme can be used to control a fully autonomous vehicle. Unfortunately solving optimal control problems with complex vehicle models online is critical with respect to solution time. Especially worst-case scenarios can hardly be calculated online for complex vehicle models.

The first approach for the online optimal control of cars is to simplify the vehicle model, using a simplified point-mass model. By a specific definition of this model and with the introduction of various extensions, the model can be adjusted such that it reflects the dynamics of a vehicle with sufficient accuracy. The online capability of this approach was successfully tested with an RC-car. The implementation for this approach on a real car is currently in progress.

For the secound approach a speed up of the optimizer is targeted. Currently many optimal control optimizers work with several layers, to discretize and solve the optimal control problems. For this approach, a structure exploiting interior point method was developed, taking into account the specific structure of the optimal control problem. Numerical results with this structure exploiting interior point method will be reported and compared to standard solvers.

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