Professorship Autonomous Vehicle Systems
Department of Mobility Systems Engineering
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SA/MA

Bayesian Optimization of Model Predictive Control Parameters for Autonomous Vehicle Guidance

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 correct choice of the cost function and its parameters used in the optimization problem.

Determining the optimal cost function parameters to optimize different control objectives is a challenging and time-consuming task that requires hand tuning by skilled MPC experts. Still, it may not result in the optimal solution due to the high-dimensional and complex nature of the cost function.

The goal of this thesis is to develop an automated method for tuning the MPC cost function, improve its performance and ensure robust parametrization by using Bayesian Optimization (BO). BO is a powerful optimization method that can be used to find the optimal values of a function by using prior information and a probabilistic model. This approach allows us to automate the tuning process and help to solve the problems that arise with manual tuning by experts.

Tasks to be completed during the thesis:

- Conduct a state-of-the-art review on the use of Bayesian Optimization in MPC
- Formulate the problem of optimizing the parameters of the cost function used in the MPC
- Concept, develop and implement a Bayesian optimization algorithm to tune the MPC parameters
- Test and evaluate the performance of the proposed approach in simulation and/or experiment
- Compare the performance of the proposed approach with traditional manual tuning methods
- Write a comprehensive thesis report documenting the research, methodology, implementation, and results.

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