Combining Optimal Control and Combinatorial Optimization Approaches for Energy-efficient Routing of Hybrid Vehicles

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Abstract: In recent years, the development of hybrid vehicles has made a huge contribution towards energy-efficient individual traffic. In the talk, we present a new approach to route-based energy-efficient optimal control for such vehicles.

Choosing an optimal balance between conventional and electric drive including recuperation of energy when possible is a typical domain of optimal control. Obviously, topographical information on the up-coming road within the prediction horizon can improve the results significantly. In contrast, finding shortest paths in a network is a classical problem in combinatorial optimization. However, for computing energy-efficient paths we require a suitable model of energy consumption. Consequently, the problem of travelling from A to B without wasting energy is an example of a hybrid system which is best solved using both optimal control methods and combinatorial optimization algorithms.

Our approach contains three main components. Firstly, model predictive control is used to create a simplified consumption model as well as to optimize the control of the engine and power train when the optimized route is actually used by the driver of the hybrid vehicle.

Secondly, we analyze the shortest path problem with respect to time and ressources. Due to the possibility to convert fuel into electric energy stored in the battery, this problem provides a higher combinatorial variety than standard constraint shortest path problems.

Thirdly, we use methods from machine learning to obtain a personalized parametrization of control and routing.

Finally, we emphasize advantages and challenges of this integrated approach and we present first computational results and open problems.

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