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Optimization-based Hierarchical Robust Motion Control for In-wheeled Motor Vehicles against Road Disturbance

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Abstract— **In this benchmark challenge, we propose a motion control strategy for in-wheeled motor vehicles to achieve multiple control objectives, such as improving maneuverability, minimizing energy loss, and tracking position and/or velocity references under uncertain road condition. In order to deal with a variety of control purposes as well as constraints at the same time, a vehicle controller in two-layered hierarchical structure is presented. The upper-layer controller in the hierarchy is constructed based on the finite-time optimal control problem formulated as an optimization problem, serving as a coordinator by computing optimal values for the torque distributed to each in-wheeled motors. The aim of the upper-layer controller is to minimize energy consumption and to generate a trackable motion by modifying the given reference. Then we employ a lower-layer controller to follow the refined reference generated by the upper-layer controller, in the presence of disturbance caused by uncertain road condition. For this, robust control schemes are utilized in design of the lower-layer controller. In doing so, the proposed hierarchical controller achieves both robustness and energy efficiency at once. To verify the validity of the proposed controller, simulations are conducted in MATLAB/Simulink environment with a sophisticated model of a vehicle offered by Modelon. In the simulation, two main scenarios introduced in the technical paper on Autonomous Driving Control Benchmark Challenge are dealt with: one aims to address a velocity tracking problem, while the other pursues lane change on a slippery road.**

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