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INTEGRATED VEHICLE DYNAMICS CONTROL FOR BATTERY ELECTRIC VEHICLES

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ABSTRACT

This study investigates a method for enhancing Battery Electric Vehicle (BEV) longitudinal and lateral stability in a broad range of conditions. As with the state-of-the-art, a hierarchical control is developed: the upper layer uses vehicle state errors and predicted driver intentions in order to generate a corrective yaw moment using a sliding mode control (SMC); the lower layer distributes the requested torque to the electric motors using a vertical-load-based torque distribution algorithm. The first contribution of this work is the additional term inside the yaw moment controller: the expected trajectory of the vehicle is predicted over a certain time horizon, allowing a more effective action of the controller and thus reducing path errors. Another contribution of this work is the development of a sliding mode-based cruise control, featuring good responsiveness when the velocity error is high and robustness when it approaches zero. Moreover, some peculiar e-drive maneuvers (like the tank-turn) can be realized by properly commanding the electric motors with the controller. The development of both sliding mode controllers is analyzed and their design choices are thoroughly explained. At first, the proposed control system is verified in MATLAB-Simulink environment, using a seven degree of freedom vehicle model (longitudinal, lateral, yaw and rotation of each wheel) and the bicycle model as reference model. Then, it is verified in co-simulation environment using MotionView and MATLAB-Simulink. Several simulations under different driving scenarios are run and the results are discussed, highlighting the merit of the proposed control strategy, especially under certain conditions like the start from standstill while bending a curve. Furthermore, the simulation environment that has been built allows the benchmarking of different BEV architectures. When changing the number and position of the electric motors, the developed integrated vehicle stability controller is able to split the required torque among the available motors in order to optimize available traction depending on the vehicle configuration.