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Enhancing Vehicle Stabilization in Harsh Driving Conditions using Model Predictive Control with Neural Network Integration

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Abstract

Motion stabilization and energy-efficient driving algorithms are crucial in autonomous driving for four-independent drive wheel-based electric vehicles. Nonetheless, a significant challenge arises for AI within autonomous vehicles: generating an optimal driving path while accounting for the intricate interplay of vehicle performance and status inheritance. This poster introduces an innovative approach to address these challenges within specific driving scenarios. Notably, it focuses on scenarios involving driving under low friction load conditions and executing a double lane change maneuver. In these scenarios, predetermined speed profiles and driving routes are provided. The primary objective is to drive the vehicle along the predefined path while prioritizing stability, overall performance, and energy efficiency. To achieve this, a model predictive control algorithm is proposed, incorporating slip ratio control. This approach manages inputs, including steering angle and yaw moment, and outputs, like yaw rate, side slip angle, and speed. The system operates under diverse constraints reflective of the vehicle's dynamic behavior. Moreover, a neural network-based auxiliary controller is combined with the proposed model predictive control scheme to improve the path-following performance. The effectiveness and accomplishments of the proposed algorithm are demonstrated through simulations using Modelica, a vehicle motion analysis simulator integrated with Matlab/Simulink.

Index Terms

Vehicle motion control, Vehicle dynamics, Model Predictive Control, Neural Network

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