A Comparison between Zero Steady State Compensators and Optimal Control Regulators in a 4WS vehicle

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Abstract

This paper discusses about a LQR controller as optimal regulator and the following zero steady state compensators: Zero side slip (ZSS) and zero yaw rate (ZYR). LQR controller is a simple proportional regulator, which is suited for state variable regulation and tracking with the proper gain matrix definition and suitable state variable choice. This controller yields constant control gains and have the structure of full state feed back controllers. ZSS and ZYR compensators are controllers that force the linear system yield the following steady state conditions: ZSS regulates the steady state response of side slip state variable (have linear relation with lateral velocity) in linear model and ZYR regulates yaw state variable. As dynamic models, a 2 DOF linear handling model with yaw rate and lateral velocity variables is used as controller model, where a 3 DOF nonlinear model with yaw rate, lateral velocity and roll variables and CALSPAN tire coefficients is proposed for simulations.

Results show that in spite of LQR controller, which yields suitable results in both linear and nonlinear models and both regulation and tracking strategies, zero steady state compensators (ZSS and ZYR) could not yield acceptable results in nonlinear model that simulates real condition of vehicle; in addition not to have flexible nature (like LQR) to perform a multi purpose control aims.

Key Words: 4WS Vehicle, Linear Modeling, Nonlinear Modeling, Model Reference Control, Dual steering Control

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