Dynamic and Control Analysis of A 4WS Vehicle- A Comparison between Control Algorithms

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ABSTRACT

Many developments and researches have been initiated since the beginning of the 20th century, when 4WS systems invented in order to optimize cornering behavior of vehicle. These studies have focused on a suitable control strategy and a useful controller to steer wheel of the vehicle in various maneuver conditions. A review of the related researches shows that the majority of these studies are based on Linear Quadratic Regulator (LQR) controller in single steering control scheme and simulations are based on a simple 2 DOF car models.

In this thesis, in addition to comparative analysis of rear steering control procedures of a 4WS vehicle, new controllers are proposed. In this regard, the following controllers are designed as regulators and model reference trackers in single and dual steering control scheme: Linear Quadratic Regulator (LQR), Dynamic Programming (DP), Model Reference Adaptive Control (MRAC), Time Delay Control (TDC) and proportional controllers like Zero Side Slip (ZSS) and Zero Yaw Rate (ZYR). It is proposed to use dual steering control scheme for MRAC and TDC controllers to track both yaw rate and lateral velocity state variables and single steering control scheme, which can only track one of the mentioned state variables, for the other controllers. A 3 DOF linear handling vehicle model is used as a controller model while a 3 DOF nonlinear model with CALSPAN tire coefficients is used for simulation. It is also assumed that vehicle is remained in quasi-static longitudinal condition while cornering.

Simulation results, which are suited for lane change and steady state cornering maneuvers, show better behavior of TDC in comparison with other controllers and with dual steering scheme.

Key Words:
Handling Car Model, Optimal Control, Adaptive Control, Time Delay Control, Vehicle Dynamics, Vehicle Handling, Model reference Tracking Control, Regulation Control