VARIABLE DYNAMIC TESTBED VEHICLE: MODEL-FOLLOWING CONTROL DESIGN

Allan Y. Lee
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Abstract

The Variable Dynamic Testbed Vehicle (VDTV) is being developed by the National Highway Traffic Safety Administration (NHTSA) as a research tool to evaluate collision avoidance systems, to perform driving-related human factors research, among other applications. The vehicle is designed to have a "steer-by-wire" front steering system and an independent rear steering system. These steering systems enable the VDTV to emulate the directional control characteristics of a broad range of passenger vehicles. In this study, a "model following" control method (sometimes called a "reference model" control method) is used to alter both the steady-state and transient lateral response characteristics of a compact sized VDTV (a Ford Escort) to match those of a small-sized Buick Skylark as well as those of a mid-sized Ford Taurus. To this end, the yaw rate and lateral acceleration of the target vehicle are first computed using an on-board mathematical model of the target vehicle, and the measured steering wheel angle and forward speed of the VDTV. These computed vehicle variables are then compared with the measured VDTV's yaw rate and lateral acceleration, and the differences are used to control the front and rear steering servo-mechanisms. For two classes of steering inputs used in this study ("pseudo-step" and "sinusoidal"), the model-following control design method allowed the VDTV to accurately and robustly track the lateral responses of the target vehicles. The effects that the steering servo system bandwidths and sensor fidelity have on the viability of the proposed design method will also be discussed.

Key Words: Emulation, Four-wheel-steering, Directional response characteristics, Model-following Control Method, Simulation, Variable Dynamic Vehicle.