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ORIGINAL PAPER

Attenuating noise effect on yaw rate control of independent drive electric vehicle using minimum variance controller

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Abstract In almost all real-world application such as electric vehicles, system outputs are corrupted by various types of noises. Although the sliding mode controller is a popular controller in the electrical vehicle applications, it is vulnerable to the noisy signals, and even intensify its unwilling effects. In this paper, to eliminate process noise and stabilize the vehicle in noisy conditions, a minimum variance controller is utilized. It is shown that this controller is able to decrease the system output variance, optimally. Besides, it can track yaw rate and velocity reference inputs. Also stability condition is reached. Furthermore, decreasing control signal variance along with output variance is studied in this paper. Finally, the proposed approach is compared with sliding mode controller in noisy condition on four wheel drive electric vehicle which is simulated in MATLAB and CARSIM environments.

Keywords Four wheel drive electric vehicle · Yaw rate control · Generalized minimum variance control · Process noise reduction

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1 Introduction

Due to the environmental concern and depletion of natural oil resources, electric vehicle is considered to be a suitable option for personal transportation in future. These electric vehicles are not only energy efficient and environment friendly but also are very good from control point of view [1].

In the recent years, electric vehicle technologies have become one of the most important fields of research and investment, bring various structures of electric and hybrid electric vehicles [2] among which the four wheel independent drive (4WID) vehicles with four independent electric motors, each designed to drive one wheel, are one of the absorbing ones.

The configuration of independent motors eliminates heavy mechanical transmission systems and provides more space for the passengers and cargo. More importantly, this configuration allows independent driving torques to be generated, which in turn provides a new means to enhance vehicle stability and handling. Many novel techniques have been devised for the overall motion control of 4WID electric vehicle such as model following control (MFC), direct yaw moment control (DYC), and slip ratio control (SRC) [3].

DYC is applied to improve the cornering performance of the vehicle during turning motion from the differential torque commands [4]. In direct yaw moment control, the desired yaw rate is calculated on the base of driver's steering commands and compared