Advances in Automotive Engineering, *Vol. 1, No. 2 (2019) 185-199*
DOI: https://doi.org/10.12989/aae.2019.1.2.185

Study on stability and control analysis for cascade hybrid electric vehicle

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(Received November 8, 2018, Revised January 13, 2019, Accepted March 20, 2019)

Abstract. This research contributes in studying the configuration of hybrid electric vehicles (HEV) which have been developed and used in modern days. The hybrid topologies that combine multiple power sources with motive force to increase the driving function are also studied. The objectives of this study are to determine the time and frequency domain equations that characterize the relationship between the input, output, and state variables for the forward path of car motive dynamics system. In this paper, a block diagram of HEV forward path with feedback signal and controller gain was proposed while assuming the motor to be an armature controlled direct current. The transfer function and state-space were developed and its stability was analyzed and used to describe the car motive dynamics. Matlab and Simulink were used to simulate the system. The simulation results showed the state-space and transfer function of HEV system with excess motive force of 2650 N. The results clearly indicated that the designed controllers were able to improve the steady-state, transient analysis, and desired output. It was also demonstrated that the step input with proportional-integral-derivative controller was efficient in term of the best transient response with zero steady-state error. While, bode plot graph illustrated that the system was inherently stable.

Keywords: hybrid electric vehicle; classical control; stability analysis; cascade system; frequency domain; modeling and simulation

1. Introduction

Around the world, one of the major end user sectors that consumes energy is transportation

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http://www.techno-press.org/?journal=aae&subpage=7 ISSN: 2465-927X (Print), 2586-7237 (Online)

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