Study of Vehicle Drive-by-Wire Cruise Control and Hardware in-the-Loop Simulation Design Technology Integration

王朝森、張一屏

E-mail: 9419910@mail.dyu.edu.tw

ABSTRACT

This study is proposed to develop a longitudinal vehicle Drive-By Wire (DBW) cruise control dynamic simulation system by using object-oriented program. The main objective of this study is to integrate the design of the intelligent cruise control system involving the automatic control of throttle position for DBW system. The Pulse Width Modulation(PWM) signals generated from the Hardware In-the Loop (HIL) were send to the drive-electronic circuits of an electronic throttle DC motor, the dynamic response were been observed then by corresponding throttle position sensor. According to the variation of electronic throttle input and output parameters, different system identification methods were used to conjecture dynamic transfer function of the electronic throttle. This study also established longitudinal vehicle powertrain dynamic simulation model by using an object-oriented program. The engine torque measured from dynamometer test data, were used in the powertrain simulation program which involves the rigid body rotating dynamics and corresponding vehicle dynamics. The integrated powertrain model includes five main components which are engine, torque converter, gear box, differential and wheel. These components were modeled separately with stiffness element which composed with the stiffness coefficient and the damping coefficient and torque elements containing the moment of the inertia and internal parameters. By proper setting of the relevant parameter of the powertrain dynamic models, the vehicle driving performance including output engine speed and vehicle speed can be simulated. The simulation result was compared with real vehicle test data and model parameters were adjusted and validated. This vehicle powertrain dynamic model proved to predict dynamic performances of the tested vehicle with reasonable accuracy. Fuzzy Logic Control, (FLC) was applied in this research to design the DBW controller, because it enable control according to driver ’ s experience transformed rules, although vehicle powertrain dynamics contains many nonlinear elements with complex and strongly nonlinear process. The integration for electronic throttle model and vehicle powertrain dynamics model and FLC can then be used to compare and evaluate the longitudinal vehicle DBW system performance. According to the driver specified vehicle speed command, the corresponding electronic throttle position angle was determined by FLC and change into a real electrical signal from HIL, then PWM signals were send to the throttle DC motor actuator. There are three modes of throttle control which are UP for acceleration, DOWN for deceleration and HOLD for fixing vehicle speed according to the fuzzy control algorithms controlled signal to DBW system by a personal computer. The integrated methodology for HIL environment and longitudinal vehicle powertrain dynamic simulation system by this study accumulates precious experience which can be helpful for the future vehicle DBW control system design and manufacture. The vehicle dynamic system and control parameter ’ s effects on the dynamic response of a vehicle driving performance can be handled quickly and their correlations are important practical information for controller design and parameter evaluation. This study can also help the engineer to reduce the trial-and error time and expanse for developing the future DBW system controller.

Keywords : Vehicle Powertrain System Simulation, Intelligent Cruise Control System, Drive-by-Wire System, Hardware Inthe-Loop, System Identification, Fuzzy Controller.

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