Backward Powertrain Simulation and Analysis of Hybrid Electric Vehicle Performance

章文堯、張一屏

E-mail: 9314784@mail.dyu.edu.tw

ABSTRACT

The purpose of this study is to establish dynamic models and evaluation methodology between subsystems performance for backward powertrain simulation of Hybrid Electric Vehicle (HEV). This study used the fuzzy logical based and logical based energy management in the parallel powered HEV to compare the controlled system performance. The control input factors in power switch system are velocity demand, vehicle torque, and the state of charge (SOC) of battery. Rules of fuzzy and logic control were being set for different operating conditions, for the purpose of more effective output power management to improve the HEV fuel mileage and emission. HEV powertrain system simulation can integrate the modules of subsystems including internal combustion engine, electric motor-generator, fuel cell system and transmission system and their controllers. This study established HEV powertrain system dynamic models by an object-oriented simulation software Matlab/Simulink, to analyze relationship the HEV parameters and its performance. The simulation results were compared with a HEV simulation program ADVISOR. This HEV simulation program was used to study the transient responses of vehicle torques, speeds, fuel economy, battery power, and emissions under different vehicle driving conditions. Different control methods and power combination performance were compared, results showed that a potential fuel economy improvement by using the proper fuzzy logic and logic controller. This simulation program can promptly established correlations between performance parameters, and the design parameters, control parameters under different operating conditions, thus provides the engineers a better reference to reduce designing errors and shorten the designing schedule, which could reduce the HEV cost and increase the design and commercial competitive ability of HEV controller.

Keywords : fuzzy logical based, logical based energy management

Table of Contents

REFERENCES

[1]K. Hirose et.al.,“ The high-expansion-ratio gasoline engine for the hybrid passenger car ”. JSAE Review, pp. 13-21, 1999.

[2]P. Bowles et.al.,“ Energy Management in Paralled Hybrid Electric Vehicle With a Continuously Varable Transmission ”. American Control Conference, PP. 55 -59, 2000.

[3]G. Paganelli et.al.,“ Equivalent consumption minimization strategy for parallel hybrid powertrains ”. Vehicular Technology Conference, pp. 2076- 2081, 2002.
[4]E. Yamada and Y Kawabata,“ Development of test system for motor of hybrid electrical vehicle ”. JSAE Review, pp. 393-399, 1997.
[5]黃朝顯,“ 無刷直流馬達在電動機車應用之控制設計 ”. 國立成功 大學碩士論文, 1997。
[6]陳皇佑,“ 無刷直流馬達高性能轉矩控制設計在動力系統之應 用 ”. 國立成功大學碩士論文, 1999。
[7]W. S Worley,“ Designing Adjustable-Speed V-Belt Drives for Farm Implements ”. SAE Transactions, pp. 321-333, 1955.
[8]蔡豐榮,“ 皮帶式無段變速器(CVT)之電腦輔助設計 ”. 國立清華 大學碩士論文, 1995。
[9]林信吾,“ 無段變速機車性能模擬與測試分析 ”. 國立清華大學碩 士論文, 1996。
[10]李敦維,“ 皮帶式無段變速器之效率分析與改善設計 ”. 國立清 華大學碩士, 1996。
[11]游恭豪,“ 電動機車動力系統之電腦模擬與參數設計 ”. 國立台 灣大學碩士論文, 1999。
[12]林秋豐、曾全佑,“ 機車無段變速箱系統動態模型之建立 ”. 國立 屏東科技大學車輛工程, 2002。
[13]F. Freudenstein and A. T Yang,“ Kinematics and Statics of a Coupled Epicyclic Spur-Gear Train ”. Mechanism and Machine Theory, Vol. 7, pp. 263-275, 1972.
[14]S.D. Farrall,“ Energy management in an automotive electric/heat engine hybrid powertrain using fuzzy decision making ”. IEEE International Symposium on, pp. 463-468, 1993.
[15]H.R. Berenji and E.H Ruspini,“ Experiments in multiobjective fuzzy control of hybrid automotive engines ”. IEEE International Conference , pp.681 – 686, 1996.
[16]C.C. Lee,“ Fuzzy logic in control systems ”. IEEE Transactions, pp.404 – 418, 1998.
[17]E.S. Koo et.al.,“ Torque control strategy for a parallel hybrid vehicle using fuzzy logic ”. IEEE Industry Applications Conference, pp.1715 – 1720, 1998.
[18]H.D. Lee, E.S. Koo and S.K. Sul,“ Torque control strategy for a parallel-hybrid vehicle using fuzzy logic ”, IEEE Industry Applications Magazine, pp.33 – 38, 1998.
[19]H.D. Lee and S.K. Sul,“ Fuzzy-logic-based torque control strategy for parallel-type hybrid electric vehicle ”. IEEE Transactions Industrial Electronics, pp.625 – 632, 1998.
[20]N.J. Schouten et.al.,“ Fuzzy logic control for parallel hybrid vehicles ”. IEEE Control Systems Technology, pp.460 – 468, 2002.
[21]M. Salman, N.J Schouten and N.A Kheir,“ Control strategies for parallel hybrid vehicles ”, American Control Conference, pp. 524 – 528, 2000.
[22]R.B. Sepe et.al.,“ High efficiency operation of a hybrid electric vehicle starter/generator over road profiles ”. IEEE Industry Applications Conference, pp.921 – 925, 2001.
[23]R.B. Sepe et.al.,“ Intelligent efficiency mapping of a hybrid electric vehicle starter/alternator using fuzzy logic ”. Digital Avionics Systems Conference, pp.18th 8.B.2-1 - 8.B.2-8 vol.2, 1999.
[24]C.P. Quigley et.al.,“ Predicting journey parameters for the intelligent control of a hybrid electric vehicle ”. IEEE International Symposium, pp.402 – 407, 1996.
[25]Brahma et.al.,“ Modeling, performance analysis and control design of a hybrid sport-utility vehicle ”. IEEE International Conference, pp. 448 – 453, 1999.
[26]T.E. Springer, T. A. Zawodzinski, S. Gottesfeld,“ Polymer Eletrolyte Fuel Cell Model ”. J. Electrochem.Soc, Vol.138, 1991.
[27]C. Marr, X. Li,“ An engineering model of proton exchange membrane fuel cell performance ”. An Interdisciplinary Journal of Physical and Engineering Sciences, pp.190-200, 1998.
[28]G. Vladimir et.al.,“ An analytical solution of a half-cell model for PEM fuel cell ”. J.Electrochem.Soc, Vol.147, 2000.
[29]陳玠汶,“ 質子交換膜燃料電池之動態模型與模擬 ”. 大葉大學 碩士論文, 2003。
[30]Advisor User Manual, NREL-DOE, 2000.
[31]U. Kiencke and L．Nielsen,“ Automotive Control Systems For Engine Driveline and Vehicle ”, Springer ISBN 3-540-66922-1, pp.47-52, 2000.
[32]P. Setlur et.al.,“ Nonlinear control of a continuously variable transmission (CVT) ”. Control Systems Technology, pp.101 -108, 2003.
[33]黃華馨,“ 馬達與發電機 ”. 無線電界雜誌社, 1995。
[34]L.J. M.J.Blomen and M.N.Mugerwa,“ Fuel cell Systems ”. Plenumprees, New York, 1993.
[35]M.T. Iqbal,“ fuzzy-logic-based Simulation of a small wind fuel cell hybrid energy system ”. Renewable Energy, pp. 511-522, 2003.
[36]翁芳博,“ 元智大學第一次燃料電池研習會 ”, 2000。
[37]李明三,“ 空氣污染減量策略-PEM 燃料電池在機車上之應用與 研究 ”. 十九年度國科會/環保署科技合作計畫期末報告。
[38]陳榮俊,“ 智慧型車輛動力系統之動態模擬與分析 ”. 大葉大學 車輛工程碩士論文, 2202。