Vehicle Lateral Stability by Wire Control System Hardware-In-the-Loop Integration Analysis

游鈞敦、張一屏

E-mail: 9706767@mail.dyu.edu.tw

ABSTRACT

The purpose of this study is to develop an appropriate vehicle yaw stability control system by using vehicle longitudinaland lateral dynamic simulation model. The system input of this study includes the steering wheel angle, vehicle speed change, and vehicle yaw rate to calculate the distribution of vehicle traction and braking force distribution so that the vehicle lateral stability control can be assured. This study established vehicle longitudinal and lateral dynamic simulation model from vehicle dynamics of longitudinal and lateral force, and vehicle design parameters. The object oriented simulation program Matlab/SimulinkR was used to analyze vehicle motion dynamic response. Simulation program can be used to predict the yaw rate response of vehicle when one side wheel slip happened. When the vehicle yaw rate is calculated, the proper locked and controlled Limited Slip Differential (LSD) mechanism and brake force applied to reduce the yaw motion of the vehicle. This study propose a compound traction force control method by using fuzzy logic controller to determine the proportion of longitudinal traction distribution out of LSD from vehicle wheel speed and yaw rate. Vehicle yaw stability control hardware-in-the loop simulation used CAN Bus as the By-Wire platform communication network. Vehicle longitudinal and lateral dynamic simulation program established in this study integrated the CAN control interface card with xPC Target with vehicle sensors and actuators to analyze the vehicle yaw controlled response. This study developed vehicle stability control simulation and hardwires integration methodology which can be used to optimize vehicle controlled lateral stability states with shorter tuning period. This method can improve vehicle active safety, reliability and prevent vehicle instability accident, reduce research and development time of vehicle stability control system.

Keywords : Vehicle Lateral Stability Control, Traction Force Control, Controller Area Network, CAN Bus Hardware-in-the-Loop

Table of Contents

REFERENCES

[1] 王朝森，“車輛定速線傳控制與硬體迴路模擬設計技術整合之研究”，大葉大車輛工程研究所學碩士論文，2005。

[2] F. Petrone, et al.,“A Numerical Model to Analyze the Dyznamic Response of a Vehicle to Variations in Torque Transmitted by the Drive-line,”SAE Paper, No. 2001-01-3334, 2001.

[3] M.K. Salaani, et al, “ Powertrain and Brake Modeling of the 1994 Ford Taurus for the National Advanced Driving Simulation, ” SAE Paper, No. 981190, 1998.
[4] M.K. Salaani, et al., “ Vehicle Dynamics Modeling for the National Advanced Driving Simulator of a 1997 Jeep Cherokee, ” SAE Paper, No. 1999-01-0121, 1999.
[5] M.K. Salaani and G.J. Heydinger and P.A. Grygier, “ Parameter Determination and Vehicle Dynamics Modeling for the NADS of the 1998 Chevrolet Malibu, ” SAE Paper, No. 2001-01-0140, 2001.
[6] O. Hiroshi, et al., “ A study on road slope estimation for automatic transmission control, ” 2000 Society of Automotive Engineers of Japan, JSAE Review 21 (2000) 235-400, 2000.
[7] A. Haj-Fraj and F. Pfeiffer, “ Optimization of Gear Shift Operations in Automatic Transmissions, ” IEEE Proceedings pp.469-473, 2000.
[8] M. Pettersson, L. Nielsen, “ Gear shifting by engine control, ” Control Systems Technology, IEEE Transactions on Volume 8, Issue 3, Page:495 - 507. May 2000.
[9] A. Sahraeian, M. Shahbakhti A. R. Aslani, S. A. Jazayeri, S. Azadi, A. H. Shamekhi, “ Longitudinal Vehicle Dynamics Modeling on the Basis of Engine Modeling, ” SAE Paper, No. 2004-01-1620.
[10] L. Glielmo, L. Iannelli, V. Vacca, F. Vasca, “ Gearshift control for automated manual transmissions, ” Mechatronics, IEEE/ASME Transactions on Volume 11, Issue 1, Feb. Page:17 - 26. 2006.
[11] A. Brighent, A. Pavan, A. Visconti, “ Drive-An Integrated System Approach to Automotive Powertrain Simulation, ” SAE Paper, No. 2003-01-0862.
[12] S. Shan, W. Bowerman, “ An Evaluation of Torque Bias and Efficiency of Torsen Differential, ” SAE Paper, No. 2002-01-1046.
[13] B. Boning, R. Folke, and K. Franzke, “ Traction Control (ASR) Using Fuel-Injection Suppression – A Cost Effective Method of Engine-torque Control, ” SAE Paper, No. 920641, 1992.
[14] A.G. Ulsoy and H. Peng, “ Vehicle Control System ” Lecture Notes by 1997.
[15] 王信發，“ 由煞車距離推估行車速度之研究 ”，中央大學機械工程研究所碩士論文，2002。
[16] G. Baffet, A. Charara, G. Dherbomez, “ An Observer of Tire – Road Forces and Friction for Active Security Vehicle Systems, ” IEEE/ASME Transactions on Volume 12, Issue 6, Dec. 2007 Page:651 – 661. 2007.
[17] J. Y. Wong “ THEORY OF GROUND VEHICLE, ” Third edition pp.18-19, 53, 339-343, 359-361. ISBN: 0-471-35461-9. JOHN WILEY & SONG, INC.2001.
[18] L. R. Ray, “ Nonlinear state and tire force estimation for advanced vehicle control, ” IEEE Transactions on Volume 3, Issue 1, March Page:117 – 124. 1995.
[19] J. Reimpell, H. Stoll, “ The Automotive Chassis: Engineering principles, ” Second edition pp.139. ISBN: 0-7680-0657-0, INC.2001.
[20] K. R. Buckholtz, “ Use of Fuzzy Logic in Wheel Slip Assignment – Part I: Yaw Rate Control with SideslipAngle Limitation, ” SAE Paper, No. 2002-01-1221.
[21] R. W, Allen, “ Stability and Performance Analysis of Automobile Driver Steering Control, ” SAE Paper, No. 820303, 1983.
[22] T. Shim and D. Margolis, “ Using Feedforward for Vehicle Stability Enhancement, ” SAE Paper, No. 2000-01-1634.
[23] K. R. Buckholtz, “ Use of Fuzzy Logic in Wheel Slip Assignment – Part II: Yaw Rate Control with SideslipAngle Limitation, ” SAE Paper, No. 2002-01-1220.
[24] E. Silani, S. M. Savaresi* and S. Bittanti, A. Visconti and F. Farachi, “ The Concept of Performance-Oriented Yaw-Control Systems: Vehicle Model and Analysis, ” SAE Paper, No. 2002-01-1585.
[25] 謝曜兆，“ 應用車內網傳輸於電子節氣門控制之研究 ”，大葉大學車輛工程研究所碩士論文, 2006。
[26] 孫成啟，“ CAN BUS網路之鋼板熱軋溫度監控系統 ”，元智大學碩士論文，2003。
[27] K. Etschberger, “ Controller Area Network Basics, Protocols, Chips and Applications, ” pp.111-115. ISBN: 3-00-007376-0. IXXAT press, 88250 Weingarten, Germany, 2001 [28] 嚴豪緯，“ 泛用型車輛電子控制單元發展平台之研製 ”，大葉大學碩士論文，2005。
[29] L. J. Cheon, W. S. Myung, “ Hardware-in-the Loop Simulator for ABS/TCS, ” IEEE International Conference on Volume 1, 22-27 Aug. Page: 652 - 657 vol. 1. 1999.
[30] Q. Z. Yan, F. C. Thompson, R. E. Paul and J. J. Bielenda, “ Hardware in the Loop for Dynamic Chassis Control Algorithms Test and Validation, ” SAE Paper, No. 2004-01-2059.
[31] W. Huiyi and C. Xue, “ Modelling and Simulation of Electric Stability Program for the Passenger Car, ” SAE Paper, No.2004-01-2090 [32] S. Dafeng, L. Jing, M. Zhimin, L. Youde, Z. Jian, L.Wei, “ Application of CAN in Vehicle Traction Control System, ” IEEE International Conference on Volume 14-16 Oct. Page: 188-192. 2005.
[33] H. Taehun, R. Jihoon, P. Kihong, H. Jeongho, L. Kyu Hoon, L. Kangwon, L. Soo-Jin and K. Young-Jun, “ Development of HILS Systems for Active Brake Control Systems, ” SICE-ICASE International Joint Conference 2006 Oct. 18-2 1, 2006 in Bexco, Busan, Korea.
[34] S. Paual, et al., “ Automotive drive by wire controller design by multi-objective techniques, ” Control Engineering Practice, Proceedings of the IEEE 2005, pp.257-264, 2005.