OPTIMAL COMPOSITE NONLINEAR FEEDBACK CONTROL WITH MULTI OBJECTIVE ALGORITHMS FOR ACTIVE FRONT STEERING SYSTEM

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Specially dedicated to *my beloved family*

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ABSTRACT

The main purpose of controlling vehicle handling is to ensure that the vehicle follows the desired path. Vehicle yaw rate must be controlled in order to achieve a good vehicle handling. In this thesis, optimal Composite Nonlinear Feedback (CNF) controller with multi objective algorithms is proposed for the Active Front Steering (AFS) system in improving the vehicle yaw rate response. The model used to validate the performance of the controller is a 7 degree-of-freedom (DOF) nonlinear vehicle model. This vehicle model is also simplified to a 2 DOF bicycle model for the purpose of controller design. In designing the optimal CNF control, the parameter selection of optimal linear and non-linear gain parameters becomes very important to obtain a good system response. Optimization algorithms are utilized to minimize the complexity in selecting the best parameters. Hence, Multi Objective Particle Swarm Optimization (MOPSO) and Multi Objective Genetic Algorithm (MOGA) are proposed to produce the optimal CNF. Moreover, manual tuning method was utilized and has been compared with the proposed algorithms. As a result, the performance of the yaw rate response is improved with a 98 percent reduction in error. Hence, the vehicle handling can be improved and the vehicle will be able to travel safely on the desired path.

ABSTRAK

Tujuan utama dalam kawalan pengendalian sesebuah kenderaan adalah untuk memastikan kenderaan dapat mengikuti jalan yang diberikan dengan baik. Kadar rewang kenderaan mesti dikawal dalam usaha mencapai satu kawalan kenderaan yang baik. Dalam tesis ini, teknik-teknik Pengawal Maklum Balas Komposit Tidak Linear (CNF) yang optimum dicadangkan untuk aplikasi Sistem Stereng Hadapan Aktif (AFS) bagi memperbaiki kadar rewang kenderaan. Model kenderaan yang tidak linear dengan 7 darjah kebebasan (DOF) telah digunakan untuk pengesahan mutu prestasi pengawal CNF. Model ini juga dimudahkan menjadi model basikal dengan 2 DOF untuk diguna pakai dalam mereka bentuk pengawal CNF. Bagi reka bentuk pengawal CNF yang optimum, pemilihan parameter-parameter gandaan linear dan tidak linear yang optimum adalah penting untuk menghasilkan tindak balas sistem yang baik. Algoritma-algoritma pengoptimuman telah digunakan untuk mengurangkan kerumitan dalam pemilihan parameter-parameter yang terbaik. Maka, Objektif Berganda Pengoptimuman Kawanan Zarah (MOPSO) dan Objektif Berganda Pengoptimuman Algoritma Genetik (MOGA) dicadangkan untuk menghasilkan CNF yang optimum. Bagi tujuan perbandingan dan pengesahan terhadap kedua-dua kaedah optimum ini, kaedah penalaan manual telah dilaksanakan. Hasilnya, keseluruhan prestasi untuk kadar rewang kenderaan telah bertambah baik dengan kadar 98 peratus penyusutan kesilapan. Dengan ini, pengawalan pengendalian kereta dapat ditingkatkan dan kereta dapat bergerak dengan selamat tanpa terpesong keluar daripada jalan yang dikehendaki.