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by

OYAS WAHYUNGGORO

The undersigned certify that they have read, and recommend to the Postgraduate Studies Programme for acceptance this thesis for the fulfilment of the requirements for the degree stated.

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OPTIMIZATION OF HYBRID-FUZZY CONTROLLER FOR SERVOMOTOR CONTROL USING A MODIFIED GENETIC ALGORITHM

by

OYAS WAHYUNGGORO

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ABSTRACT

Servomotor uses feedback controller to control the speed or the position, or both. Typically, the PID controller is used and has evolved into more recent approaches like the hybrid with fuzzy logic controller (FLC) or neural network (NN). Many tuning methods for PID controller have been developed, and one of them is based on natural evolution, the genetic algorithm (GA). The significant drawback of GA is that the optimization process needs too many iterations and too long duration. In this thesis, a new optimization GA-based algorithm that emanates from modification of conventional GA to reduce the iterations number and the duration time, namely, semi-parallel operation genetic algorithm (SPOGA) is proposed. The aim of the algorithm is to improve a controller performance (minimize the overshoot, settling time, IAE/ITAE and achieving zero steady state error) when used for a DC servomotor application. This controller would be optimized to obtain the best overall performances of the performance criterion.

The servomotor's transfer function is obtained via system identification and is modelled using MATLAB commands. The model is used in the simulation of speed and position control and the performance of relevant conventional, fuzzy, and hybrid controllers are compared for various predefined conditions. The best controller is then selected to be optimized using SPOGA. Next, the performance comparison of GA and SPOGA is conducted based on the maximum value of parallel functions obtained. The SPOGA is then used to optimize the selected controllers and the performance comparisons of the controllers were conducted.

Detailed performance comparisons of controllers for a DC servomotor speed and position control under seven predefined conditions is presented. As compared to conventional GA, SPOGA performs better in reducing the number of test runs with the same results. The findings demonstrate the effectiveness of the hybrid-fuzzy controller for speed and position control of a DC servomotor, and confirm the ability of SPOGA as an optimization algorithm for the hybrid-fuzzy controller.

ABSTRAK

Motor servo menggunakan pengawal suapbalik untuk mengawal kelajuan atau kedudukan, atau kedua-duanya. Biasanya, pengawal PID digunakan dan telah berkembang menjadi pendekatan yang lebih baru seperti hibrid dengan pengawal logik fuzzi (FLC) atau rangkaian saraf (NN). Banyak kaedah penalaan untuk pengawal PID telah dibangunkan, dan salah satunya didasarkan pada evolusi tabii, algoritma genetik (GA). Kelemahan kentara dari GA adalah bahawa proses pengoptimuman keperluan tempoh iterasi terlalu banyak dan terlalu panjang. Dalam tesis ini, algoritma pengoptimuman baru berasaskan GA yang berasal dari pengubahsuaian GA konvensional untuk mengurangkan jumlah iterasi dan masatempoh, iaitu, semi-selari operasi algoritma genetik (SPOGA) dicadangkan. Tujuan dari algoritma ini adalah untuk meningkatkan prestasi pengawal (meminimumkan terlajak maksimum, masa pengenapan, IAE / ITAE dan mencapai ralat sifar keadaan mantap) bila digunakan untuk penggunaan motor servo AT. Pengawal ini akan dioptimumkan untuk mendapatkan prestasi terbaik daripada keseluruhan kriteria prestasi.

Rangkap pindah motor servo diperolehi melalui pengenalan sistem dan dimodelkan menggunakan arahan MATLAB. Model ini digunakan dalam simulasi kelajuan dan kawalan kedudukan dan prestasi kawalan konvensional, fuzzi, dan hibrid yang relevan untuk berbagai keadaan. Pengawal yang terbaik kemudian dipilih untuk dioptimumkan menggunakan GA / SPOGA. Selanjutnya, perbandingan prestasi GA dan SPOGA dilakukan berdasarkan nilai maksimum rangkap selari diperolehi. SPOGA kemudian digunakan untuk mengoptimumkan pengawal yang dipilih dan perbandingan prestasi kawalan dilakukan.

Perbandingan prestasi terperinci pengawal untuk kelajuan motor servo AT dan kawalan kedudukan untuk tujuh keadaan piawai dipersembahkan. Dibandingkan dengan GA konvensional, SPOGA adalah lebih baik dalam mengurangkan jumlah ujian dengan hasil yang sama. Penemuan menunjukkan keberkesanan pengawal

hibrid-fuzzi untuk mengawal kelajuan dan kedudukan sebuah motor servo AT, dan menegaskan kemampuan SPOGA sebagai algoritma pengoptimuman untuk pengawal hibrid-fuzzi.