BOILER MODELING AND CONTROLLER PERFORMANCE OPTIMIZATION USING GENETIC ALGORITHM FOR PALM OIL INDUSTRY

CHEW ING MING

FACULTY OF ENGINEERING
UNIVERSITI MALAYSIA SABAH
2020

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THESIS SUBMITTED IN FULFILLMENT FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

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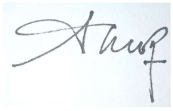

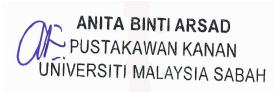

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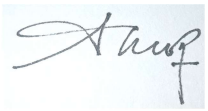
DECLARATION

I hereby declare that the material in this thesis is my own except for quotations, equations, summaries and references, which have been duly acknowledged.



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CERTIFICATION

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FIELD	:	**ELECTRICAL AND ELECTRONIC ENGINEERING**
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ABSTRACT

This research developed control algorithms and Graphical User Interfaces (GUI) using Genetic Algorithm (GA) optimization analysis for the boiler control system. The trade-off optimized PI controller tunings visualized by Adaptive GA Optimization Contol Toolboxes provided the best control performance in terms of settling time and integral error values for both servo and regulatory controls. Routh-Hurwitz necessity criterion analysis has been applied to determine the stability margins. This criterion has restricted the search region of GA to ensure proper searching of chromosomes to minimize the period for optimization analysis and avoiding the optimum PI tunings values from missing out on any search region. The conducted simulation and validation tests have shown that Adaptive GA Optimization Analysis Toolboxes has provided better PI tunings to improve the control performance indexes up to 84.61% for the simulation analysis and 93.25% improvement on the validation tests. In addition, the settling time of the control responses have improved up to 80.18% for simulation analysis and 83.49% for validation test. The reason is due to Adaptive GA Optimization has applied stochastic optimization technique, which is repetitively proposed individuals or chromosomes to be tested using objective function in the computation analysis and then, will choose the controller tunings with least integral error values for both servo and regulatory controls. It offers better tuning opportunity without relying on the fixed tuning formulas as performed by manually calculated controller tunings.

ABSTRAK

(PEMODELAN DANDANG DAN PENGOPTIMUMAN PRESTASI PENGAWAL MENGGUNAKAN ALGORITMA GENETIK BAGI INDUSTRI KELAPA SAWIT)

Kajian ini membangunkan algoritma kawalan dan Pengantara Muka Grafik dengan menggunakan analisis pengoptimuman Algoritma Genetik (GA) untuk sistem kawalan dandang. Penalaan pengawal PI yang dioptimumkan untuk pelarasan seperti divisualisasikan oleh Kotak Alat Pengawal Pengoptimuman GA Adaptif memberikan prestasi kawalan terbaik dari segi masa penetapan dan nilai ralat kamiran untuk kedua-dua kawalan servo dan kawalan selia. Kriteria Routh-Hurwitz telah digunakan untuk menentukan kestabilan margin. Kriteria ini telah menghadkan kawasan carian GA untuk mempastikan pencarian yang betul untuk kromosom bagi mengurangkan tempoh masa untuk analisis pengoptimuman dan mengelakkan nilai penalaan PI optimum daripada tercicir dalam kawasan carian. Ujian simulasi dan pengesahan yang dijalankan telah menunjukkan bahawa Kotak Alat Analisis Pengoptimuman GA Adaptif telah memberikan penalaan PI yang lebih baik untuk peningkatan indeks prestasi kawalan sehingga 84.61% untuk ujian simulasi dan 93.25% bagi ujian pengesahan. Tambahan pula, masa penyelesaian proses telah ditambah baik sehingga 80.18% untuk ujian simulasi dan 83.49% bagi ujian pengesahan. Ini disebabkan oleh Pengoptimuman GA Adaptif menggunakan teknik pengoptimuman stokastik di mana, ia secara berulangan akan mencadangkan individu atau kromosom untuk diuji dengan menggunakan fungsi objektif dalam analisis pengiraan dan kemudian memilih penalaan pengawal dengan nilai ralat kamiran yang paling rendah untuk kawalan servo dan kawalan selia. Ia memberikan peluang penalaan yang baik tanpa bergantung kepada formula penalaan tetap seperti yang digunapakai dalam penalaan pengawal yang dikira secara manual.

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