

# 中文摘要

本論文應用混合差分演化法(Hybrid Differential Evolution, HDE)於 PID 控制器之最佳化設計，並在數位訊號控制器 dsPIC30F4011 的基礎架構下，實際應用於三相感應馬達的速度控制。PID 控制為產業界較常使用的方法之一，其原因在於 PID 控制器架構簡單、易於實現，且不需精確的系統模型即可實現閉迴路控制，而 PID 控制的成功與否取決於是否能找到符合控制需求的 PID 參數解。在 PID 參數的調整上，通常必須仰賴操作者經驗或利用試誤法決定，因此較為不便。

本論文應用混合差分演化法搜尋 PID 控制參數之最佳解。混合差分演化法是一種隨機搜尋、以族群為基礎之最佳化工具，透過複製、突變、重組、遷移、加速等演化程序，以求取參數之最佳解。當獲得符合系統的 PID 參數解後，再將之寫入數位訊號控制器中，以進行感應馬達的最佳 PID 速度控制。

為驗證所提出方法的可行性，本論文利用一部三相感應馬達進行實驗，其結果並與基因演算法(Genetic Algorithm, GA)以及非線性控制設計(Nonlinear Control Design, NCD)法進行比較，其中 NCD 法由 Matlab/Simulink 軟體提供。從實驗結果顯示，本論文所提出的混合差分演化法具有較佳的啟動與負載變動特性。

# 英文摘要

This thesis proposes the hybrid differential evolution (HDE) method to the optimal design of PID controller. Based on the basis structure of digital signal controller, the proposed optimal PID controller was practically applied to the speed control of three-phase induction motor. The PID control is one of the popular methods in industrial circles. Its reason lies in that PID controller is of simple structure, easy to realize, and does not need accurate systematic model to carry out the close-loop control. However, it is necessary to find a set of adequate PID parameter to successfully implement the PID control. In general, the operators adjust PID parameters according to their experiences or by “try and error” method, which leads to the inconvenient for parameter adjustment.

This thesis applies HDE method to search for the optimal solution of PID parameters. HDE is a stochastic search and population-based optimization tool. It employs reproduction, mutation, recombination, migration, selection, and acceleration operators to find the optimal solution. When the Optimal PID parameters are obtained, they will be written into digital signal controller in order to carry out the optimal PID speed control of induction motor.

To verify the performance of the proposed method, this thesis employs a three-phase induction motor to accomplish the experiments. Results of the proposed method are compared with the genetic algorithm (GA) and nonlinear control design (NCD) method which is provided by Matlab/Simulink software. Results show that the proposed HDE method can provide better characteristics in start-up and load variation experiments.