國立中興大學機械工程研究所

碩士論文

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單軸渦輪噴射引擎性能模擬

The Simulation of Performance for a Single Spool Turbojet Engine

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摘 要

本文主要目的是建立一套計算程序，以進行單軸渦輪噴射引擎的穩態及動態模擬。本文首先建立三種模式，分別是以級疊法計算壓縮機性能的引擎穩態模式、以塊狀法來推導的動態模式，及大幅簡化引擎性能圖的動態模式，其中引擎各主要構成件的性能特性是參照J-85引擎所建立。

引擎穩態性能模式的計算，是由已知的飛行條件及控制變數，以Newton-Raphsion疊代法來求出引擎的運轉狀態；簡化的引擎模式首先是建立一組非線性動態模式，然後以一套計算程序，來計算出操作線上的一穩態解，作爲動態模擬的初始值，然後設定燃油的變化，再對狀態變數積分，便可得出引擎的非線性動態性能響應。在對該系統線性化時，以兩種不同的方法來找出對應該飛行狀態的線性化模式矩陣；本文亦比較其線性近似模式及非線性模式模擬的差異，找出線性化模式的適用條件，做爲引擎線性控制器設計的依據。本文亦將此系統降至一階，僅保留轉軸轉速的暫態特性，並和原線性及非線性系統作比較，結果其差距甚小，因此應可將其視爲準一階系統，亦可知影響此簡化引擎系統性能最重要的變數是爲引擎轉軸轉速。

實際引擎的模擬，穩態和動態模擬的結果，除數值不同外，並無多大的差異。

ABSTRACT

The objective of this thesis is to establish the calculation procedures to simulate the dynamics of a single spool turbojet engine. Three models were established in thesis. The first one is the steady state model in which the compressor performance was calculated using the stage stacking method. The second one is the lumped dynamic model, and the third one is a simplified dynamic model in which all the performance maps were replaced with simple contants. The characteristics of the main components of the simulated engine were based on the J-85 engine.

In calculating the engine steady state performance, the flight conditions and the control variables were used as input conditions and the Newton-Raphsion method was used to find the steady solution. For dynamic simulations, the steady state solutions just obtained were used as the initial conditions and the main fuel flow was set to change. The state variables were then intergrated to obtain the nonlinear dynamic response of the engine. Two different ways of linearization were used in this thesis and the results were compared. The dynamic simulations of linear and nonlinear models were also compared in this thesis to find the appropriate conditions for linearization. Furthermore, the engin dynamic model was reduced to a first order system with only the spool dynamics remained. Comparisons of the first order system and the original system showed that if the control variable was not set to change too much, the response of the first order system and the original system were almost the same. as a result, the engine dynamic system can be treated as a quasi first order system, and the most important factor that affect the engine dynamic is the spool rotor.

目　錄