Inverse modelling of multi-objective thermodynamically optimized turbojet engines using GMDH-type neural networks and evolutionary algorithms

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(Received 23 April 2004; revised 7 September 2004 in final form 18 November 2004)

A novel approach is presented in this article for obtaining inverse mapping of thermodynamically Pareto-optimized ideal turbojet engines using group method of data handling (GMDH)-type neural networks and evolutionary algorithms (EAs). EAs are used in two different aspects. Firstly, multi-objective EAs (non-dominated sorting genetic algorithm-II) with a new diversity preserving mechanism are used for Pareto-based optimization of the thermodynamic cycle of ideal turbojet engines considering four important conflicting thermodynamic objectives, namely, specific thrust (ST), specific fuel consumption (SFC), propulsive efficiency ($\eta_p$), and thermal efficiency ($\eta_t$). The best obtained Pareto front, as a result, is a data table representing data pairs of non-dominated vectors of design variables, which are Mach number and pressure ratio, and the corresponding four objective functions. Secondly, EAs and singular value decomposition are deployed simultaneously for optimal design of both connectivity configuration and the values of coefficients, respectively, involved in GMDH-type neural networks which are used for the inverse modelling of the input–output data table obtained as the best Pareto front. Therefore, two different polynomial relations among the four thermo-mechanical objectives and both Mach number and pressure ratio are searched using that Pareto front. The results obtained in this paper are very promising and show that such important relationships may exist and could be discovered using both multi-objective EAs and evolutionarily designed GMDH-type neural networks.

Keywords: Turbojet engines; Pareto optimization; Multi-objective optimization; Genetic algorithms; GMDH

1. Introduction

Optimization in engineering design has always been of great importance and interest particularly in solving complex real world design problems. Basically, the optimization process is defined as to find a set of values for a vector of design variables that leads to an optimum value of an objective or cost function. There are many calculus-based methods including gradient approaches to single objective optimization which are well documented in Arora (1989) and...