Simultaneous topology and size optimization of structures by genetic algorithm using minimal length chromosome

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Abstract

Purpose – Layout optimization of structures aims to find the optimal topology and member sizes in an integrated manner. For this purpose, the most successful attempts have addressed the outstanding features of the genetic algorithms.

Design/methodology/approach – This paper utilizes a direct index coding (DIC) in a way that the optimization algorithm can simultaneously integrate topology and size in a minimal length chromosome in order to seek the true optimum in an efficient and reasonable manner. Proper genetic operators are adopted for this special kind of encoding together with some modifications in the topological mutation aiming to improve the convergence of the algorithm.

Findings – The present DIC, has the following features: enforcing one-to-one correspondence between discrete genotype space and the problems' phenotype space; avoiding any out-of-bound parameter addressing and limiting the GA search only to necessary genotypes; reduction in the size of genotype search space to increase the algorithm convergence and the possibility of leading to the global optimum; dealing with direct genetic operators so that the GA parameters can be purely controlled to tune the desired balance between convergence and escaping from local optima.

Originality/value – Employing direct index chromosome makes it possible to eliminate the additional topological bits in treated examples.

Keywords Optimization techniques, Programming and algorithm theory, Structures

Paper type Research paper

1. Introduction

Layout optimization of structures aims to find the optimal topology and member sizes in an integrated manner (Rozvany, 1988; Prager and Rozvany, 1977; Arora, 1989). In the well-known deterministic methods, size optimization is limited to the fixed topology while optimal topology itself depends on the mechanical properties and sizing of the structural members (Rozvany, 1988; Prager and Rozvany, 1977). Thus, a paradox arises in seeking true optimal layout if the topology and members sizing are not simultaneously altered in the optimization process.

A number of attempts by researchers dealing with this problem have already been reported, (Burns, 2004; Mijar *et al.*, 1998; Katsuyuki and Noboru, 1991;

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