Advances in Computational Design, *Vol. 1, No. 3 (2016) 275-296*
DOI: http://dx.doi.org/10.12989/acd.2016.1.3.275

Discrete optimal sizing of truss using adaptive directional differential evolution

Anh H. Pham*

Department of Structural Mechanics, National University of Civil Engineering, 55 Giai Phong Road, Hanoi, Vietnam

(Received June 22, 2016, Revised July 19, 2016, Accepted July 21, 2016)

Abstract. This article presents an adaptive directional differential evolution (ADDE) algorithm and its application in solving discrete sizing truss optimization problems. The algorithm is featured by a new self-adaptation approach and a simple directional strategy. In the adaptation approach, the mutation operator is adjusted in accordance with the change of population diversity, which can well balance between global exploration and local exploitation as well as locate the promising solutions. The directional strategy is based on the order relation between two difference solutions chosen for mutation and can bias the search direction for increasing the possibility of finding improved solutions. In addition, a new scaling factor is introduced as a vector of uniform random variables to maintain the diversity without crossover operation. Numerical results show that the optimal solutions of ADDE are as good as or better than those from some modern metaheuristics in the literature, while ADDE often uses fewer structural analyses.

Keywords: adaptive directional differential evolution; population diversity; truss sizing optimization; discrete variables

1. Introduction

The goal of structural optimization is to obtain appropriate form for a structure so that it is safe and economical. Structural optimization can be classified as sizing optimization (finding optimal size of structural members), shaping optimization (obtaining the optimal form for the structure) and topology optimization (optimal size and connectivity between structural members). These have been an extensive research area both in modeling and development of optimization methods.

Optimal sizing design of truss structure is an important field within structural optimization. Truss sizing optimization is known as a difficult optimization problem because of non-linear constraints and non-convex feasible region, which requires appropriate optimization techniques. Moreover, the design variables (the cross-section areas) are usually discrete values which can be selected from a list of available values provided by manufacturers. These inherent characteristics of the problem do not favor conventional gradient-based techniques. Developing efficiently alternative methods for truss optimization with discrete design variables remains one of the interesting subjects for many researchers.

*Corresponding author, Ph.D., E-mail: anhpham.nuce@gmail.com

http://www.techno-press.com/journals/acd&subpage=7 ISSN: 2383-8477 (Print), 2466-0523 (Online)

Zamuda, A., Brest, J. and Mezura-Montes, E. (2013), "Structured population size reduction differential evolution with multiple mutation strategies on CEC 2013 real parameter optimization", *Evolutionary Computation (CEC), 2013 IEEE Congress on*, IEEE.

Zhang, J. and Sanderson, A.C. (2009), "JADE: adaptive differential evolution with optional external archive", *Evolutionary Computation, IEEE Transactions on*, **13**(5), 945-958.

CC