

A MODIFIED HARMONY SEARCH METHOD IN CONSTRAINED OPTIMIZATION

XIAO-ZHI GAO¹, XIAOLEI WANG¹, SEPPO JARI OVASKA¹ AND HE XU²

¹Department of Electrical Engineering
Aalto University

P. O. Box 13000, FI-00076 Aalto, Finland
{ gao; xiaolei }@cc.hut.fi; seppo.ovaska@tkk.fi

²College of Mechanical and Electrical Engineering
Harbin Engineering University
Harbin 150001, P. R. China
xuhe@hrbeu.edu.cn

Received April 2009; revised August 2009

ABSTRACT. *The Harmony Search (HS) method is an emerging meta-heuristic optimization algorithm. It has been employed to cope with numerous challenging tasks. Inspired by the idea of Pareto-dominance-based ranking, in this paper, we propose a modified HS method for solving the constrained optimization problems. A few nonlinear functions and three engineering design problems are also used to demonstrate and verify the effectiveness of our new HS method.*

Keywords: Harmony search, Constrained optimization, Pareto-dominance, Mobile robots

1. Introduction. Modern meta-heuristic methods, such as the Genetic Algorithms (GA) [1], evolutionary algorithms [2], and Particle Swarm Optimization (PSO) [3], have witnessed significant successes in handling various engineering optimization problems [4]. Firstly proposed by Geem *et al.* in 2001 [5], the Harmony Search (HS) method is inspired by the underlying principles of the musicians' improvisation of harmony. During the recent years, it has been successfully applied in the areas of function optimization [6], mechanical structure design [7], pipe network optimization [8], optimization of data classification systems [9], and multi-modal optimization [10]. Unfortunately, empirical study has also shown that the original HS algorithm is not suitable for dealing with the constrained optimization problems. To overcome this drawback, we here propose a modified HS method, which is based on the direct handling of the given constraints. Extensive simulations have demonstrated that our HS approach is effective in attacking difficult constrained optimization problems.

The rest of this paper is organized as follows. We briefly introduce the essential principles of the original HS method in Section 2. The modified HS method for constrained optimization is presented and discussed in Section 3. Simulation examples of several functions optimization and three practical design problems are examined in Section 4. Finally, in Section 5, we conclude our paper with some remarks and conclusions.

2. Harmony Search (HS) Method. As we know, when musicians compose harmony, they usually try various possible combinations of the music pitches stored in their memory. This search for the perfect harmony is indeed analogous to the procedure of finding the optimal solutions to engineering problems. The HS method is actually inspired by the