SN Computer Science (2024)5:175
https://doi.org/10.1007/s42979-023-02356-1

ORIGINAL RESEARCH

Opposition-Based Artificial Hummingbird Algorithm Applied to Elementary Machine Design Problems

Vidyasagar Bhattacharjee[1,3] · Provas Kumar Roy[2] · Chandan Chattoraj[1]

Received: 23 May 2023 / Accepted: 23 September 2023

Abstract

Component items and constituent units of different mechanisms or structures to transfer energy in the operational process of any system of machineries are designed and accordingly manufactured to provide a smooth and reliable functioning life to meet the desired competency in the system performance at a reasonable costing. Considering several structural and operational challenges and growing with the continuously changing modes of requirements, design optimizing the controlling factors of a working system has become a complex workspace of modern-times research. In the present study, CEC 2017 unconstrained benchmark functions and the design parameters of six number constrained cases of engineering design optimization, viz., belt-pulley drive, hydrostatic thrust bearing, cylindrical roller bearing, spherical roller bearing, plate fin heat exchanger, and a shell and tube heat exchanger, have been optimized by an improved variant of a newly proposed swarm intelligence-based metaheuristic, artificial hummingbird algorithm (AHA). An attempt has been made by integrating the opposition-based learning rule (OBL) in the initializing as well as in the final population-updating stages during each iteration of the AHA methodology to employ more diverse and effective population for a further enhancement in the solution quality and in the rate of convergence toward global optimization. Comprehensive statistical analysis of the simulated results on CEC 2017 through the standard measures and tests demonstrates that the optimization ability of the proposed opposition-based artificial hummingbird algorithm (OBAHA) is superior to all its selected competitors and optimized engineering designs, and its statistical comparison with the leading performances of literature clearly identifies the better performance of OBAHA in terms of fitness solution, convergence, robustness, and computational time, and in both the simulation phases, OBAHA seems to be a highly effective variant of AHA.

Keywords Metaheuristics · Opposition-based learning · Opposition-based artificial hummingbird algorithm · Mechanical engineering system components · Constrained design optimization

✉ Vidyasagar Bhattacharjee
vs.bhatt.04@gmail.com

Provas Kumar Roy
roy_provas@yahoo.com

Chandan Chattoraj
chandan.chattoraj@bcrec.ac.in

[1] Department of Mechanical Engineering, Dr. B C Roy Engineering College, Durgapur, West Bengal, India

[2] Department of Electrical Engineering, Kalyani Government Engineering College, Kalyani, West Bengal, India

[3] Present Address: Dr. B. C Roy Engineering College, Durgapur, West Bengal 713206, India

Published online: 10 January 2024