



Chaotic artificial hummingbird algorithm applied to elementary machine design problems

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Abstract

Artificial hummingbird algorithm (AHA) is a recently developed swarm-based metaheuristic. The three food foraging strategies of natural hummingbirds, viz., guided, territorial and migration foraging using their three unique flight skills optimally via an intelligent memory updating mechanism, called visit table have been mathematically conversed in the AHA methodology, which enables the algorithm for an effective exploration-exploitation search characteristic. With an intention of further enhancement in the search quality of AHA, the nonlinear dynamics of the selected chaotic map, Gauss/mouse has been integrated with the algorithm framework, and proposed as chaotic artificial hummingbird algorithm (CAHA). During the earlier iterations of guided foraging, the chaos-embedded flight or direction vectors enhance the search-exploration of the process and thereby reduces the local optima convergence. In the later iterations of the same event, the exploitative search by the hummingbirds gets enhanced with these chaotic direction-control vectors. In the same way, the local search-exploitation during the territorial foraging is chaotically excited to obtain more accuracy in the optimized solutions. Further, the occurrence of these two foraging events has been chaotically sequenced for more effective diversifying search towards global optimization. Welded beam design, helical compression spring, pressure vessel, gear train, speed reducer, hollow shaft and multiple disc clutch brake are the considered mechanical component design cases for the present study to evaluate CAHA. Comparative analysis of the obtained results for all the problems with the leading designs of literature reveals that, CAHA performs significantly better in terms of solution robustness, convergence speed and the constraint fulfillment criteria.

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