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Hybrid chimp optimization algorithm for degree reduction of ball Said–Ball curves

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Abstract
The optimal multi-degree reduction of ball Said–Ball curves is an unsolved and knotty important technique in computer aided design (CAD) and computer graphics (CG) and is potentially used in many engineering fields involving geometric modeling. In this paper, an improved chimp optimization algorithm (ICHOA, for short) is used to solve the degree reduction of BSB curves. Firstly, the multi-degree reduction of BSB curves is mathematically an optimization problem that can be efficiently dealt with by a swarm intelligence algorithm. In this regard, a novel enhanced version of CHOA called ICHOA, combined with the proportional weight, dimension learning-based hunting search and fractional order strategies, is developed to enhance its capability of jumping out of the local minima and improve the calculation accuracy of the native algorithm. Furthermore, the superiority of the ICHOA is verified by comparing it with standard CHOA, other improved CHOA and popular nature-inspired optimization algorithms on 23 classical benchmark functions, the CEC'17 test suite and five engineering optimization problems, respectively. Secondly, the optimization models of multi-degree reduction for the center curve and radius function of BSB curves are established, respectively; meanwhile, the proposed ICHOA is utilized to solve the established optimization models, and the optimal center curve and radius function with a minimum distance of the approximating BSB curves of lower degree are also obtained. Finally, experimental results illustrate the ability of the proposed ICHOA to effectively solve the optimization problems of multi-degree reduction of BSB curves in terms of precision, robustness, and convergence characteristics.

Keywords Chimp optimization algorithm · Dimension learning-based hunting search · Fractional order strategy · Ball Said–Ball curves · Multi-degree reduction

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