Novel Metaheuristic Hybrid Spiral-Dynamic Bacteria-Chemotaxis Algorithms for Global Optimisation

A.N.K. Nasir[a, b], M.O. Tokhi[a]

[a] Department of Automatic Control & Systems Engineering, University of Sheffield, UK

[b] Faculty of Electrical & Electronics Eng., Universiti Malaysia Pahang, 26600 Pekan, Pahang, Malaysia

ABSTRACT

This paper presents hybrid spiral-dynamic bacteria-chemotaxis algorithms for global optimisation and their application to control of a flexible manipulator system. Spiral dynamic algorithm (SDA) has faster convergence speed and good exploitation strategy. However, the incorporation of constant radius and angular displacement in its spiral model causes the exploration strategy to be less effective hence resulting in low accurate solution. Bacteria chemotaxis on the other hand, is the most prominent strategy in bacterial foraging algorithm. However, the incorporation of a constant step-size for the bacteria movement affects the algorithm performance. Defining a large step-size results in faster convergence speed but produces low accuracy while defining a small step-size gives high accuracy but produces slower convergence speed. The hybrid algorithms proposed in this paper synergise SDA and bacteria chemotaxis and thus introduce more effective exploration strategy leading to higher accuracy, faster convergence speed and low computation time. The proposed algorithms are tested with several benchmark functions and statistically analysed via nonparametric Friedman and Wilcoxon signed rank tests as well as parametric *t*-test in comparison to their predecessor algorithms. Moreover, they are used to optimise hybrid Proportional-Derivative-like fuzzy-logic controller for position tracking of a flexible manipulator system. The results show that the proposed algorithms significantly improve both convergence speed as well as fitness accuracy and result in better system response in controlling the flexible manipulator.

KEYWORDS: Spiral dynamics; Bacteria chemotaxis; PD-like control; Fuzzy logic control; Flexible manipulator system

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