A NOVEL PARTICLE SWARM-BASED SYMBIOTIC EVOLUTIONARY ALGORITHM FOR A CLASS OF MULTI-MODAL FUNCTIONS

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Abstract. *Particle swarm-based symbiotic evolutionary (PSSE) algorithm is a novel symbiotic evolution (SE) that incorporates particle swarm optimization (PSO). Different from the conventional genetic algorithm (GA), PSSE established the coevolution and the cooperation between symbiotic relationship and swarm intelligence. Moreover, due to the adoption of sexual selection and biological arms race, PSSE is easily added into a global optimum when solving multi-modal numerical optimization problems. In this novel algorithm, gene hierarchy and gene particle swarm (GPS) model are defined. Except for the prototype PSSE, two collocating strategies of inertia weight for PSSE-LTI (linear time invariant) and PSSE-NTI (nonlinear time invariant) are also considered when the genes lie on a different level of hierarchy. Four famous benchmark functions are used to test the performance. Simulation results show this algorithm can improve the performance significantly.*
Keywords: Genetic algorithm, Particle swarm optimization, Symbiotic evolution

1. **Introduction.** Symbiotic evolution (SE) is a gene population-based and random searching optimization method. It was first introduced by Moriarty [1-3] in 1996 and is classified in the category of genetic algorithm (GA). Its fundamental idea is based on a simulation of simplified biological *symbiotic relationships*, such as clownfish amid sea anemone tentacles, bumblebees and flowers, etc. During the recent years, it has been successfully applied in the areas of neural fuzzy network for controller design [4], surface reconstruction in stereo vision [5], diagnostic system for abdominal pain [6] and job-shop scheduling [7]. Unfortunately, empirical studies have shown that the original SE method sometimes suffers from a local search result [4-6,8], and it is not suitable for handling the multi-modal problems [3,9-11]. To overcome these drawbacks, two modified SE methods are proposed in this article. The basic modified SE method is a hybridization of the Particle Swarm Optimization (PSO) and Symbiotic Evolution (SE): PSSE, which can improve the convergent performance of the regular SE method. The PSO technique is a simple but universal optimizer [12,13]. The particles in the PSO are updated by an amount of the different between personal best position and global best position. The PSO has the distinguishing advantages of computation simplicity as well as convergent efficiency [14-17]. The second modified SE method is based on the employment of effective diversity maintenance for the inertia weight of the gene hierarchy. Extensive computer simulations have shown that these two modified SE methods can outperform the original SE and GA in attacking the multi-modal optimization problems.

The organization of this paper is as follows. The essential principle of the SE method is introduced in Section 2. In Section 3, a typical model of particle swarm optimization