PSO-LFDE Algorithm on Constrained Real-Parameter Optimisation Test Functions

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ABSTRACT: This paper introduces a new version of the particle swarm optimisation (PSO) algorithm particle swarm optimisation with Lévy Flight and Doppler Effect (PSO-LFDE), maintaining an optimal balance between the exploration and exploitation phases of the optimisation process. Keeping this balance between global and personal bests' roles in attracting particles, on the one hand, and convergence and diversity, on the other, will hold a better exploration-exploitation balance in the proposed algorithm. The proposed PSO-LFDE algorithm was compare with the PSO algorithm by Gaing on single-objective constrained real-parameter optimisation test functions. The results indicated that the PSO-LFDE has achieved competitive results on the single-objective constrained real-parameter optimisation test functions as compared to PSO algorithm by Gaing. Thus, the PSO-LFDE is validated as a stable, well-designed algorithm and can be a functional alternative approach to deal with various single-objective constrained real-parameter optimisation problems.

Keywords: *PSO, Optimisation, Single Objective Function*

1. INTRODUCTION

Particle swarm optimisation algorithm (PSO) is an Evolutionary Computation technique that is less expensive computer-based and can converge faster than other approaches. Currently, the PSO algorithm attracts researcher attention and is wide implements in various fields [2]–[5]. The terms swarm is maintained in the PSO algorithm proposed by Kennedy and Eberhart under the principles of swarm intelligence, namely proximity, quality, diverse response, stability and adaptability [1], [6]–[9].

Maintaining a suitable balance between the exploration and exploitation phases of the optimisation process is the main shortcoming of PSO and every other metaheuristic algorithm. Some algorithms, such as PSO, have a good capability for exploiting a high convergence rate to promising areas in the search space encountered [1]. Additionally, to a brief theoretical background and happy programming and coding of the machine, the PSO technique can produce high-quality solutions in a short computational time [10]. This paper introduces a new swarm intelligence algorithm called particle swarm optimisation algorithm with Lévy Flight and Doppler Effect (PSO-LFDE), an upgraded version of the original PSO [11]–[13].

2. CURRENT RESULTS

PSO-LFDE is validated on single-objective constrained real-parameter optimisation test functions. The selected functions come from different types; quadratic, cubic, nonlinear, linear, and others. All test functions are to minimise the values. The best optimum, mean, worst, and standard deviation of the 30 runs of the algorithm are calculated and employed as the primary performance criteria. The PSO-LFDE method based on the result achieved, and some of them will achieve the desired global optimum values in 30 runs.

Additionally, the standard deviation will determine the algorithm's accuracy since the most negligible standard deviation effects prove that the algorithm has the highest precision. A low standard deviation indicates that most of the results are very similar to the average and thus more accurate. On the other hand, a high standard deviation indicates that the measurements are inconsistent and less accurate.

Figure 1 shows the average percentage deviation between PSO and PSO-LFDE on single-objective constrained real-parameter optimisation test functions with different dimensions in the form of a graph. This graph is presented the standard deviation of PSO and PSO-LFDE in percentage to show the difference between the algorithms for a better view. Moreover, the ANOVA test will be used to determine whether or not the findings are significant.

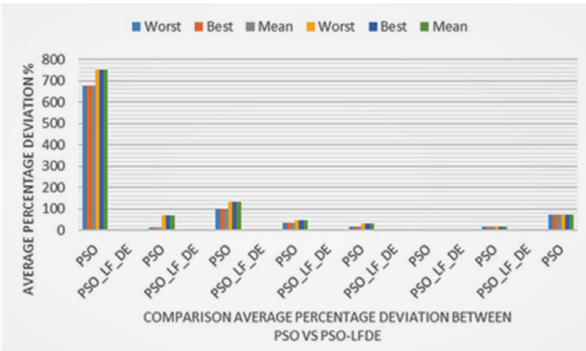

Figure 1 Comparison average percentage deviation between PSO vs PSO-LFDE for single-objective constrained real-parameter optimisation test functions over 30 independent runs

Table 2 compares the performance of PSO and PSO-LFDE on the mean value ∓ standard deviation of the optimal global value for single-objective constrained real-parameter optimisation test functions using one-way analysis of variance (ANOVA) [7]. The table illustrates that the PSO-LFDE findings on single-objective constrained real-parameter optimisation test functions are substantial and significant in indicating that this method can achieve a superior global optimum value.

Table 2 Minimisation results of single-objective constrained real-parameter optimisation test functions with n = 30

No	F(x)		Mean	σ
F01	-15.00	PSO	-116.33	5.778E-14
		PSO_LF_DE	-127.80	5.778E-14
F02	5126.49	PSO	4539.1641	1.849E-12
		PSO_LF_DE	1674.5755	6.933E-13
F03	0.7499	PSO	0.00	0.00
		PSO_LF_DE	-0.238719	8.464E-17
F04	0.05394	PSO	0.035919	0.00
		PSO_LF_DE	0.030158	1.058E-17
F05	-5.5080	PSO	-6.43144	3.611E-15
		PSO_LF_DE	-7.21243	5.417E-15
F06	-30665.5	PSO	-32154.43	2.227E-11
		PSO_LF_DE	-32154.43	2.227E-11
F07	-6961.8	PSO	-7973	0.00
		PSO_LF_DE	-7973	0.00
F08	7049.2	PSO	2100	0.00
		PSO_LF_DE	2100	0.00

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