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GLOWWORM SWARM OPTIMIZATION ALGORITHM DISCRETE APPLICATIONS

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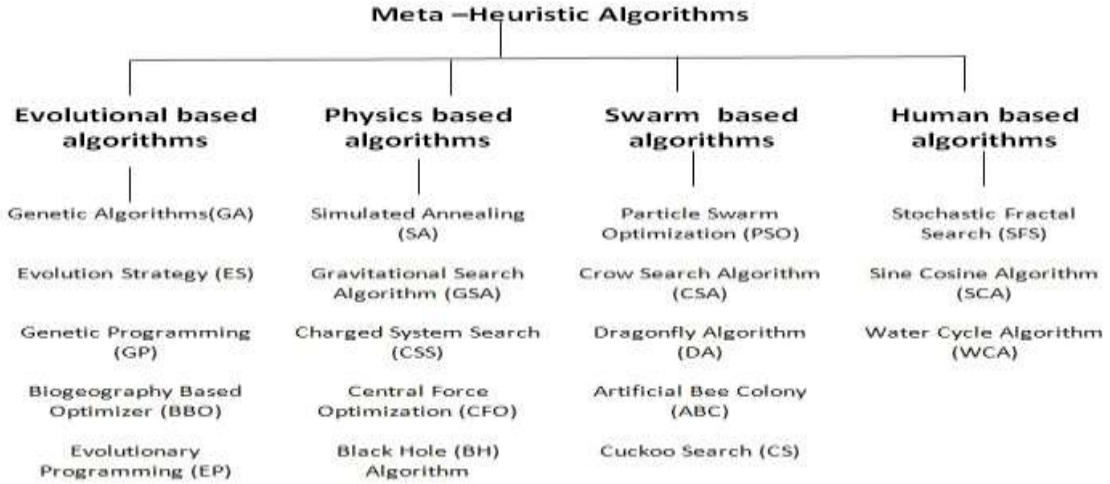
Abstract
Researchers are now a days showing interest in metaheuristic algorithms. Optimization is the best property of these metaheuristic algorithm. These algorithms are used toresolve the multifaceted problems. GlowwormSwarm Optimization (GSO) is a metaheuristic algorithm that is inspired by nature.K. Krishnanand and D. Ghose are the inventers of GSO algorithm. GSO algorithm imitates behaviour of Glowworm. Glowworm has the quality luciferin accompanying itself to exchange data with cohorts. The paper focuses on the applications of GSO algorithm.
Keyword: Glowworm Swarm Optimization, Metaheuristic, blind signal separation, data clustering, Image clustering, PV system.

I. Introduction

Metaheuristic heuristic algorithms are performing exceptionally well due to their nature inspired quality. the metaheuristic algorithms are characterized as physics based, human based, evolution based, andswarm-based algorithms. The algorithms which falls under the evolution-based techniques are: evolution strategy, genetic algorithm, genetic programming, evolutionary programming, biogeography-based optimizers. The algorithms which fall under physics-based algorithms category are: gravitational search algorithms, simulated annealing, central force optimization, charged system search, and black hole algorithm. The swarm basedalgorithms examples are: particle swarm optimization, crowsearch algorithm, dragon fly, artificial bee colony, and cuckoo search. The human based algorithms are stochastic fractal search, sine cosine algorithm, and water cycle algorithm [18][19].

Glowworm swarm optimization (GSO) algorithm falls underswarm-based algorithm category. GSO algorithm is presented by K. Krishnanand and D. Ghose.GSO algorithm simulates Glowworm movement depending on the distance amid them luciferin. Luciferin is a radiantmeasure.GSO procedure is applied in many fields and it found very effective. There are many fields where GSO is applied such as dock scheduling, vehicle routing problem, wireless sensor network and so on.

Fig 1. Categorization of metaheuristic algorithm [18]



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In the search space at the start assign the glowworm population Initially, random assignment of glowworm is performed in search space randomly. At the start, equal quantity of luciferin is assigned to all the glowworms. At every cycle of the algorithm there are 3 phases :1) luciferin update,2) movement, and 3) neighbourhood. Figure 2 shows phases of GSO algorithm.

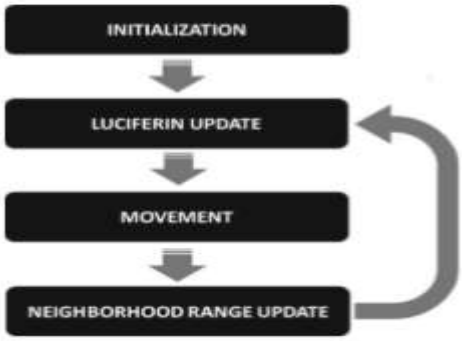

Fig 2: GSO Algorithm Phases [2]

TheGlowworm position has a function value and the luciferin update is depend on that function value. Throughout the luciferin update phase, each glowwormadds to its prior luciferin level. A quantity of luciferin is proportional to the fitness of its present location in the objective function space. Similarly, decay is simulated in luciferin with time by subtracting luciferin values fraction.

Next phase is a movement phase, each glowwormusesa probabilistic mechanism to move near the neighbour. The neighbour has luciferin value that is more than its own. It means that Glowwormsget attracted towards the neighbours that glow brighter.

After movement phase, there will be neighbourhood range update phase. In this phase, every agent is related thru a neighbourhood whose perfect series is active in nature. A fixed neighbourhood range that is not used requires some explanation. To decide the movements when the glowworms are dependent upon only on local data then its predictable that radial sensors function is the obtained number of peaks. If the complete search space is covered by each agent's sensor, then each agentwill move to global optimum, and local optimum will be overlooked. Here, it is assumed that there is no prior datarelated tostandard function offered,if fixingneighbourhood rangedifficult at value that works fine for several function landscapes. Therefore, GSO algorithm used and an adaptive neighbourhood range perceive the existence of several peaks in a multi model function landscape. Figure 3 shows flowchart of GSO algorithm.

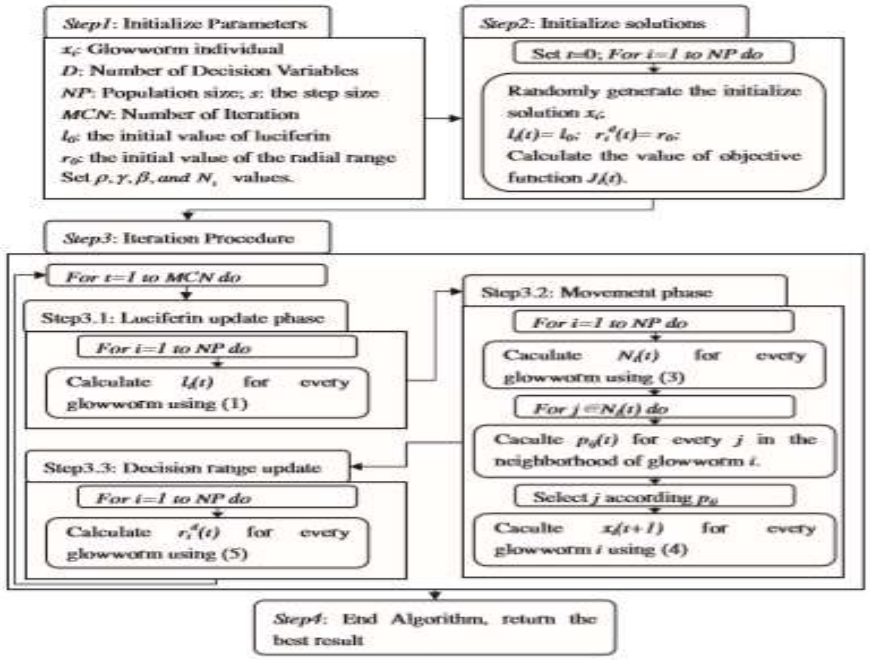

Fig 3: Flowchart of GSO algorithm [4]

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II. Literature Survey

Krishnandan and Ghosh have implemented huge class of standard multimodal functions and they verified against the ability of GSO in taking multiple Optima [12][13].Krishnandan and Ghosh have implemented Iarge class of standard multimodal functions and they verified against the capability of GSO in takingseveral Optima. Subsequently, they have investigated theoreticfundamentals that were concerning local convergence outcomes for basicmodels [15]. Later on, krishnanand Applied algorithms to multiple localisation tasks. Real robots are used to demonstrate these tasks. The GSO algorithm was implemented on a four-wheel mobile robot to cooperate and accomplishthorough source localisation tasks [17].

Bharat [14] used GSO algorithm for estimating the eigenvalues which were gained from a consistent transcendental equation. It is used for searching the analytical results for flow of chemical pollutants through soils. The projected system was faster in estimating the design parameters thrugreataccuracy on the actual inverse problem in environmental engineering.

Traditional GSO algorithm for blind signal separation (BSS) are dependent on gradient, andgradient need standard function to be uninterruptedly differentiable. Due to this,applications of the algorithms are limited. Additionally, this algorithm also has issues with the convergence speed as well as precision. So, to solve the mentioned problems Li Zhucheng, and Xianglin Huang [1] have introduced Modified GlowwormSwarm Optimization algorithm (MGSO) for blind signal separation (BSS). The MGSO is depend on a novel step adjustment rule. First the step adjustment rule is applied, after that MGSO is applied for BSS. The kurtosis of diverse signals is taken as standard function of BSS, MGSO-BSS. In MATLAB environment, mixed signalssuccessfully separated and simulation results shows that MSGO effectively captured global optimum of standard function of the BSS.

Wenhui etc el. [5] introduced the GSO for determining optimal value of a reference voltage in the photovoltaic (PV) system. The Maximum Power Point Tracking (MPPT) technology used for extracting the utmost power from the PV system. There are many MPPT control methods available, for example, perturb and observe, and conductance increment method. But these methods were used under few constant irradiances and these methods also showvariationsamongst the maximal power point. Additional environmental changes parameters like plant shelter, cloud cover, and building block cause radiation change, this change directly affect MPP location. In this paper, GSO determines reference voltage optimal value in the photovoltaic system.

Zhengxin Huang and youngquan [6] implemented a cluster analysis method that is based on the glowworm Optimisation algorithm. Authors have implemented two algorithms. First algorithm is for analysis of self-organizing cluster and second is hybrid algorithm to analyse the clusters using k-means algorithm to speed up the classification. List the algorithms and tested on free data sets and the results of clustering algorithms are high.

Youngquan Zhouet al. [7] implemented LeaderGlowwormSwarm Optimization algorithm (LGSO) to solve non-linear equation system. If there are higher dimensions then the GSO has bad Optimisation ability. So, to strengthen the Global Optimisation ability GSO is proposed with the leader mechanism. This algorithm has strong Global Sourcing capability and find the solution quickly for the equations.

Nurezayana et al. [8] uses GSO algorithms in machine processes to enhance the value of machining performance measurement. There are three parameters as in meaning which affects the machining performance of the measurement, they are minimal surface roughness, speed of cutting, and cut's feed rate and depth. Experimental design was built on the Taguchi scheme. Cutting speed and cut'sfeed rate and depth on surface roughness is investigated by applying analysis of variance.

Youngquan Zhou et al. [9] focused on the disadvantages of the k-means clustering algorithm and introduced a fresh image clustering algorithm that is built on Glowworm Swarm Optimisation (ICGSO). Proposed algorithm dodges local Optima and gainswell image classification effects.

Tatiana et al. [10] implemented hybrid GSO algorithm to find solution to structural optimisation problem. The proposed structure issimple buoyed concrete I-beam describedthrough 20 variables. Here, they have studied a different concrete mixture with the variation of compressive strength grade and compacting system. Proposed algorithm applied on two standard functions called embedded CO_2 emission, and the financialprice of the construction. The GSO ability of searching the full solution space is joint with simulated annealing local search algorithm for getting the better results.

Magdalene et al. [11] has used GSO algorithm in hybrid technique named Combinatorial Neighbourhood Topology Glowworm Swarm Optimization (CNTGSO), it also uses some additional meta heuristic algorithm like Variable Neighbourhood Search (VNS)and Path Relinking (PR) to resolve vehicle routing problem thruvague demand. Proposed algorithm applied ontough combinatorial optimization problem and offerresult to constant optimization problem. There are two solution vectors. One vector represents continuous space, it is a

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space that get restructured in the classic glowworm algorithm. Second vector represents the route path in discrete space.Combinatorial neighbourhood topology technique is used to update second vector. Solutions that are not promising and information exchange between the solution that are in different place are replaced in restart/migration phase. Lastly, variable neighbourhood search is used to enhance all the glowworms separately. The testing of the algorithm is performed on the two problems, one is capacitated vehicle routing problem, second is vehicle routing problem with vague order. Results are compared with other algorithms on the basis of number of sets of standardoccurrences.

Table 1: Applications of GSO

Paper	Algorithm	Application
[1]	MSGO	Blind Signal Separation
[5]	GSO	In PV system for optimal value of reference voltage.
[6]	GSO	Cluster analysis
[7]	LSGO	To solve nonlinear equation system
[8]	GSO	In machine process for improving machining performance measurement.
[9]	ICGSO	Image clustering
[10]	GSO+SA	To solve structural optimization problem
[11]	CNTGSO+VNS+PR	Vehicle Routing Problem
[12][13]	GSO	Capture multiple optima
[15]	GSO	Local convergence results
[14]	GSO	Estimating eigen values
[17]	GSO	multiple localization tasks using robot

III. Conclusion

Glowworm swarm optimization metaheuristic algorithm and its applications are discussed in this paper. GSO is discovered by Krishnanand and Ghose and this algorithm falls in swarm-based algorithm category. The algorithm initially tested for capturing multiple optima, then after that applied for local convergence. eigen value estimation and for multiple localization task which uses a real robot, cluster analysis and improving machine performance . Then the GSO is combined with other algorithms like CNTGSO and this hybrid algorithm is used for vehicle routing problem, MSGO is used for blind signal separation, GSO and SA is used to solve structural optimization problem, LGSO for nonlinear equation system, ICGSO is used for image clustering.

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