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AN OPTIMAL ALLOCATION OF DG AND DSTATCOM IN RADIAL DISTRIBUTION SYSTEM BY USING FLOWER POLLINATION ALGORITHM

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Abstract:

Flower Pollination Algorithm (FPA) is a nature inspired algorithm based on pollination process of plants. Recently, FPA has become a popular algorithm in the evolutionary computation field due to its superiority to many other algorithms. As a consequence, in this paper, FPA, its improvements, its hybridization and applications in many fields, such as operations research, engineering and computer science, are discussed and analyzed. Based on its applications in the field of optimization it was seemed that this algorithm has a better convergence speed compared to other algorithms. The survey investigates the difference between FPA versions as well as its applications. To add to this, several future improvements are suggested.

Keywords: flower pollination algorithm; inspired algorithms; optimization; hybridization.

1. INTRODUCTION

Mathematical model for system modeling and objective function is used in most of the optimization algorithms but establishing mathematical model is not efficient due to its high cost of solution time, classical optimization algorithms are not efficient due to many causes such as ineffectiveness in adaptation of a solution algorithm, the dependency on type of objective and constraints, on type of variables used in modeling of problem, on solution space (convex, non-convex), number of decision variable, and the number of constraints in problem modeling that's why classical optimization algorithms are insufficient in large-scale combinational and non-linear problems. Most of algorithms solve models which have a certain type of object function or constraints. However, optimization problems in many different areas such as computer science, management, and engineering require concurrently different types of decision variables, object function, and constraints in their formulation. Therefore, meta-heuristic optimization algorithms become quite popular methods in recent years, because they provide good computing power and easy conversion, and due to its flexibility to convert meta-heuristic program from a single objective function problem to a multi objective problem or a different problem. Recently, Yang [1] developed a new Flower pollination algorithm that draws its inspiration from the flow pollination process of flowering plants. FPA testing results in many fields proved their ability to be used in a wide range of optimization problems and also their ability to provide better performance in comparison with other traditional optimization techniques. This paper introduces improvements, hybridization and applications of FPA.

2. FLOWER POLLINATION ALGORITHM

FPA, inspired by the flow pollination process of flowery plants, was developed in 2012 by Xin-She-Yang [1]. The following 4-rules are used as a matter of convenience.

1.Biotic and cross-pollination is considered as global pollination process with pollen-carrying pollinators performing L´evy flights.
2. Abiotic and self-pollination are considered as local pollination.
3. Flower constancy can be considered as the reproduction probability is proportional to the similarity of two flowers involved.
4. Local pollination and global pollination is controlled by a switch probability $p \in [0, 1]$. In order to formulate updating formulas, we have to convert the aforementioned rules into updating equations. For example, in the global pollination step, flower pollen gametes are carried by pollinators such as insects, and pollen can travel over a long distance because insects can often fly and move in a much longer range[1]. Though Flower pollination activities can occur at all scales, both local and global, adjacent flower patches or flowers in the not-so-far-away neighborhood are more likely to be pollinated by local flower pollen than those faraway. In order to imitate this, we can effectively use the switch probability like in Rule 4 or the proximity probability p to switch between common global pollination to intensive local pollination. To begin with, we can use a naive value of $p = 0.5$as an initially value.

3. FPA MULTI-OBJECTIVE VERSION

Multi-objective optimization problems are typically complex problems. The methods for solving multi-objective problems differ from algorithms for single objective optimization. For single objective optimization, the optimal solution can often be a single point in the solution space, while for bi- objective optimization, the Pareto front forms a curve, and for tri-objective cases, it becomes a surface. In fact, higher dimensional problems can have extremely complex hyper- surface as its Pareto front Consequently, it is typically more challenging to solve such high-dimensional problems. Real-world design problems in engineering and industry is considered as multi-objective optimization that requires to produce many points on the Pareto front for good approximations. In order to compare the performance of the proposed MOFPA with other multi-objective algorithms, we have selected a few algorithms with available results from the literature, such as vector evaluated genetic algorithm (VEGA), NSGAII ,multi-objective differential evolution (MODE)([10];[11]),differential evolution for multi-objective optimization(DEMO)[12],multi-objective bees algorithms, and strength Pareto evolutionary algorithm(SPEA). The experimental results for 11 test functions and two design examples suggest that MOFPA is a very efficient algorithm for multi-objective optimization. The algorithm can deal with highly nonlinear, multi-objective optimization problems with complex constraints and diverse Pareto optimal sets. Binary-constrained version of the Flower Pollination Algorithm [15] (FPA) is implemented for feature selection, BFPA determines the features that compose the final set by using Boolean search space, this method was applied to some public and private datasets. Numerical experiments in comparison with Particle Swarm Optimization.

4. DG DISTRIBUTION

After testing the FPA they found an important impact on the computational burden and convergence solution in the initial population and switching from local to global pollination. The following modifications improve the algorithm performance: A. Looking for the Best Initial Condition B. Switching the Local to Global Pollination Process This modification eliminates the use of the probability switch and combines Lévy flights with Brownian motion into a single random walk equation. MFPA has been successfully implemented to solve optimal power flow problem. The algorithm has been tested on the IEEE 30-bus system. The experimental results show results enhancement compare to other meta-heuristics algorithms. The main advantage of the MFPA is to

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find fitter initial solutions with improvement of the switching process. Both modifications let the algorithm reach the convergence with minimum number of iterations and little processing time. The definite integrals are useful in a wide range of applications in many regions such as operation research, computer science, mathematics, mechanics, physics, and engineering. Improved Flower pollination algorithm with chaos (IFPCH) introduced by [17] for solving definite integrals. Numerical results show that the algorithm offers an effective way to calculate numerical value of definite integrals, it can converge to the best solution and it has a high convergence rate, high accuracy and robustness. After making several hybridization between the flower pollination algorithm and other inspired meta-heuristic algorithms, there is certainty that Hybridization improve the performance of the FPA to reach the optimal solution faster than the algorithm itself in a short period of time and to reduce the algorithm limitations. Integration of flower pollination algorithm with chaotic harmony search aims to improve the searching accuracy, the planned algorithm is used to solve Sudoku puzzles. The algorithm has been tested on a set of Sudoku problems. The results verify that the planned algorithm is more efficient compared with other algorithms. Integration of Flower pollination algorithm with particle swarm optimization aims to improve the searching accuracy, the hybrid algorithm is used to solve constrained optimization problems, FPPOS has been validated using several benchmark mathematical and engineering design problems and the results prove that the FPPOS is more efficient at finding global optimal solution than other algorithms. FPAKM is a hybrid data clustering approach using Flower Pollination Algorithm and K-Means, K-Means algorithm solve the data clustering problems in a very fast way but find the local optimum solution , the flower pollination algorithm is the global optimization technique that eliminate this drawback , FPAKM has been tested on eight datasets , The experimental results prove that FPAKM find optimal cluster centers and that is better than these individual algorithms.

In the HFPA the flower pollination algorithm (FPA) and differential evolution (DE) algorithm are integrated to solve wind-thermal dynamic multi-objective optimal dispatch problem that improves the exploration and exploitation potential of the flower population which is conducting the search, in this problem there are more constraint such as minimization of cost, emission and losses , and other complex constraints like valve point loadings, ramp limits, prohibited zones and spinning reserve . To solving multi-objective problems HFPA is integrated with a 5-class, 3-step time varying fuzzy selection mechanism (TVFSM) that effectively searches the best compromise solution (BCS) .HFPA-TVFSM is tested and validated on two wind-thermal test systems from literature , the results prove that the hybrid algorithm performs efficiently and all constraints are satisfied.

5. ANALYSIS

The Flower Pollination Algorithm is hybridized with the Clonal Selection Algorithm, The Experimental results of testing the Algorithm in 23 optimization benchmark problems verify the algorithm superiority compared to other famous optimization algorithm such as Simulated Annealing, Genetic Algorithm, Flower Pollination Algorithm, Bat Algorithm, and Firefly Algorithm , and also verify that the algorithm is able to find more accurate solutions than the other optimization techniques. Integration of the Flower Pollination Algorithm with Chaos Theory (IFPCH) to solve large-scale ROP with an optimal solution at a finite point and an unbounded constraint set .The technique is tested using several ROP benchmark. The test aims to prove the capability of the IFPCH to solve any type of ROPs. The experimental results show the feasibility, effectiveness, and robustness of the technique. The results revealed the superiority of the technique among others in computational time. FPA implemented to decides the locations and size of capacitors to realize the optimum sizable reduction in active power loss and significant improvement in voltage profile. This method is tested on 10, 15, 69 and85-bus radial distribution systems, the results found is better than the other methods in terms of the quality of solution. Apply FPA to the electromagnetic and antenna community for the optimization of linear antenna arrays. FPA was applied to obtain optimized antenna positions in order to achieve desired array pattern with minimum SLL along with null placement in specified directions. Results have been compared to conventional array (non-optimized), and with arrays optimized using other nature-inspired evolutionary algorithms such as ACO, CSO and PSO, Consequent FPA outperforms the other evolutionary algorithms and at times it yields a similar performance.

A method of reducing the loss by placing shunt capacitors at the optimal location, using Loss Sensitivity Factor and FPA to determine capacitor placement make significant decrease in power loss, increase in voltage profile and decrease in total annual cost. Flower pollination algorithm is implemented to adjust real power generations for minimizing the fuel cost, FPA is tested on the standard IEEE-30 bus system and the results are compared with those of the other algorithms, The results are found improved and encouraging.

CONCLUSION

How to solve real world optimization problems is a question asked every day and researchers seek to find the answer ,therefore implementing Nature inspired algorithm has being one of the effective methods to solve these problems, since 2012 the Flower Pollination Algorithm proposed by Xin-She Yang [1] was implemented in many fields such as operation researches ,computer science and electrical engineering. This paper is a review which explores the FPA efficiency whether by implementation or by hybridization with other algorithms, the studies prove that FPA is a powerful tool in solving several optimization problems, a consequence FPA is one of the more commonly used algorithms until now.

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