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A RADIAL DISTRIBUTION NETWORK RECONFIGURATION FOR MINIMUM POWER LOSSES BY USING MODIFIED META-HEURISTIC TECHNIQUE

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ABSTRACT

The generation, transmission, distribution, and use of electrical power are all aspects of the electrical power system. The main difficulty facing power system engineers is matching the available generating capacities to the constantly rising load demand. This study provides a new approach that uses a meta-heuristic technique to address the issue of distribution network reconfiguration. By reaching a high rate of convergence, the suggested method is very capable of reducing the power losses in the distribution system. The suggested algorithm seeks to minimize power losses in distribution networks; it is highly effective and ensures that the global optimum is achieved.

Keywords: Heuristic, Meta-Heuristic, Radial Distribution System, Convergence, Power Losses, Optimum Power.

I. INTRODUCTION

NREC is a way toward modifying the geography of agronomists in conveyance frameworks by adjusting the open or shut status of changes to gracefully the heaps among the feeders without islanding any of the heaps. By and large, conveyance networks are worked as interlinked systems, duration in activity, they are orchestrated in a spiral or tree framework [1]. The setups might be differed from manual or programmed exchanging activities, so the entirety of the heaps is provided and can lessen power misfortune, upgrade the framework's dependability and improve the nature of influence flexibly. Thus, the exchanging tasks are acted so that the spiral idea of the network stays the same and all the heaps should be invigorated. Simultaneously, reconfiguration additionally assuages the over-burdening of the network segments [2].

The principal target of the NREC is to diminish the force misfortunes or enhance the energy outline. For the reconfiguration cycle, two kinds of controls are utilized in the appropriation frameworks [3]. The power system comprises almost all the electrical equipment placed at different locations and works together to supply the electrical energy to the consumers on an economical basis [4]. In power system planning and design, much attention is needed to the distribution systems for improving the quality of power supplied to consumers. The development of additional generation capacity involves enormous capital investment. Therefore, with better utilization by network reconfiguration with low capital expenses. Network Reconfiguration (NREC) of a power distribution system is an operation for altering the topological structure of distribution feeders or feeder laterals by changing closed status of sectionalizing and open status of tie switches. Network reconfiguration balances feeder loads and helps in managing overload situations of the network by transferring part of their load from heavily loaded feeders to lightly loaded feeders [2].

The powerful mix of switches that are to be opened, can essentially improve the exhibition of outspread appropriation networks. Reconfiguration does not just include finding all concerned trees comprising of the hubs similar to flexibly focuses yet in addition all heaps in the diminished network by fulfilling voltage and current limitations [4]. For distinguishing proof of ideal switches in the network by testing various mixes in exchanging utilizing circle vectors. Contingent upon how exchanging tasks are accomplished for network reconfiguration in appropriation networks, the exchanging activities can be partitioned into two sorts [6].

Some of the optimization techniques are as follows:

A few decades ago, a few strategies have been proposed in the writing to settle the feeder reconfiguration issue. Some of them are as per the following:

(a) Genetic Algorithm: It is the most established hunt put together calculation based on respect to the geography of characteristic hereditary qualities and common determination, it is proficient to take care of multi-objective combinatorial advancement issues.

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(b) Heuristic Methods: Several creators have tackled the FR issue by utilizing heuristic strategies for single and multi-target work. This strategy has to lead to the ideal or close to an ideal arrangement with lessening calculation time while combining the arrangement.

(c) Fuzzy Logic: Fuzzy rationale-based procedure doesn't need load stream arrangement; anyway, it utilizes sensible guidelines to tackle the FR issue. This strategy faces a lack of clarity in keeping up the radiality imperative.

(d) Artificial Neural Network Method: Likewise fluffy rationale-based strategies and fake neural network-based procedures do not need load stream arrangement while looking through the ideal arrangement. ANN-based procedures lead to digressing arrangements relating to a huge framework.

(e) GSA: is a hybrid heuristic smoothing out methodology which has been established by E. Rashidi in 2009. The fundamental genuine speculation which GSA is propelled from is Newton's postulate that communicates: Each piece known to man pulls in one another atom with a force that is comparing to the aftereffect of their masses and on the other hand comparative with the square of the division between them.

(f) PSO Technique: PSO is a speculative upgrade count that is roughly shown on pack lead, for instance, moving of winged creatures towards an abnormal target. The interesting space is D-dimensional where each particle is a part. It is a charming system considering the way that the number of limits isn't many. Glancing through a cycle in PSO relies upon the past best plan of an atom and the best course of action between all the pieces of the general citizens further to revive the piece's location and speed.

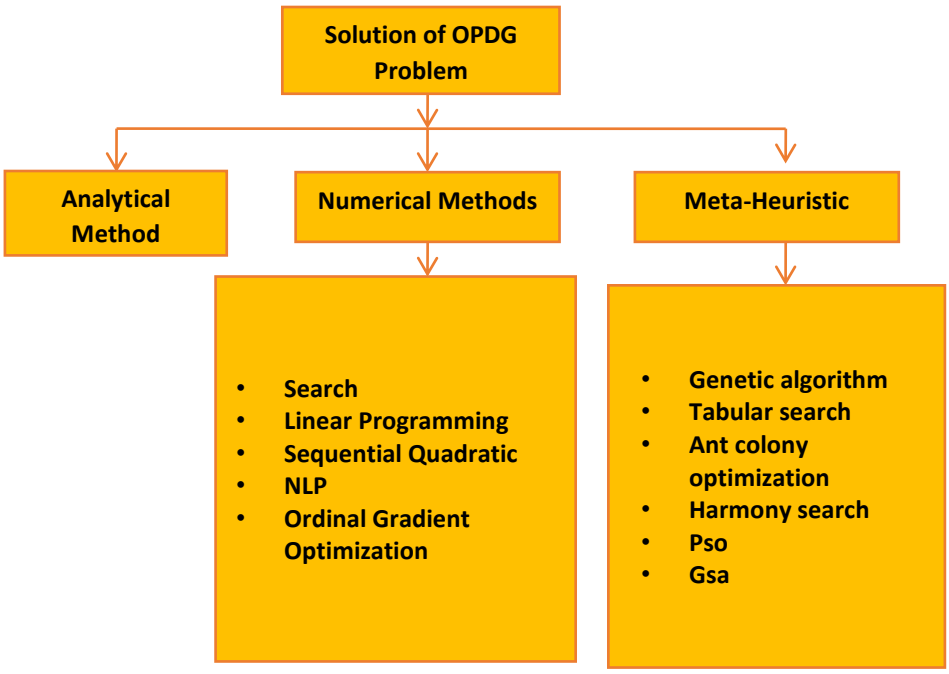

Figure 1: Various Techniques to Solve OPDG Problem

Types of distribution of networks:

The two most important aspects to reconfigure the distribution networks are-

- Minimization of genuine force misfortunes and
- Maximization of the heap adjusting

Network reconfiguration and dispersed ages are broadly used to limit power misfortune, improve voltages and improve framework unwavering quality and so on in theory, the two procedures are utilized all the while to accomplish the goal of genuine force misfortune minimization in circulation frameworks. In this section network reconfiguration and appropriated age innovation are talked about [7].

The main objective of network reconfiguration is to reduce power losses and enhance the voltage profile. In the reconfiguration process, two types of controls are used in the distribution systems. They are normally closed switches which connect two-line sections and normally open switches on the tie lines which join two primary feeders.

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In this paper, a new Meta-heuristic approach is proposed. The proposed approach consists of hybrid particle swarm optimization and Gravitational Search Algorithm generally known as meta-heuristic. The proposed approach is highly efficient to reduce power losses and obtain the benchmarks outcomes.

II. METHODOLOGY

In this paper, a hybridized meta-heuristic using low-level co-evolutionary heterogeneous hybrid [5]. The hybrid is low-level because we combine the functionality of both algorithms. It is co-evolutionary because we do not use both algorithms one after another. In other words, they run in parallel. It is heterogeneous because two different algorithms are involved to produce the final results. The basic idea of meta-heuristics is to combine the ability of social thinking in heuristics with the local search capability of heuristics. To combine these algorithms [6].

The network reconfiguration can be resolved by the following two approaches:

- Particle Swarm Optimization (PSO) Technique
- The Hybrid Meta-Heuristic Algorithm

2.1 Particle Swarm Optimization (PSO) Technique

In PSO wellness estimation of every individual molecule is assessed by the target capacity to choose its very own decent encounter and among the whole populace. PSO instates particle position and their speeds haphazardly. A component is every molecule in the multitude. Depending on the pbest and gbest values, the molecule location is refreshed in every focus. Until this point, pbest is the best looking through individual experience or gbest is the better outcome between the population's whole molecule. The motivation to invigorate location is to arrange the pieces pushing toward the compound vector of pbest and gbest. This would cause the piece to achieve the main (overall optima) would be expanded. The dormancy weight term in the speed condition expects a basic capacity to change the glancing through domains. A more unobtrusive inaction weight would cause the request to a local hunt while a greater weight would drive the count to tie its interest toward an overall ideal plan. The chase space chart of emblematic PSO is showed up in Fig. 7 In the simple PSO, for every D estimation SS, the location, speed, better past circumstance of the atom or the better circumstance between whole pieces are addressed through accelerators and portrayed.

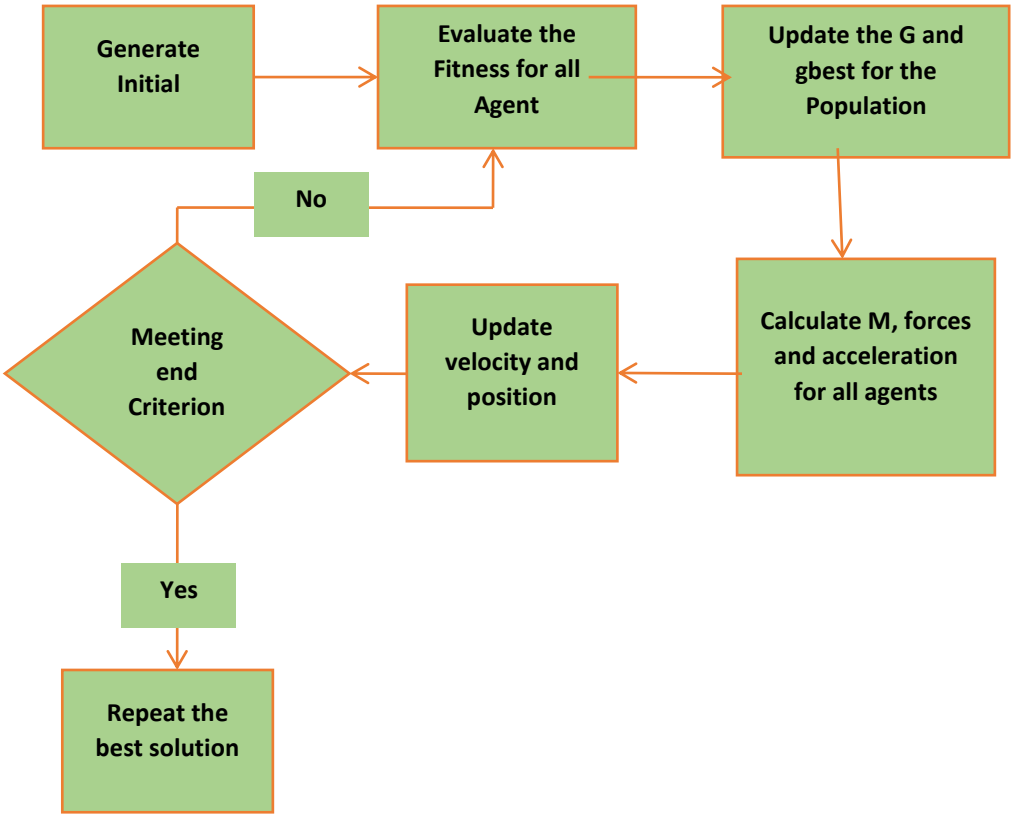

Figure 2: Flow chart proposed approach

The word ViDk is considered a part of idleness that gives a memory of the previous heading of the flight that implies creation in the immediate past. This section is energy that forestalls the radical alteration of the particles' path and the predisposition to the present bearing.

The term c1r1 is referred to as the psychological section or staff effect, which tests the particle presentation as opposed to previous exhibitions. The best for the molecule is given in this section. The effect of the intellectual component prompts a re-visitation of the places that most recently pleased them. The intellectual section referred to the molecule's sentimentality as being.

The term c2r2 is referred to as a social segment or social effect that quantifies the particle display among a set of particles or the entire population. The social impact drives each molecule to travel to the best location defined by the region of the molecule. The quickening coefficients c1 and c2, along with the irregular characteristics r1 and r2, individually preserve the arbitrary effect on the intellectual and social segments of the speed of the molecule. The clear c1 tells how much faith a molecule has in itself, while c2 shows how much faith a molecule has in its neighbors.

The PSO calculation is a speculative calculation that requires communal association in a multitude between all the particles. By exchanging data about the achievement of and molecule in the multitude, particles collaborate. At the point at which a molecule finds a superior location in the entire multitude, all particles shift towards this molecule. This article's presentation is dominated by the neighborhood of the particles.

2.2 The Hybrid Meta-Heuristic Algorithm

A few hybridization strategies for heuristic calculations were implemented. As per the creator, two equations can be hybridized as homogeneous or heterogeneous at a significant phase or small phase with a transfer or co-transformational strategy. In this article, a low-level co-developmental heterogeneous mixture is used to hybridize PSO with GSA. When we combine the utility of the two calculations, the crossbreed is low-level. Because we don't use all equations one after another, it is co-transformative. All in all, they work at similar speeds. Since two different calculations are used to provide eventual results, it is heterogeneous. The primary topic of meta-heuristic is to consolidate the communal deduction power (gbest) in PSO with GSA's neighborhood search capability. It is proposed to consolidate these equations as follows:

$$V_i(t+1) = w \times V_i(t) + c_1' \times \text{rand} \times ac_i(t) + c_2' \times \text{rand} \times (\text{gbest} - X_i(t)) \qquad (1)$$

Here Vi(t) is the speed of specialist I at focus t, C'j is an element of weighting, w is an ability of weighting, rand is an arbitrary set somewhere in the range of 0 and 1, aci(t) is the quickening of operator I at cycle t, gbest is the better arrangement further. The locations of pieces in any focus are refreshed as follows:

$$X_i(t+1) = X_i(t) + V_i(t+1) \qquad (2)$$

In meta-heuristic, each operator is irregularly implemented from the outset. Each specialist is regarded as an arrangement for rivals. Gravitational force, gravitational steady power, and resulting powers among specialists are determined after installation. The growing speeds of particles are defined from that point forward. The best arrangement so far should be refreshed in every way. After determining the increasing speeds and refreshing the best arrangement until this point,

It is possible to decide the point, the speeds, all things considered. Finally, the positions of operators are characterized. By reaching an end basis, the way towards refreshing speeds and positions will be halted.

III. MODELING AND ANALYSIS

Three Feeder 16-Node Test System.

Network reconfiguration is one of the significant processes that is performed for the efficient employment of automation in the distribution system. Network reconfiguration is performed by modifying the feeder topologies by proper handling of operation of sectionalizing and tie-switches and taking care of their open/close status at the time of emergency or normal operation. Modification of feeder topologies is an adequate and effective technique to minimize losses, enhance voltage stability, better load balance and strengthen power reliability. A great deal of research & analysis has already been performed to solve the problem of reconfiguration of existing networks.

To meet these demands, the automation of the distribution system is widely adopted. The distribution system is the most perceptible and significant unit of the power system. A power engineer always aims to design optimal

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planning and control strategies. The strategies and designs are related to all three sub-parts of the power system i.e., generation, distribution and transmission. The most critical and important part of the design is related to the distribution side as it is directly connected with the customers.

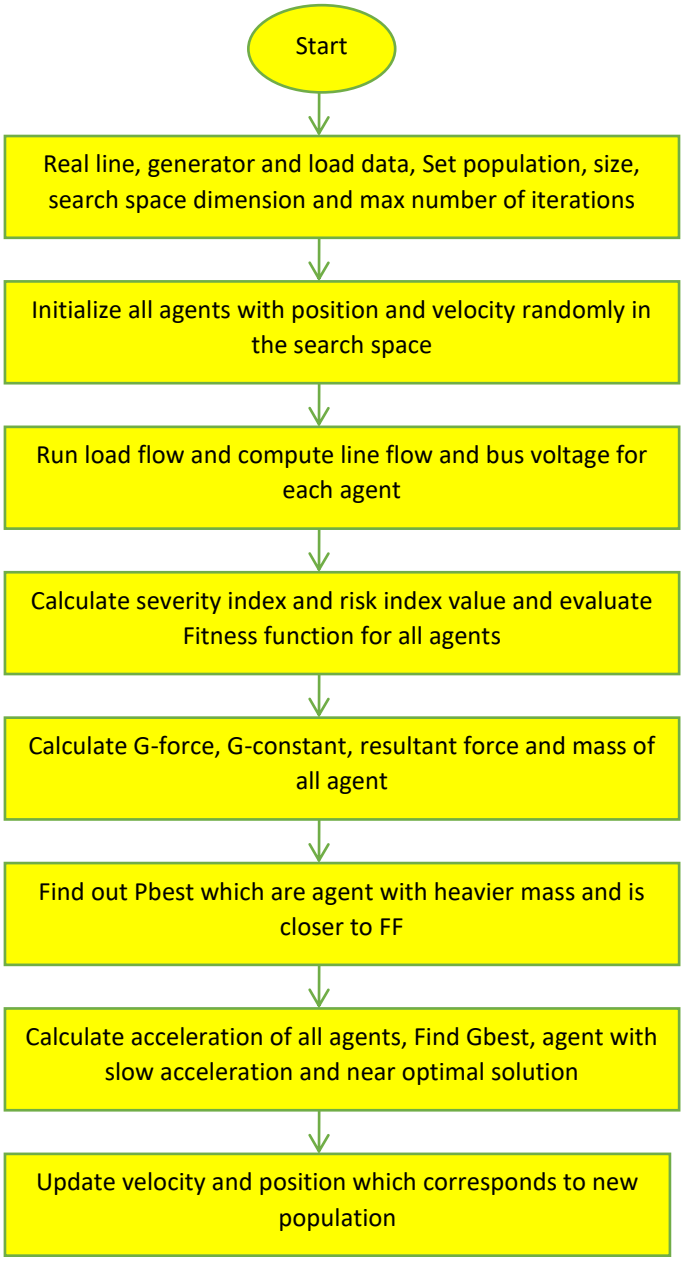

Figure 3: Shows the Proposed Heuristic Algorithm flowchart

Hybrid Algorithm of working model Steps:

Step 1: Initialize the fitness variables.

Step 2: Compute fitness parameters.

Step 3: Analyze the current value of the fitness parameter

Step 4: Consider the best present value of the particle, if not then repeat step 3.

Step 5: Assign the past best value to the global best.

Step 6: Compute the velocity of each particle.

Step 7: Now, Update the best velocity value of the particles.

Step 8: Analyze the best convergence rate achieved, if not then again repeat steps 3 and onwards again.

Step 9: Compute the improved fitness parameters obtained from PSO.

Step 10: Analyze the current value of the space search and fitness parameter.

Step 11: Consider the best present value of the velocity, if not then repeat step 3 again.

Step 12: Assign the past best value to the space parameter.

Step 13: Compute the velocity of each G-force search parameter.

Step 14: Now, Update the best velocity value of the space search G-value and the particles.

Step 15: Analyze the best convergence rate achieved, if not then again repeat steps 3 and onwards again.

Step 16: Terminate.

A few comments are noted as follows, and meta-heuristic is successful. In meta-heuristic, in the refreshing technique, the essence of arrangements (wellness) is taken into account. Operators close to excellent arrangements are trying to attract numerous specialists who are researching the hunting space. They pass increasingly at the point where all specialists are almost a respectable arrangement. The gBest assists us to abuse the better worldwide for this case. Up to this point, meta-heuristic utilized a cache(gBest) to spare the better arrangement identified up to this point, so it is open at any time. Each specialist will up to now watch the best arrangement and incline towards it.

IV. RESULTS AND DISCUSSION

The proposed system was implemented through simulation using Mat-lab programmers, and it was managed to employ an i-7 processor desktop computer running at 4 GHz and 6 GB of RAM. Each situation's time requirement was noted. To test the effectiveness of the approach provided for comparison with other ways discovered in the literature to achieve the goal of minimizing power loss, it was implemented on a 33-bus distribution system. The based hybrid meta-heuristic algorithm is implemented on a standard IEEE 33-bus test system. For the dependent variables, the device information as well as the minimum and maximum values are provided.

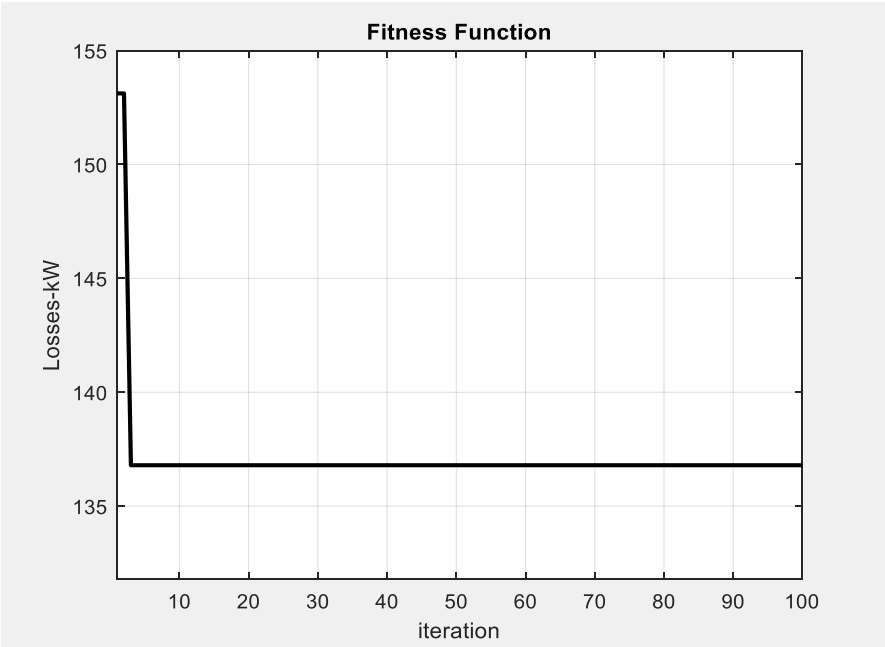

Figure 4: Fitness Function of Losses - KW and iteration

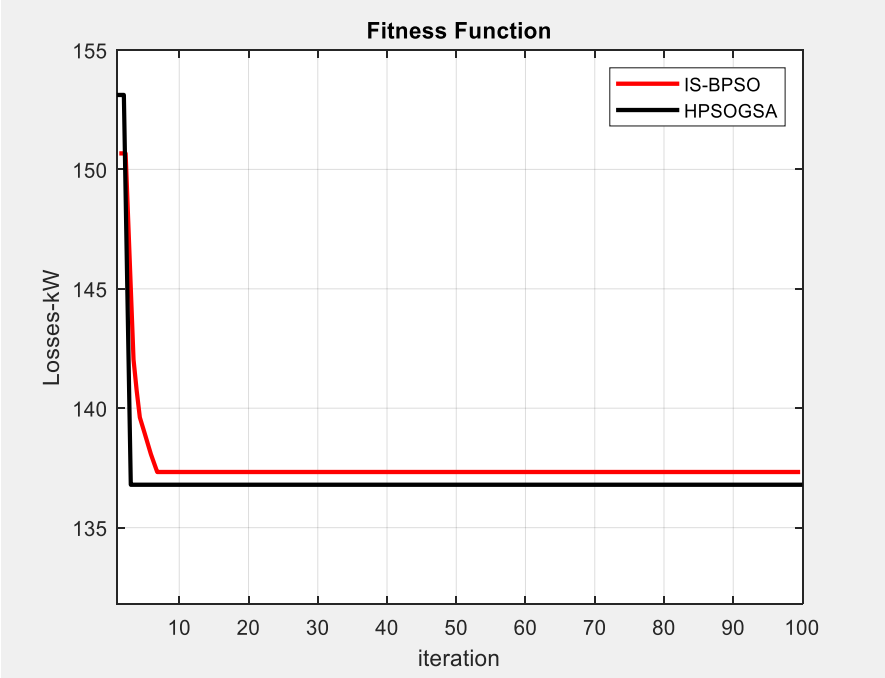

Figure 5: Fitness function in between Losses-KW and iteration

V. CONCLUSION

The meta-heuristic is effective, with a few comments as follows. In meta-heuristic, in the refreshing process, the essence of arrangements (wellness) is considered. Operators close to great agreements aim to attract numerous experts who examine the space of inquiry. They pass steadily at the point where all operators are nearly a decent arrangement. The gBest helps them to misuse the best worldwide for this case. A memory is used by a meta-heuristic to retain the better arrangement that has been identified further, so it is still usable. Up to this point, each operator should track the best arrangement and lean towards it. The capacities of global inquiry and nearby hunting can be changed with the modification of C1, C2. The outcome comparison has indicated that the suggested approach is more effective than many other methods for test systems in terms of power loss reduction and voltage profile improvement. Therefore, the suggested meta-heuristic could be a very promising potential approach for fixing the reconfiguration issue in distribution systems.

The outcomes show that compared to available evolutionary methods the meta-heuristic gives a better solution for voltage improvement as well as the reduction in power loss.

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