Optimal Power Flow Using Modified ALO

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***Abstract*— The unique meta-heuristic algorithm Ant-Lion Optimization (ALO), used to find optimal flow of power (OPF) problem. ALO is modelled on the unique ant lions hunting behaviour. ALO , a newly proposed swarm-based algorithm that imitates the flocking behaviour of antlion. A modified ALO has been proposed by incorporating Lévy-flight (LF) in ALO. This increase the algorithms capability in some extend and improve the solution quality. The suggested methodology is used to determine the optimum values of the OPF problem variable i.e., called control variables for cost of the fuel. Performance of the suggested solution is evaluated and checked on the standard bus system IEEE-30-bus compared with some other heuristic approaches recently mentioned in literature. The results obtained along with the correlation with other methods suggests that MALO provides a secure and reliable high-quality solution to the problem of OPF with various complexities. The proposed technique exceeds other approaches shows in the experimental results, find the optimum solution with a correct orientation towards convergence, it is robust, adaptable and can be used for practical selection of features.**

Keywords— Lévy-flight distribution, Modified antlion optimization, Meta-heuristic, Optimal power flow, Power system optimization.

I. INTRODUCTION

The Optimal Power Flow (OPF) is one of the most significant issue, designing process of power system and is generally studied for optimal power flow of the operation. OPF problem recently been more widely observed by many scientists. Modifies electric utilities to provide secure states & operations of economic operations we can use the basic tool of OPF in power system. -Minimizing the objective function as like quadratic cost function, fuel cost, about optimal changes of the parameters the power system provides various operating systems at the same time, such as inequality and equality [1,2] is the main goal of OPF issue. The constraints of equality are equations of power flow balance, where the constraints of inequality are the limits of all variables of state or control. The varying control parameters associated with the generator real(active) powers, the tap ratios of transformers, bus voltages of generator and VAR sources Q_p generations associated with generator of reactive power outputs, system line flows and the voltage of load bus [3,4] normally, the OPF issue is a large-level, extremely restricted trouble for nonlinear optimization. The OPF firstly introduced the formulation by Tinney and Dommel [5]. Later on, many researchers addressed about this topic. Evolutionary and traditional algorithms have explained the optimal power flow problem. Conventional methods to solve the OPF problem are applied [6-11]. Nevertheless, demerits of these techniques are that these methods cannot be used in realistic environments due to non-linear properties such as restricted operating zones, partially quadratic value function. Hence, it`s essential to propose methods of optimisation that can overcome these demerits and deal with these difficulties [14]. Recently, several techniques of the optimization based on population have been employed to solve optimization problems which are complex in nature. These techniques are increasingly used to determine problems of power system optimisation such as optimal power flow by using reactive element, economic dispatch and in decades, OPF. For solving optimal power flow problem, some of the methods based on the population have been implemented successfully, such that evolutionary programming [12], GA [15], GA development [16], particle swarm [17], a method for differential evolution [18], tabu search [4], simulated annealing [13].

Insecure properties of convergence and complexity of algorithms commonly seen in non-linear programming-based systems. Some of the Demerits associated with quadratic programming-based methods are parts approximation of quadratic costs. A demerits of convergence properties in initial condition very sensitive can be found in newton- based technique and because of the insufficient initial conditions may not converge. Sequential non-constrained techniques of minimisation show numerical problem with penalty factor is extremely high. Therefore, the method of linear-programming is fast and reliable, many demerits related to the linear value approximation can be seen. A computationally efficient method is an interior point strategy where, unless the size of step is properly specified, the problem of sub-linear will have a solution in the original nonlinear system that's impossible. Computationally efficient and optimality criteria are seen in interior-point methods, and most of the time, it is not possible to solve quadratic and objective nonlinear functions. We invite the reader to consult the full survey for further discussion of these techniques.

Most of these methods use algorithms for gradient optimisation, system constraints around a point of operation and sensitivity analysis for linearizing the objective function. Nonetheless, the optimum power flow is a strongly multimodal and nonlinear problem of optimisation, therefore, more than one or multiple local optimal exists. Therefore, local optimisation methods for one local optimum are not suitable. But, assess whether a local solution is a solution of global as well, there is no local criterion. Hence, conventional methods of optimisation using gradients and derivatives are not able to identify (or) locate global optimal. Problem should be simplified by many mathematical guesses as analytical, objective convexes and differentials. OPF problem is the problem of optimization objective functions which are not-smooth, nonconvex and non-differentiable.

These characteristics became more dominant and evident when results of thermal generator valve-point loading and non-linear behaviour of devices of electronic, FACTS are taken into account. It is therefore important to develop methods of optimization which are effective in overcoming these disadvantages. Evolutionary programming [19] & genetic algorithm (GA) [20] which are part of Heuristic algorithms, recently used to solve the issue of OPF. The results encourage further research in this direction. But, some shortcomings in the performance of GA are identified in recent research [21]. This degradation inefficiency, in applications the objective functions are highly epistatic apparent, where optimization of the parameters is highly correlated. GA's premature convergence degrades and decreases its search capability.

ALO [46] is based on global random search algorithm which are introduced newly. ALO has widely used in various applications at present. ALO to optimize controller simultaneously, which could be safer when faced with a random load sequence as a disturbance [22]. The ALO to solve the electrical system's dynamic and non-convex in the problem of economic load dispatch [23]. It is being concluded from detailed study and respective results, that ALO shows a fair balance between both the phases like first exploration and then followed by exploitation of search space. ALO for an unmanned aerial vehicle for route planning [24]. That was higher in terms of its robustness to other swarm intelligence algorithms, speed convergence, Accuracy and minimal local avoidance. The selection of features is considered as a discrete problem of optimization in the paper, Unable to be solved with the standard ALO. Emary introduced an ALO novel using Lévy (LF) flight, what was renamed LévyALO (LALO) to boost the basic algorithm's local optimization capability for [25].

AI techniques are popularly used algorithms, due to their superior convergence and complexity handling capabilities. These are stochastic in nature to solve many optimization problems: like as genetic-algorithm, antlion optimization, simulated annealing, ant colony method, black hole-based method and PSO etc. They have graded it as meta-heuristic and heuristic methods. They are currently used extensively for solving the actual problems of optimization [30-32]. The Ant Lion based optimization method is also used for deriving optimal solution for an power flow problem. The other techniques like Black Hole Based Optimization [31], League Championship Algorithm [32], Teaching Learning Based Optimization [30] has also shown their capabilities to handle complexities involved in OPF. In this paper an analysis for different practical constraint involved in optimal power flow are taken into consideration to minimize fuel cost. The MALO is tested on the standard IEEE-30-Bus system [47].

II. OPTIMAL POWER FLOW (OPF) FORMULATION

The control variables of OPF settings. Given set of loads it minimizes a mentioned objective function, i.e., the cost of generation. The operating limits of the device are taken OPF, as shown below:

Mini J (X^k, U^k) (1)

Sub to s $(X^k, U^k) = 0$ (2)

And h $(X^k, U^k) \leq 0$ (3)

U^k= Control variables (or) independent variables.
X^k= State variables (or) dependent variables.
J (X^k, U^k) = The objective function.
s (X^k, U^k) = Equality constraints.
h (X^k, U^k) = Inequality constraints.
State variables X^k & control variables U^k of stated the OPF problem.

A. The Control Parameters:

These are the list of parameters that can be changed for satisfying the equations of optimal load flow. In the OPF problem arrangement, the set of control variables are:

P_G generation of real power at the bus PV, V_G is absolute value of voltage at PQ bus, T is transformer tap settings of tap regulating, Q_C is VAR output shunt.

Here, U^K is following below:

$${U^k}^T = [P_{G2} \ldots P_{GNG}, V_{G1} \ldots V_{GNG}, Q_{C1} \ldots Q_{CNC}, T_1 \ldots T_{NT}] \quad (4)$$

Where NC is no. of VAR compensator, no. of generators is NG and no. of regulating transformers is NT.

B. The State Parameters:

The set of variables define the system's particular state. In the problem formulation, the list of state parameters is:

Output real power at slack bus is P_{G1} , V_G is absolute value of voltage at PQ buses, S is tr-line loading, Q_G output power of reactive element.

Here, X^k is following below:

$${X^k}^T = [P_{G1}, V_{L1} \ldots V_{LNPQ}, Q_{G1} \ldots Q_{GNPV}, S_{l1} \ldots S_{lNTL}] \quad (5)$$

Where, NPQ defines the no. of PQ buses; NPV depicts the no. of voltage-controlled buses; NTL the no. of transmission lines.

C. Objective constraints:

OPF constraints are categorized as constraints of equality, inequality constraints as detailed below:

1. <u>*Equality constraints:*</u>

The OPF's equality constraints reflect the power system physics. Typical power flow equations represent the power system physics. These constraints of equality are the following.

a) Constraint based on real (or) active power:

$$P_{Gi} - P_{Di} - V_i \sum_{k=1}^{NB} V_k [G_{ik}\cos(\delta_i - \delta_k) + B_{ik}\sin(\delta_i - \delta_k)] = 0 \quad (6)$$

b) Reactive Power Constraints:

$$Q_{Gi} - Q_{Di} - V_i \sum_{k=1}^{NB} V_k [G_{ik}\sin(\delta_i - \delta_k) + B_{ik}\cos(\delta_i - \delta_k)] = 0 \quad (7)$$

Here, V_i and V_k are voltages of i^{th} and k^{th} bus, NB no. of buses available, P_G power generation of the active element, Q_G is the power generation by reactive element, P_D is demand of active load, Q_D is demand of reactive load, G_{ik} and B_{ik} are the admittance matrix ($Y_{ik} = G_{ik}$ +jB_{ik}) is the conductance & susceptance between bus i and bus k, δ_{ik} is the phase difference bus i and k.

2. <u>*Inequality Constraints:*</u>

Inequality (h) constraints as follows:

I. <u>*Constraint based on generator*</u>: Voltage of the generator (V_G), as shown below, active outputs and output of reactive elements should be limited by their limiting values:

$$V_{Gi}^{min} \le V_{Gi} \le V_{Gi}^{max}, \text{ i=1, 2, 3…, NPV}$$
$$P_{Gi}^{min} \le P_{Gi} \le P_{Gi}^{max}, \text{ i=1, 2, 3…, NPV} \quad (8)$$
$$Q_{Gi}^{min} \le Q_{Gi} \le Q_{Gi}^{max}, \text{ i=1, 2, 3…, NPV}$$

Whereas, V_{Gi}^{max} and V_{Gi}^{min} are the maximum generator voltage of i^{th} generating units and minimum generator voltage of i^{th} generating units; P_{Gi}^{max} maximum output of real power of i^{th} generating and P_{Gi}^{min} minimum output power of active element of i^{th} generating and Q_{Gi}^{max} maximum output power of reactive element of i^{th} generating unit and Q_{Gi}^{min} minimum output power of reactive element of i^{th} generating unit.

II. <u>*Constraint based on transformer*</u>: Tap the transformer settings as shown below to be limited by their limiting values:

$$T_i^{min} \le T_i \le T_i^{max}, \text{ i=1, 2, …, NT} \quad (9)$$

T_i^{min} and T_i^{max} minimum tap settings limits and max. tap settings limits of i^{th} transformer respectively.

III. <u>*Constraint based on reactive power*</u>: The shunt VAR compensator should be limited by its limiting values:

$$Q_{Ci}^{min} \le Q_{Ci} \le Q_{Ci}^{max}, \text{ i=1, 2…, NC} \quad (10)$$

Q_{Ci}^{min} and Q_{Ci}^{max} minimum limits of VAR injection and maximum limits of VAR injection of i^{th} shunt capacitor.

IV. <u>*Constraint based on security:*</u> Contain the voltage magnitude constraints with the load busses and the loading of the tr-line. Each load bus of voltage of should be controlled by its lower operating bounds and upper operating bounds. Line flows should be limited by capacity limits on each transmission line. Such constraints can be formulated mathematically.

$$V_{Li}^{min} \le V_{Li} \le V_{Li}^{max}, \text{ i=1, 2, 3…, NPQ} \quad (11)$$
$$S_{li} \le S_{li}^{max}, \text{ i=1, 2, 3…, NTL} \quad (12)$$

V_{Li}^{min} and V_{Li}^{max} minimum and peak voltage for load of i^{th} unit. S_{li} apparent power of i^{th} branch, S_{li}^{max} maximum apparent limit on the power flow of i^{th} branch.

$$J_{mod} = \sum_{i=1}^{NPV} F_i\ (P_{Gi}) + \lambda_p (P_{G1} - P_{G1}^{lim})^2 + \lambda_v \sum_{i=1}^{NPQ} (V_{Li} - V_{Li}^{lim})^2 + \lambda_v \sum_{i=1}^{NPV} (Q_{Gi} - Q_{Gi}^{lim})^2 + \lambda_s \sum_{i=1}^{NTL} (S_{li} - S_{li}^{max})^2 \quad (13)$$

λ_p , λ_v , λ_v and λ_s are the different factors of penalty. x^{lim} the dependent variable limit value x.

$$x^{lim} \begin{cases} x^{max}; & x > x^{max} \\ x^{min}; & x > x^{min} \end{cases} \quad (14)$$

III. Overview of MALO

Seyedali introduced a heuristic algorithm is based on searching is known as antlion optimizer (ALO) in 2015 that simulates the antlions hunting action in nature and there are no parameters to modify [46]. So, ant-lion optimizer has lots of ability for averting the local optimal stagnation, because of the effectiveness of wheel of roulette and random walk. In ALO search space of the exploration is confirmed by the random pick of the ants with a respective random walk and antlions, and search space of the exploration is confirmed through shrinking adaptive borders of antlions' traps. ALO can be described with the help of the mathematical model by given steps.

A. *Random walk of ants:*

$$Z^t = [0, cs\,(2y\,(t_1) - 1), cs\,(2y\,(t_2) - 1), \ldots, cs\,(2y\,(t_n) - 1)] \quad (15)$$

Z^t is random movement of ants, n is maximum no. of iterations, cs is cumulative sum, t no. of iteration, y(t) is function of Stochastic.

$$y(t) = \begin{cases} 1\ if\ rand > \frac{1}{2} \\ 0\ if\ rand \le \frac{1}{2} \end{cases}$$

Here, rand is called random number [0,1] by a uniform distribution. In the search area, the random walk of ants, the rank of every ant is standardized by using minimum normalization and maximum normalization:

$$Z_i^t = \frac{(Z_i^t - a_i) \times (d_i - c_i^t)}{(d_i^t - a_i)} + C_i \quad (16)$$

Where a_i defined the min-random walk of i^{th} variable, b_i defined the max random walk of i^{th} variables, c_i^t defined the minimum of i^{th} variables at t^{th} iteration and d_i^t defined the maximum of i^{th} variables at t^{th} iteration.

The location of ants is given matrix:

$$M_{Ant} = \begin{bmatrix} Ant_{11} & Ant_{12} & \cdots\cdots & Ant_{1d} \\ Ant_{21} & Ant_{22} & \cdots\cdots & Ant_{2d} \\ \vdots & & \vdots & \vdots \\ Ant_{n1} & Ant_{n2} & \ldots\ldots & Ant_{nd} \end{bmatrix} \quad (17)$$

An ant's location indicates the parameter for every solution. M_{Ant} matrix is considered to save the location of every ant. The objective function is applied while optimization and for each ant, in the given matrix saves the fitness value:

$$M_{OAnt} = \begin{bmatrix} F_t([Ant_{11}, Ant_{12}, \ldots\ Ant_{1d}]) \\ F_t([Ant_{21}, Ant_{22}, \ldots\ Ant_{2d}]) \\ \vdots \\ F_t([Ant_{n1}, Ant_{n2}, \ldots\ Ant_{nd}]) \end{bmatrix} \quad (18)$$

Moreover, in the search space ant-lions are hiding and save their locations.

$$M_{Ant-lion} = \begin{bmatrix} Antlion_{1,1} & Antlion_{1,2} & \cdots\cdots & Antlion_{1,d} \\ Antlion_{2,1} & Antlion_{2,2} & \cdots\cdots & Antlion_{2,d} \\ \vdots & & \vdots & \vdots \\ Antlion_{n,1} & Antlion_{n,2} & \ldots\ldots & Antlion_{n,d} \end{bmatrix} \quad (19)$$

$$M_{OAnt-lion} = \begin{bmatrix} F_t([Antlion_{1,1}, Antlion_{1,2}, \ldots\ Antlion_{1,d}]) \\ F_t([Antlion_{2,1}, Antlion_{2,2}, \ldots\ Antlion_{2,d}]) \\ \vdots \\ F_t([Antlion_{n,1}, Antlion_{n,2}, \ldots\ Antlion_{n,d}]) \end{bmatrix} \quad (20)$$

M_{OAnt} The matrix indicates the fitness values of the ants ' matrix location M_{Ant}, $M_{OAnt-lion}$ The matrix indicates the fitness values of the ant lion's matrix location $M_{Ant-lion}$.

B. *Trapping in ant-lion pits:*

The mathematical equation trappings antlion pits are given below:

$$c_i^t = Antlion_j^t + c^t \quad (21)$$
$$d_i^t = Antlion_j^t + d^t \quad (22)$$

C. *Sliding ants towards ant-lions:*

$$c^t = \frac{c^t}{I} \quad (23)$$
$$d^t = \frac{d^t}{I} \quad (24)$$

Where, I = A ratio, (I= $10^{\beta \frac{h}{H}}$), H is defined the maximum number of iteration, and β is a constant specified (β =2; h > 0.1H, β = 3; h > 0.5H, β = 4; h> 0.75H, β = 5; h > 0.9H and β = 6; h > 0.95H). Basically, β is the exploitation level of accuracy.

D. LF distribution with random walk:

Most of the animals having the similar habits of LF (Le`vy flight) search for the food as reported in the recent studies and also known as random walk. This is the randomly walk policy in this case the step-lengths have a heavy tallied distribution [26]. Because of the dynamic and ergodic properties of random walk, Le`vy flight distribution have been universally used in the case of evolutionary computational programming for determining the difficult optimization problems [27,29]. Therefore, ant position is denoted by Z_i and Le`vy distribution transforms into the new position LZ_i. Hence, Levy distribution is chosen to build modified ALO in this paper as shown below expression:

$$LZ_i = Z_i + \alpha \oplus \text{Levy}(\lambda) \tag{25}$$

Where,

$\oplus$ is defined as wise multiplication of entries, α is the step size of the scales and set as α=1, Levy(λ) is the Levy distribution function as shown below expression:

$$\text{Levy} \sim u = t^{-\lambda} \;,\; (1< \lambda \leq 3) \tag{26}$$

$$L(a,\rho,\gamma) = \begin{cases} \sqrt{\frac{\rho}{2\pi}} \exp\left[-\frac{\rho}{2(a-\gamma)}\right] \frac{1}{(a-\gamma)^{\frac{3}{2}}} & 0 < \gamma < a < \infty \\ 0 & otherwise \end{cases} \tag{27}$$

Here $\gamma, \rho > 0$. ρ is parameter of scale, γ is the parameter of shift. The Lévy flight mathematical expression given below:

$$\text{Lévy (y)} = 0.01 \times \frac{x_a \times \mu}{|x_b|^{\frac{1}{\alpha}}} \tag{28}$$

x_a, x_b two random number of normal distributions [0,1], α =1.5 constant in present work, μ is follows below:

$$\mu = \left(\frac{gamma(1+\alpha) \times \sin\left(\frac{\pi\alpha}{2}\right)}{gamma\left(\frac{1+\alpha}{2}\right) \times \alpha \times 2^{\left(\frac{\alpha-1}{2}\right)}} \right)^{\frac{1}{\alpha}} \tag{29}$$

Gamma(y) = (y-1)!.

E. Elitism with crossover operation:

One of the primary characteristics of the swarm intelligence algorithm is elitism. Elitism provides for maintaining optimal solutions, which are obtained at steps of the optimization process. Addition operations which are not adaptable in binary coding form are used to base assumed the ants travel around the elite and roulette wheel antlion as follows solution for children from the entire population. This is operations of 2 binary solutions, which are obtained from random walks [28]. Each iteration provides an optimal antlion which is saved as the "Elite." The Elite is regarded as best of the antlion. It can affect the movement of ants during iterations. Hence, the ants can be assumed to be walking around the elite and roulette wheel antlion as follows:

$$Ant_i^t = \text{Crossover}\,(R_D^t, R_O^t) \tag{27}$$

Here, R_D^t is the arbitrary walk around the wheel of the roulette antlion selected for no. of iteration t, R_O^t is walk around the elite randomly at iteration t.

IV. Results and discussion

The MALO approach was used for solving the problem of OPF for the standard test system for IEEE 30-bus [47]. To determine the problem of OPF implemented MALO algorithm. Data of the generator, data of the line, data of the bus and limits of minimum control variable & maximum control variable are specified in IEEE-30 Bus data [47] The population size in MALO or no. of ant agents is chosen to be 40 in our analysis.

There are six generators on the bus system i.e., P_{g1}, P_{g2}, P_{g5} , P_{g8} , P_{g11} and P_{g13} and Four off-nominal tap-ratio transformers on lines i.e., 06–09 (T_{11}), 04–12 (T_{12}), 06–10 (T_{15}) and 28–27 (T_{36}). At the same time, buses Q_{C10}, Q_{C12}, Q_{C15}, Q_{C17}, Q_{C20}, Q_{C21}, Q_{C23}, Q_{C24} and Q_{C29} were chosen as shunt VAR buses. The entire demand of the system is 2.834 per unit (p.u.) at 100 MVA base. All load buses are considered to have the maximum and minimum voltages 1.05 to 0.95 per unit. The proposed method has been used to determine OPF problem for several cases that have multiple objective functions.

Table:1. Settings of control variable for different cases.

Settings of control variables	Case=1 Cost function of MALO	Case=2 Cost function of ALO	Case=3 Cost function of BHBO [31]
P_{g1}	177.1161	177.1190	175.3418
P_{g2}	48.2561	48.7788	48.3528
P_{g5}	21.2842	21.3953	21.5323
P_{g8}	21.8952	21.0767	20.0198
P_{g11}	12.8956	11.8851	13.4241
P_{g13}	11.9852	12.0000	13.1081
V_{g1}	1.1000	1.1000	1.0965
V_{g2}	1.0884	1.0885	1.0790
V_{g5}	1.0615	1.0605	1.0506
V_{g8}	1.0682	1.0692	1.0604
V_{g11}	1.1001	1.1000	1.0831
V_{g13}	1.1000	1.1000	1.0650
T_{11}	1.0504	1.0504	1.0033
T_{12}	0.9003	0.9000	1.0265
T_{15}	1.0356	1.0395	1.0033
T_{36}	0.9865	0.9731	0.9741
Q_{C10}	0	0	0
Q_{C12}	0	0	0
Q_{C15}	0	0	0
Q_{C17}	0	0	0
Q_{C20}	0	0	0
Q_{C21}	0	0	0
Q_{C23}	0	0	0
Q_{C24}	0	0	0
Q_{C29}	0	0	0
Fuel cost ($/hr)	799.7031	799.8778	799.9271
Real Power losses(p.u.)	8.6421	8.8895	8.6793
Reactive losses(p.u.)	-0.9654	-0.6334	0.8727
L_{max}	0.1323	0.1341	0.1361
Voltage deviations	1.1172	1.1173	1.1183

A. Cost function:

The characteristics of cost of the generator are described as the power output generator's quadratic cost function and the chosen objective variable.

$$H = \sum_{j=1}^{Ng} F_j(P_{gj}) = \sum_{j=1}^{Ng}(a_j + b_j P_{gj} + c_j P_{gj}^2) \quad (30)$$

Where, a_j, b_j and c_j are the linear, basic and quadratic unit cost co-efficient. These coefficient values are explained in detailed.

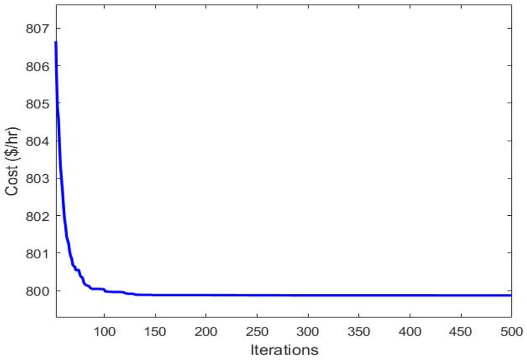

Fig: 1. Fuel cost in case 1

The variation between iterations of the cost of total fuel is shown in figure:1 the suggested method tends to have outstanding characteristics of convergence. Table 1 displays the best configurations of the variable i.e., control variables. The total fuel costs of the proposed MALO approach ($799.8701). Compared with the original case ($901.9516), the cost of total fuel is significantly decreased by 11.33%.

In the primary case or case 0 has a violation of voltage in buses from 19- 30. Such violations are mitigated by the control parameters identified, in this case using the suggested MALO method. Using the same additional conditions (limits of control parameters, primary conditions and data from the system), the results obtained in Case 1 using the MALO method were associated with other literature methods as illustrated in the table 2. From the below obtained results it shows that MALO gives better results compared to other approaches in order to address the problem of OPF by reducing the reducing the cost of fuel generation. The MALO's results are more reliable than the well-known ALO, BHBO [31], PSO [17] and MDE [45] strategies.

Table:2. Comparison of methods:

Method	Cost function	Method description
MALO	799.8701	Modified antlion optimization
ALO	799.8778	Ant lion optimization
BHBO [31]	799.9271	Black hole-based optimization

B. Real or true power transmission losses:

The objective of the problem with OPF is to reduce the losses of active or real power transmission that can be shown below:

$$H = \sum_{j=1}^{Ng} P_j = \sum_{j=1}^{Ng} P_{gj} - \sum_{j=1}^{Ng} P_{Dj} \quad (31)$$

Displays the ability for optimizing the total losses of true power or the objective of the transmission function real power using different types of techniques.

C. Reactive power losses:

Stable system-related voltage stability limit relies on reactive power availability to deliver the transmission true power from the source to sink.

$$H = \sum_{j=1}^{Ng} Q_j = \sum_{j=1}^{Ng} Q_{gj} - \sum_{j=1}^{Ng} Q_{Dj} \quad (32)$$

D. Voltage deviation:

The voltage of the bus is considered the essential protection and service good criteria. Hence, the objective function is given by:

$$X_{Vd} = \sum_{j=1}^{Ng} |V_j - 1.00| \quad (33)$$

CONCLUSION

It is found in this paper that the optimization method which was inspired by nature is presented, proved and occupied to solve the problem under numerous types of constraints. The problem developed is a non-linear based OPF problem with limits on equality and inequalities of systems. The study conduted, reduced the cost of fuel such as the function of quadratic cost. The suggested algorithm, MALO was checked and analysed on the standard IEEE-30 Bus. This method has been carried out extensively and influentially to determine the optimum configurations of the test system of control parameters. The MATLAB results demonstrated the superiority and robustness of the developed method for solving the problem. The results of the MALO algorithm has been analyse & comparing with this reported results with other algorithm in literature. After comparing results of MALO, with other techniques we can conclude that MALO gives better results to the problem of OPF.

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