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BANKS CAPACITOR COMPENSATION FOR CRITICAL NODAL DETECTION BY AUGMENTED RED WOLF OPTIMIZATION ALGORITHM

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Abstract

In this paper Banks Capacitor Compensation for Critical Nodal Detections by Augmented Red Wolf Optimization Algorithm has been worked out. Projected ERWO algorithm hybridizes the wolf optimization (WO) algorithm with swarm based algorithm called as particle swarm optimization (PSO) algorithm. In the approach each Red wolf has a flag vector, and length is equivalent to the whole sum of numbers which features in the dataset of the wolf optimization (WO). Exploration capability of the projected Red wolf optimization algorithm has been enriched by hybridization of both WO with PSO. Efficiency of the projected Enriched Red wolf optimization (ERWO) is tested in standard IEEE 57 bus test system. Simulation study indicates Enriched Red wolf optimization (ERWO) algorithm performs well in tumbling the actual power losses.

Keywords: Reactive Power; Loss; Red Wolf Optimization.

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1. Introduction

Reactive power problem plays major role in improving secure& economic of power system operation & control. To determine the size, type, and location of capacitor banks to be installed on radial distribution feeders to achieve positive economic response is the objective of optimal capacitor placement problem. Loss reductions weighted against capacitors costs with constraints are in limits to obtain the economic benefits. A variety of methodologies [1-6] have been implemented to solve the problem, but difficulty found in handling the constraints. Now days various types of Evolutionary algorithms implemented to solve problem [7-19]. For last twenty years various types of programming and probabilistic based approach has been used to solve the problem. In this work Enriched Red wolf optimization (ERWO) algorithm has been implemented to work out the problem. Both Exploration & Exploitation has been improved. In basic Wolf

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optimization algorithm (WO) [20], exploration spaces are missing the diversity and the high-quality diversity is needed to upgrade the performance of the algorithm to find an optimal solution. Particle swarm optimization (PSO) [21] has good feature of exploration ability and it has been hybridized with Wolf optimization algorithm (WO) to produce an enriched version called as Enriched Red wolf optimization (ERWO). PSO will aid to form better preliminary population to WO. In standard IEEE 57 bus test system efficiency of Enriched Red wolf optimization (ERWO) algorithm has been evaluated. Results indicate that Enriched Red wolf optimization (ERWO) algorithm performs well in tumbling the actual power losses.

2. Problem Formulation

Reducing power loss, bus voltage with specified limits with minimized cost is the objective function of capacitor placement. Voltage limits are considered as constraints. Due to the capacitor placement the annual cost and power losses are given by,

Minimize $\left\{F = Z_{PL} P_L + \sum_{j=1}^{N} Z_{cj} D_j\right\}$ (1)

Where F - total annual cost function ($),
ZPL the annual cost per unit of power losses,
($/KW), PL – total active power loss (KW),
N- Number of buses.

Constraint of voltage is given as

$$V_i^{min} \le V_i \le V_i^{max} \tag{2}$$

3. Red Wolf Optimization

Red wolf optimization mimics the communal management and hunt deeds of Red wolves in nature. There are three fittest candidate solutions assumed as α,β and γ to lead the population toward promising regions of the exploration space in each iteration of red wolf optimization. φ is named for the rest of Red wolves and it will assist α,β and $\gamma$to encircle, hunt, and attack prey, that is, to find Enriched solutions. In order to scientifically replicate the encompassing behavior of Red wolves, the following equations are proposed:

$$\vec{G} = \left|\vec{F}.\overrightarrow{Y_P}(t) - \vec{Y}(t)\right|, \tag{3}$$

$$\vec{Y}(t+1) = \overrightarrow{Y_P}(t) - \vec{H}.\vec{G} \tag{4}$$

Where $t$indicates the current iteration, $\vec{\mathrm{H}} = 2\vec{\mathrm{b}}.\vec{\mathrm{r}_1} - \vec{\mathrm{b}}$, $\vec{\mathrm{F}} = 2.\vec{\mathrm{r}_2}$, $\widehat{\mathrm{Y}_\mathrm{P}}$the position vector of the prey, $\vec{\mathrm{Y}}$is the position vector of a Red wolf, $\vec{\mathrm{b}}$ is linearly decreased from 2.0 to 0, and $\vec{\mathrm{r}_1}$and $\vec{\mathrm{r}_2}$are arbitrary vectors in [0, 1].

Hunting behavior of Red wolves are mathematically simulated by following equations,

$$\overrightarrow{G_\alpha} = \left|\overrightarrow{F_1}, \overrightarrow{Y_\alpha} - \vec{Y}\right| \tag{5}$$

$$\overrightarrow{G_\beta} = \left|\overrightarrow{F_2}, \overrightarrow{Y_\beta} - \vec{Y}\right| \tag{6}$$

$$\overrightarrow{G_\gamma} = \left|\overrightarrow{F_3}, \overrightarrow{Y_\gamma} - \vec{Y}\right| \tag{7}$$

$$\overrightarrow{Y_1} = \overrightarrow{Y_\alpha} - \overrightarrow{H_1}\ .\overrightarrow{G_\alpha} \tag{8}$$

$$\overrightarrow{Y_2} = \overrightarrow{Y_\beta} - \overrightarrow{H_2}\ .\overrightarrow{G_\beta} \tag{9}$$

$$\overrightarrow{Y_3} = \overrightarrow{Y_\gamma} - \overrightarrow{H_3}\ .\overrightarrow{G_\gamma} \tag{10}$$

$$\vec{Y}(t+1) = \frac{\overrightarrow{Y_1}+\overrightarrow{Y_2}+\overrightarrow{Y_3}}{3} \tag{11}$$

In this work, a new Enriched Red wolf optimization (ERWO) algorithm is proposed to solve reactive power dispatch problem & the position of a Red wolf was updated & the following equation is used to discrete the position.

$$flag_{i,j} = \begin{cases} 1 & Y_{i,j} > 0.50 \\ 0 & otherwise \end{cases} \tag{12}$$

Where i, indicates the jth position of the ith Red wolf, $flag_{i,j}$ is features of the wolf.

4. Particle Swarm Optimization

In Particle swarm optimization (PSO) algorithm the positions and velocities of the Particles are modernized as follows:

$$\mathrm{v}_{t+1}^{i} = \omega_t . \mathrm{v}_t^i + cg_1 . Rm_1 . \left(m_t^i - y_t^i\right) + cg_2 . Rm_2 . \left(m_t^g - y_t^i\right) \tag{13}$$

$$y_{t+1}^i = y_t^i + \mathrm{v}_{t+1}^i \tag{14}$$

The current position of particle is y_t^i&search velocity is v_t^i. Global best-found position is. m_t^g. In uniformly distributed interval (0, 1) Rm_1&Rm_2 are arbitrary numbers. Where cg_1 and cg_2 are scaling parameters.ω_t is the particle inertia. The variable$\omega_t$is modernized as

$$\omega_t = (\omega_{max} - \omega_{min}) . \frac{(t_{max} - t)}{t_{max}} + \omega_{min} \tag{15}$$

Maximum and minimum of ω_t is represented by ω_{max} and ω_{min}; maximum number of iterations is given byt_{max}. Until termination conditions are met this process will be repeated.

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5. Enriched Red Wolf Optimization (ERWO) Algorithm for Solving Optimal Reactive Power Dispatch Problem

In this approach red wolves α,β and γ determine the position of the prey. $\vec{H} = 2\vec{b}.\vec{r_1} - \vec{b}$ directs the exploration & exploitation process by reducing the value from 2 to 0. When $|\vec{H}| < 1$ it converged towards the prey& If $|\vec{H}| > 1$ diverged away. The first best Minimum loss and variables are accumulated as"α"position, score & as like second best, third best accumulated as "β" and " γ" position & score.

Commence
Initialize the parameters
Initialize b, $\vec{H}$ and $\vec{F}$; beginning positions of Red wolves has been stimulated.
i = 1: population size
j=1: n
When (i, j) > 0.500
(i) = 1;
Else
(j) = 0;
End if
End for
Work out the maximum fitness of Red wolves as follows,
Primary maximum fitness of the Red wolf is designated as "α"
Second maximum fitness of the Red wolf is designated as "β"
Third maximum fitness of the Red wolf is designated as "γ"
While k <maximum iteration
For i = 1: population size
Exact Location of the existing Red wolf has been revised periodically
End for
For i = 1: population size
For i=1: n;If (i, j) > 0.500
(j) = 1;
Else
(j) = 0;
End if
End for
Sporadically revise the values of b, $\vec{H}$ and $\vec{F}$;
At this stage Fitness of Red wolves has been calculated
The assessment of red wolves "α","β" and " γ"has to be revised
k=k+1;
End while
Re-examine the value of"α"as the optimal characteristic division;
End

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6. Simulated Outcomes

The Enriched Red Wolf Optimization (ERWO) has been applied in standard IEEE 57 bus system. The base voltage each bus taken as 135 kV. In primary case Enriched Red Wolf Optimization (ERWO) has been applied & table 1 shows the critical busses & value of the capacitor. Table 2 shows the various parameters values before & after placement of the capacitor. Real power loss & reactive power value for various approach (Brahim GASBAOUI et al.2011) has been compared in table 3. After application of Enriched Red Wolf Optimization (ERWO) power losses are decreased by 23.79 7 reactive power injected into the electrical distribution system are diminished by 14.82 %.

Table 1: capacitor value in critical buses

Number of critical buses	Value of capacitor [MVAR]
10	3.89
19	1.98
21	3.02
28	3.12
32	4.99
33	6.97
52	1.02

Table 2: key parameters value before & after placement of capacitors

	Value – before placement of optimal capacitor	Value – after placement of optimal capacitor
Value of real Power loss in MW	17.35	13.98
Minimum Voltage value in per unit	0.918	0.956
Value of Reactive power [MVAR]	274.892	234.590

Table 3: comparison of Real & reactive power values

Technique	Real Power Loss In MW	Reactive Power In MVAR
METHOD QN-OPF (Brahim GASBAOUI Et Al.2011)	17.16	-
METHOD ACO-OPF (Brahim GASBAOUI Et Al.2011)	17.96	-
METHOD MAT POWER (Brahim GASBAOUI Et Al.2011)	16.51	270.56
METHOD FLC-HSO (Brahim GASBAOUI Et Al.2011)	15.29	239.27
METHOD FLC-GAO (Brahim GASBAOUI Et Al.2011)	14.19	235.14
PROPOSED ERWO (Brahim GASBAOUI Et Al.2011)	12.98	232.86

7. Conclusion

Enriched Red wolf optimization (ERWO) approach effectively solved the problem. Exploration & Exploitation has been considerably improved through the proposed methodology. Proposed technique has been tested in standard IEEE 57 bus test system. Comparison of the real power loss has been done along with reactive power values.

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