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Optimal Allocation of D-Statcom in Multimachine Power System for Stabilization of Voltage Using GWO

Rawaa A. Abdul –Nabi[1], Rana Adil Abdul-Nabe[2] And Karrar Hameed Kadhim[3]

[1]AL-Musaib Technical College, AL-Furat Al-Awsat Technical University.

[2]Al - Mussaib Technical Institute, Al- Furat Al - Awsat Technical University, Babylon, Iraq.

[3]Institute of Power Engineering, Tomsk Polytechnic University, Tomsk, Russian Federation, AL-Musaib Technical College, AL-Furat Al-Awsat Technical University.

[1]com.aa.rwaa@atu.edu.iq, [2]ranaalbakri2018 @gmail.com, [3]karrar.almussawi.87@gmail.com

Abstract.
In this paper, the Gray Wolf Optimization algorithm (GWO) is used to solve the optimal allocation of D-STATCOM, which acts as a flexible ac transmission system in the distribution device. The main goal of this research work comprises voltage profile improvement and power loss reduction. Here, the backward/forward sweep method is used to evaluate the power flow in the distribution system. The voltage and angles values of each bus nodes are calculated. IEEE 30-bus radial distribution system is designed for testing and their performance are analyzed using MATLAB 2016 software. The obtained values of voltage and angles are compared with base values which provide the optimal placement location D-STATCOM. The proposed GWO techniques are outperformed when compared to Particle Swarm Optimization (PSO) and Bacteria Foraging Optimization (BFO) method.

Keywords. MATLAB 2016 Software, D-STATCOM, LFA of the Device, Voltage and Angles, Artificial Bee Colony, AC Voltage.

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INTRODUCTION

Nowadays, the power system can be classified such as distribution, generation and transmission. The distribution system plays a major role in the power system, which causes power loss due to the design of the distribution system, high flowing current and faults. The Flexible AC transmission system (FACTS) devices concepts can be made to avoid these problems appears in the voltage regulator and capacitor. In addition to that most concentrations needed for load flow analysis. FACTS device increasing the controllability and stability of the AC device, in addition to rises the power transfer capability of the device [8]. Main types of powers in power systems are reactive power, active power, and apparent power [10]. However, loss due to reactive power is mainly considered although it is not considered by the loads. Therefore to attain extreme active power transmission the reactive power should be compensated [16-22]. These devices improve the performance of electrical networks by handling reactive and active power. The shunt connected controller is called static synchronous compensator (STATCOM).

In the multi-machine system, the optimal placement of STATCOM is of high complexity. To make the optimal placement different types of techniques are introduced [15, 12]. The optimal placement of D-STATCOM reduces the power loss in a radial network and improves the voltage profile. The optimal location of STATCOM is done using FVSI. Newton Raphson technique is utilized to do the power flow analysis of the radial distribution systems. Weakest bus in the system can also be identified using FVSI technique [14]. To minimize the harmonics, the passivity-based controller is implemented in the D-STATCOM which compensates the reactive power and load current. These methods consider the line current and then perform the compensation. This method produces better result even though low switching frequency or the limited bandwidth inverter circuit [11].

In D-STATCOM, the Artificial Neural Network (ANN) is implemented which has an advantage as well as disadvantage. This method improves the performance at the same time it takes extended training time in choosing the layers and number of neurons. Fuzzy Logic Control (FLC) is the artificial intelligence methods which give more controllability [7, 9]. The global optimization technique is used to solve the D-STATCOM problems [2, 3, 4]. The PSO with self-tuning PI controller is used in STATCOM which produces better dynamics at all load points. During the short period, the algorithm gives better gains using a self-tuning controller [13]. The BAT optimization algorithm is used in the D-STATCOM. The feeder load is varied with 1% step size and the optimal allocation and sizing for D-STATCOM are calculated for each load step. This optimization method is verified on IEEE 33-bus and 69-bus radial distribution system [6]. The Artificial Bee Colony (ABC) algorithm is implemented in the D-STATCOM controller. The Bacteria Foraging (BF) method can be recognized just by [1, 5]. This algorithm based on the haphazard search ways which tend to interruption in attainment the global resolution.

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In the proposed work, the optimized controller of D-STATCOM device is used for voltage regulation. The GWO Optimization algorithm is utilized to obtain the gain of the controller. For voltage stability improvement and LFA, the D-STATCOM is utilized. The optimal placement of D-STATCOM leads to reduce power loss and improves voltage profile, which is the main goal of this work. LFA of the device is completed by Backward/Forward Sweep (BFS) techniques which estimate the voltage and angle at each bus. The IEEE 30-bus structure is used to analyze the performance of the system [23-31]. The organization the further paper is given below: the proposed methodology of the D-STATCOM given in section 2. The distribution system is explained in section 3, the optimization algorithm is described in Section 4. In section 5, the simulation results are discussed. The conclusion of the paper is given in section 6.

PROPOSED METHODOLOGY OF D-STATCOM

D-STATCOM is a shunt device in which active and reactive power at the bus can be either injected or absorbed. To provide constant DC-link voltage D-STATCOM has an energy storage device. Since it turns like synchronous voltage source it can control bus voltage and power factor [32-37]. To raise the voltage profile in the bus DSTATCOM injects the required amount of current in the intersection point. The radial distribution system is connected with the coupling transformer. Backward/Forward Sweep (BFS) techniques are utilized to analysis system load. The conversation of reactive and active power through D-STATCOM. Figure 1 illustrates the methodology of D-STATCOM.

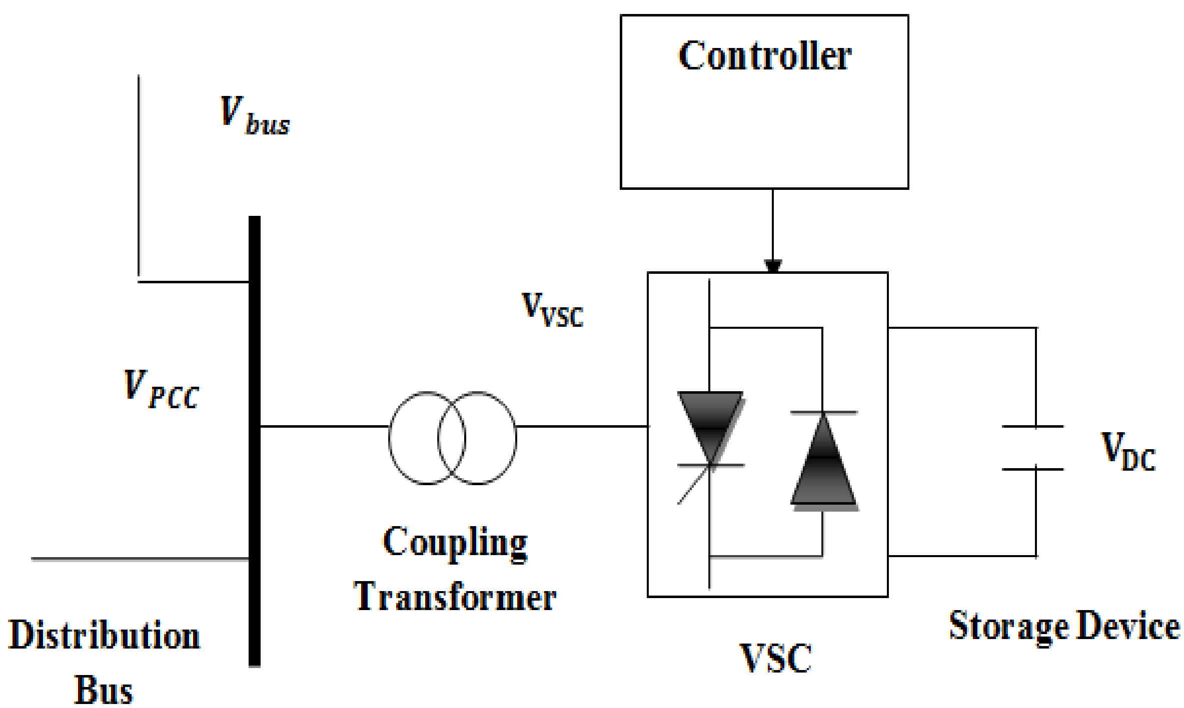

Figure 1. Block diagram of D-STATCOM

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The D-STATCOM continuously test the line waveform with the reference signal to minimize the voltage fluctuations. The controller parameter is tuned by using the HBF-GWO algorithm. D-STATCOM system contains voltage source converter (VSC), controller and a set of coupling reactors. The voltage source inverter is linked to the dc capacitor which is an energy storage device. D-STATCOM creates a manageable ac voltage from VSI. The transformer leakage reactance appears behind the AC voltage. Because of the voltage change through the reactance, there is a reactive and active power transfer among D-STACOM and power system. Point of common coupling (PCC) is where the power system and D-STATCOM are connected. Voltages and currents fed to the controller are associated with the reference then the controller executes the feedback control and the results are fed to the power system converter accordingly. At PCC, the magnitude of voltage value is more than voltage source amplitude then the D-STATCOM consumes the additional reactive power and supposes the magnitude of voltage value is less than the source amplitude then the D-STATCOM injects the reactive power by acting as a variable capacitor [38-45].

DISTRIBUTION SYSTEM

Distribution system delivers the electricity to the customer from the transmission line, which is the ending point in the electric power transport. There are two types of the distribution system, which given as Ring Main Distribution System and Radial Distribution System and. The radial system is utilized in the distribution system because it is less expensive compared to the ring main system.

BACKWARDS/ FORWARD SWEEP TECHNIQUES

Considering a radial basis network, the backward/forward sweep techniques designed for LFA which is an iteration technique, two computation steps are accomplished per iteration: two sets of equations are utilized to resolve the problem of load flow in the distinct source network iterative. Each node power flow is estimated beginning from the least branch to the root node in the backward directions using the first set of equation. Each node voltage magnitude and angle value is estimated beginning from the root feeder node to the last node in the forward direction using another set of equation.

Forward Sweep

In the forward sweep, the values of power and voltage are updated which is starting from the feeder basis node to last nodes. Each node the voltage values are estimated in the forward direction and power value will be constant in the backward propagation. The actual voltage value is set as the feeder substation voltage.

Backward Sweep

In the backward sweep, the values of power and current are updated which is beginning from the least branch node to the root feeder node moving towards backward propagation. It takes the voltage of the previous

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iteration during the power flow estimation in each branch. In the forward direction, the voltage values remain constant during the power flow calculation in the backward propagation through the feeder.

The process of forwarding/backward sweep method is given below:

- Calculation of branch current, the current summation techniques are utilized;
- Calculation of power flow branches, the power summation techniques are utilized;
- Calculation of admittance value in the node by node, the admittance summation techniques are utilized.

In each iteration procedure, the backward/forward sweep techniques are modified inappropriately for the convergence analysis. Consider 2 nodes, between the nodes the branch is linked 'k' and 'k+1'. Real (P_k) and Reactive (Q_k) branch power in node 'k' to node 'k+1' is estimated backwards in the least node and represented below,

$$P_k = P'_{k+1} + R_k \frac{\left(P_{k+1}^2 + Q_{k+1}^2\right)}{V_{k+1}^2} \tag{1}$$

$$Q_k = Q'_{k+1} + X_k \frac{\left(P_{k+1}^2 + Q_{k+1}^2\right)}{V_{k+1}^2} \tag{2}$$

Where

$$P'_{k+1} = P_{k+1} + P_{Lk+1}$$

$$Q'_{k+1} = Q_{k+1} + Q_{Lk+1}$$

P_{Lk+1} and Q_{Lk+1} were loads linked at node 'k+1', P_{k+1} and Q_{k+1} were the actual real and reactive flow of power in feeder node 'k+1'.

In the forward direction, the voltage values will be updated. Considered a voltage $V_k < \delta_k$ at node 'k' and $V_{k+1} < \delta_{k+1}$ at node 'k+1', then the flow of current over branch impedance, $Z_k = R_k + jX_k$ lined among 'k' and 'k+1'is represented below,

$$I_k = \frac{V_k < \delta_k - V_{k+1} < \delta_{k+1}}{R_k + jX_k} \tag{3}$$

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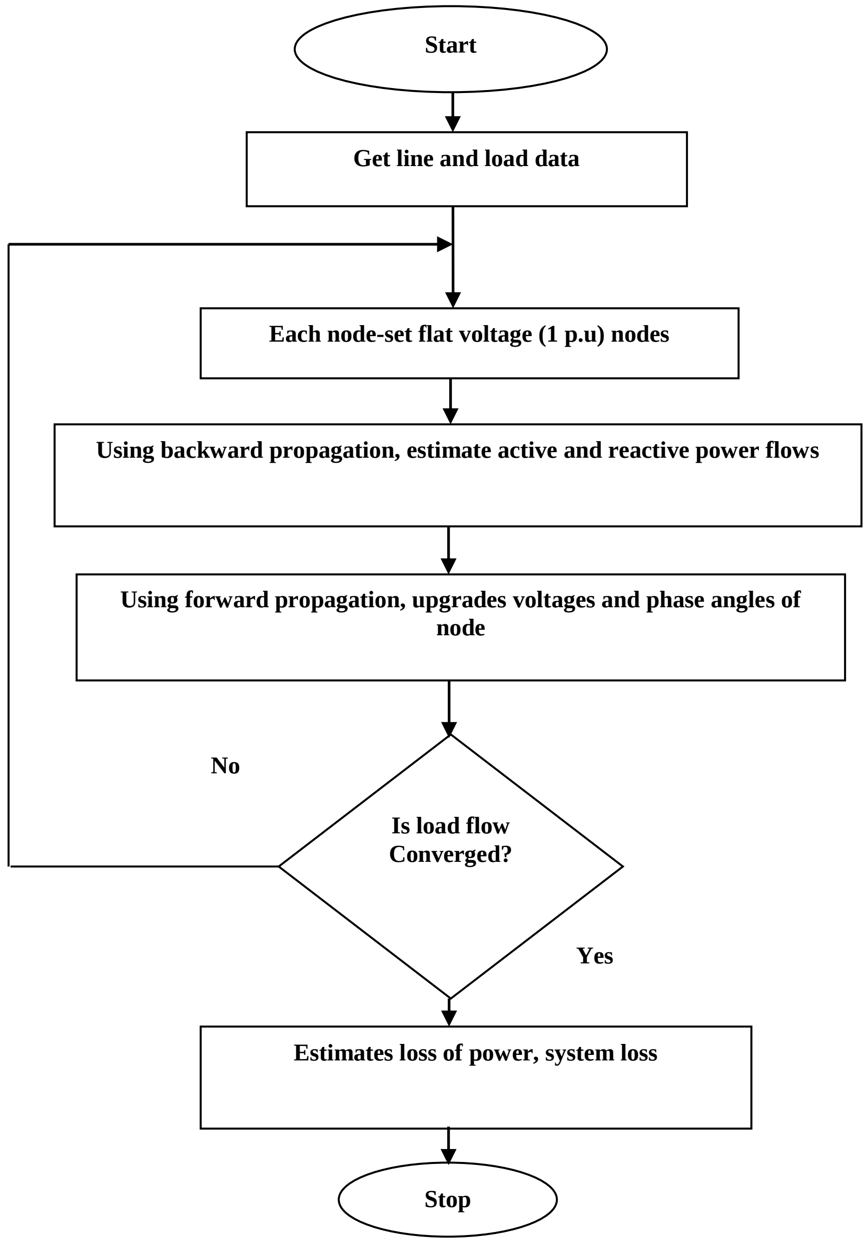

Figure 2. Flow chart for forwarding/backward sweep method

Equations of magnitude and phase are utilized in the forward direction to determine the voltage and angle, correspondingly, each node of the radial distribution system. Firstly, the smooth voltage summary is expected at each node i.e., 1.0 pu. Power of each branch is estimated iteratively at each node. The flow of power is analyzed in backward direction and voltage is analyzed in the forwarding direction. Figure 2 represents the comprehensive process of the power flow estimation using a forward and backward sweep algorithm.

OPTIMIZATION ALGORITHM

The optimization techniques are utilized to found the optimum placement and size of D-STATCOM. Here gray wolf optimization algorithm (GWO) is used.

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Grey Wolf Optimization (GWO)

Gray wolf optimization algorithm based on hunting scheme of wolves. It considers the guidance hierarchy, migration operation and hunting scheme of the wolves. Grey wolf can remember the locations of the victim and to surround them. The purpose of the wolf techniques is to live the wolf in a pack. GWO algorithm provides information about every search area of each iteration where the Evolutionary techniques eliminate the previous value data. Exploration is the process of enquiring the potential area of the search space where the exploitation is the local search ability around the regions receiving from the exploration process.

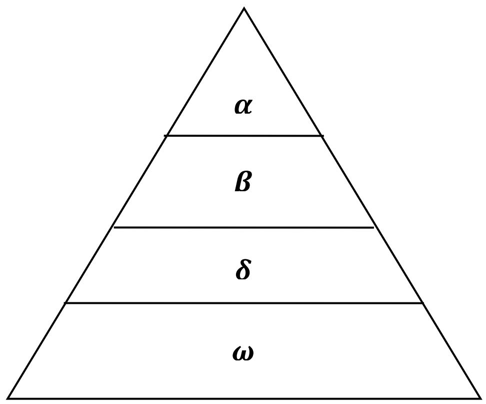

Figure 3. Types of Grey Wolf

Grey wolves are the top-line predators in the food pyramid. The order of the wolves can be classified as four types; they are alpha, beta, omega and delta shown in figure 3. Here the female wolves are the decision-makers known as alpha and reinforce the command of alpha is said to be beta. The lowest rank orders in the grey wolf level which obey all orders of the upper-level wolves are called as omega. Delta wolves are dominant to omega and inferior to both alphas and betas.

The Grey Wolf Optimization (GWO) algorithm filters redundant and irrelevant information by searching the optimal value. The selection operation is performed by considering the fitness value, and it is calculated and sorted from the minimize function. Then they followed packs are created arbitrarily to replace the emigration wolf. The optimal solution is improved by applying the GWO algorithm for optimization.

The distance of the wolf and the victim can be calculated by using equation 4, 5 and 6.

$$\overrightarrow{D_{\propto}} = \left|\overrightarrow{C_1}.\overrightarrow{X_{\propto}} - \vec{X}\right| \qquad (4)$$

$$\overrightarrow{D_{\beta}} = \left|\overrightarrow{C_2}.\overrightarrow{X_{\beta}} - \vec{X}\right| \qquad (5)$$

$$\overrightarrow{D_{\delta}} = \left|\overrightarrow{C_3}.\overrightarrow{X_{\delta}} - \vec{X}\right| \qquad (6)$$

Where $D_{\propto}, D_{\beta}, D_{\delta}$ are the distances of α, β, δ of the wolves. The remaining wolves values are given as $\overrightarrow{X_1}, \overrightarrow{X_2}, \overrightarrow{X_3}$ which is represented in equation 7, 8 and 9.

$$\overrightarrow{X_1} = \overrightarrow{X_{\propto}} - \overrightarrow{A_1}.\overrightarrow{D_{\propto}} \qquad (7)$$

$$\overrightarrow{X_2} = \overrightarrow{X_\beta} - \overrightarrow{A_2}.\overrightarrow{D_\beta} \quad (8)$$

$$\overrightarrow{X_3} = \overrightarrow{X_\delta} - \overrightarrow{A_3}.\overrightarrow{D_\delta} \quad (9)$$

$$\overrightarrow{A} = 2\vec{a}.\overrightarrow{r_1} - \vec{a}, \vec{c} = 2.\overrightarrow{r_2}, \quad \vec{X}(t+1) = \frac{(\overrightarrow{X_1}+\overrightarrow{X_2}+\overrightarrow{X_3})}{3} \quad (10)$$

Where a, c, A are the controlling parameters in the algorithm r1 and r2 are the arbitrary variables. These random vectors will help the wolf to predict the victim at any point. The component vectors decrease as the iterations go longer.

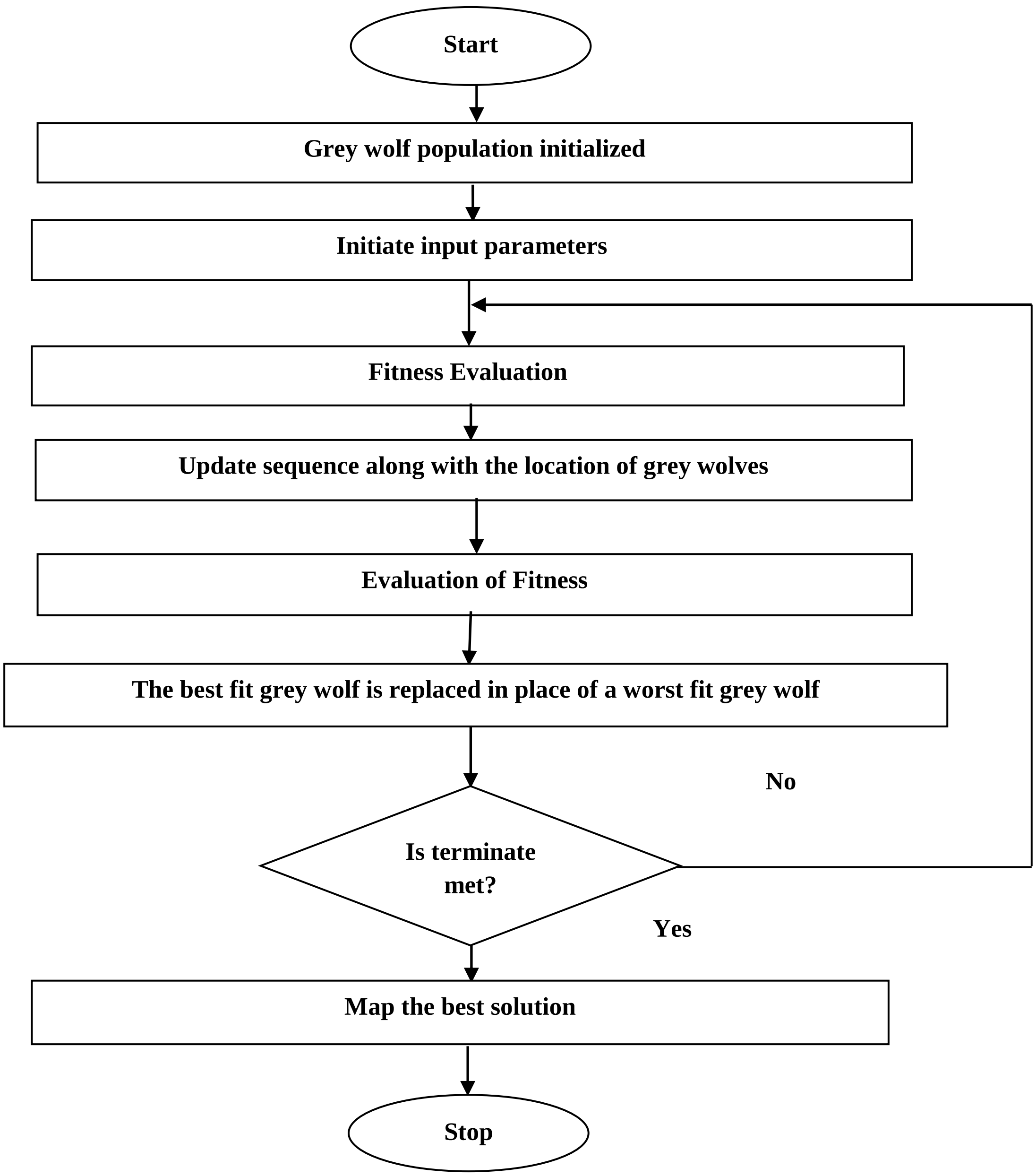

Figure 4. Flowchart of GWO algorithm

Figure 4 represents the flowchart of the GWO algorithm which performs the optimization of the roller bearing design by considering some benchmarks.

The Grey Wolf Optimization algorithm is given below.

1) Initialize the population of a wolf in the counter.
2) Initialize the suitable values for the population.
3) Initialize the search agent values.
4) The fitness strength values are calculated for each wolf.
5) Characterize the wolves based on the quality and rank among them as the best wolf.
6) The grey wolves are arranged based on fitness strength.
7) Update the values based on the GWO algorithm map.
8) Update the positions of grey wolf depends on the number of iterations and the value of the wolf.
9) Update the best fit values for each search and replace the worst fit values for each iteration.

SIMULATION RESULTS AND DISCUSSION

The 30-bus power system is considered, in which the amount of load bus is represented as n_p and the amount of generator bus is represented by n_g. The amount of bus in the power device will be represented as $n = n_p + n_g + 1$. Bus-1 is reserved as a reference bus (slack bus). This method is similar to solving the set of non-linear equations. In the LFA, at each iteration, we need to perform forward and backward process.

IEEE 30-bus test system

This device consisting of 30 buses and 29 branches. Network information, contains the resistance and reactance lines and loads linked to nodes are utilized to execute the LFA. Base network voltage is 11kV and the apparent power is 100MVA. IEEE 30-bus radial distribution system is presented in figure 5.

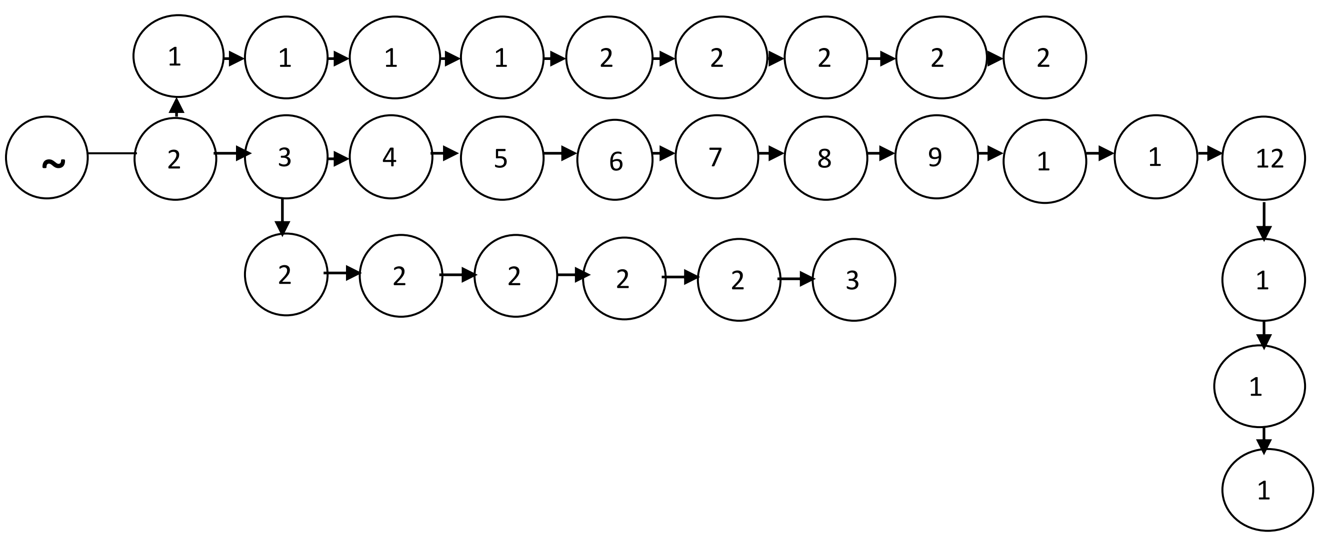

Figure 5. IEEE 30-bus system

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In IEEE 30-bus test system, contains 2 cases for analyzing the proposed techniques.

1. Network without compensation
2. Network with DSTATCOM

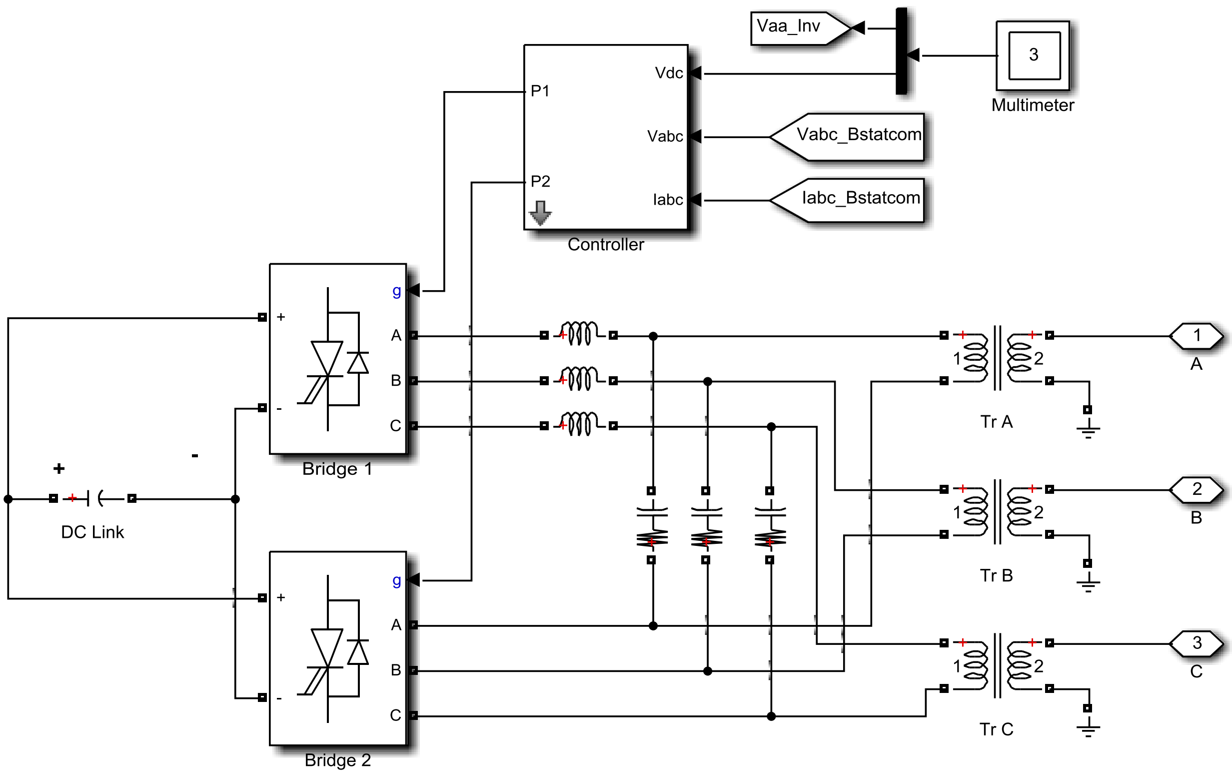

Figure 6. D-STATCOM

Figure 6 shows the subsystem of D-STATCOM. In the distribution static synchronous compensator, the Gate Turn-Off Thyristor(GTO) is used as a voltage source converter. Depending upon the DC capacitor input voltage, the AC output voltage is controlled in this type of VSC. The DC-link capacitor produces constant dc voltage to the VSC.

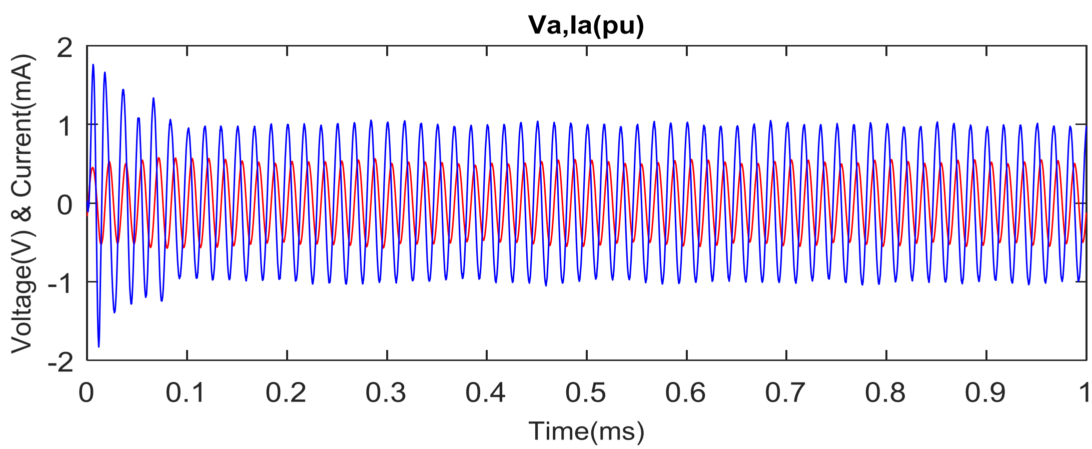

Figure 7. D-STATCOM current and voltage (phase a)

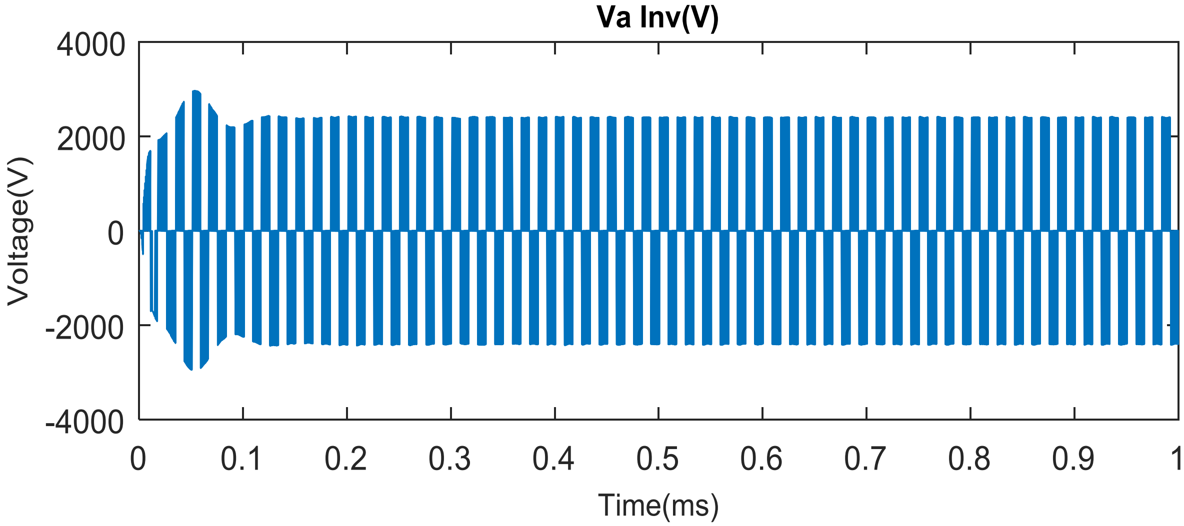

Figure 8. Inverter voltage (phase a)

Figure 7 shows the D-STATCOM voltage and current waveforms. Here, the three-phase system is implemented which is denoted as a, b, c. The phase a voltage and current are shown here. The Simulink running time is set as 1. The inverter output voltage graph is shown in figure 8.

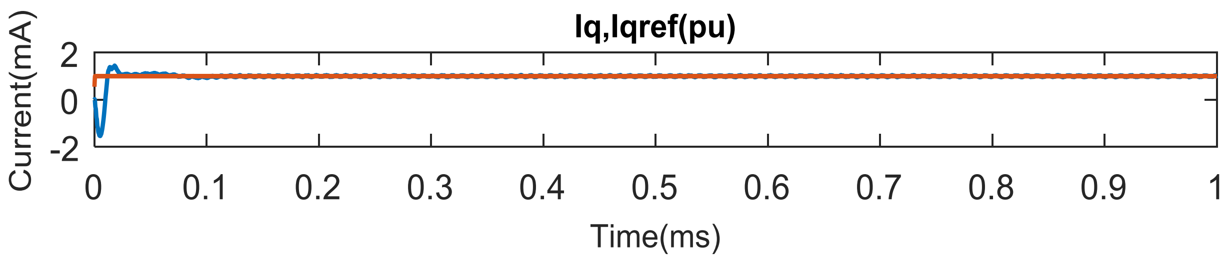

Figure 9. Reactive current and reactive reference current

Reactive current and reactive reference current is shown in figure 9. The graph plotted against the current and time. The reactive and active power of the Bus system is represented in figure 10. The real and imaginary components are represented as the reactive and active power of the apparent power in the current components in-phase and quadrature with voltage.

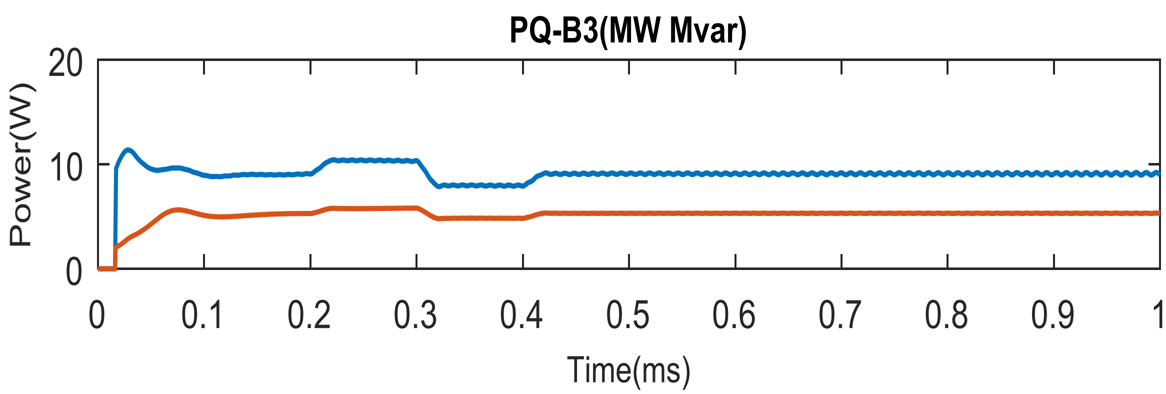

Figure 10. Active and reactive power of Bus

Table 1. Voltage profile and angle in each bus with and without D-STATCOM

Bus number	Without D-STATCOM		With D-STATCOM	
	Voltage (pu)	Angle (degree)	Voltage (pu)	Angle (degree)
1	1.0600	0.0000	1.0641	0.0000
5	1.0100	-14.2193	1.0141	-14.2213
8	1.0100	-11.8857	1.0141	-11.8884
10	1.0134	-15.5934	1.0173	-15.6000
13	1.0710	-15.3533	1.0751	-15.3564
15	1.0184	-15.9736	1.0210	-15.9459
18	1.0040	-16.5673	1.0041	-16.4647
19	1.0018	-16.4981	1.0066	-16.5314
23	1.0010	-16.1781	1.0046	-16.1753
25	0.9988	-16.1165	1.0026	-16.1201
28	1.0078	-11.7839	1.0119	-11.7858
30	0.9799	-17.9030	0.9838	-17.9082

The voltage profile improvements can be mentioned in table 1. For each bus, the angle and voltage have been calculated and tabulated. Without D-STATCOM the voltage profile ranges from 0.9799pu to 1.0710pu. Thus the minimum voltage in the base case is 0.9799pu. With D-STATCOM the voltage profile ranges from 0.9838pu to 1.0751pu. Most of the bus voltages after the D-STATCOM placement is improved and are within the range can be seen. Also, the angle calculation in each bus has been increased when the D-STATCOM is placed on various buses.

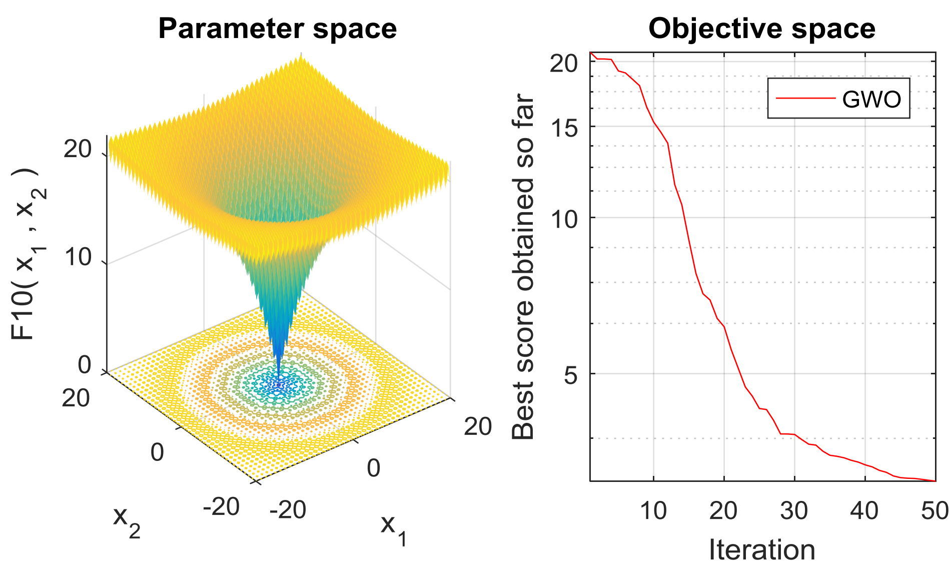

Figure 11. Gray Wolf Optimization

Figure 11 represents the optimized value of the given benchmark attained by GWO techniques where this algorithm produces the best fitness strength and best optimal score when compared to the other optimizers.

Table 2. D-STATCOM parameters after the D-STATCOM placement

D-STATCOM placement Bus No	Vsh (pu)	Thst (degree)	Qsh (pu)
18	0.9947	-16.4346	0.0526
19	1.0045	-16.7895	-0.0446

Table 2 shows the voltage, power and angle in the D-STATCOM after the D-STATCOM placement in the IEEE 30-bus system. The optimal placement required for the D-STATCOM is calculated from the voltage and power values of the backward/forward sweep LFA. After placing D-STATCOM at the 18th and 19th bus, the voltage, angle and reactive power of the D-STATCOM is calculated and tabulated in table 2.

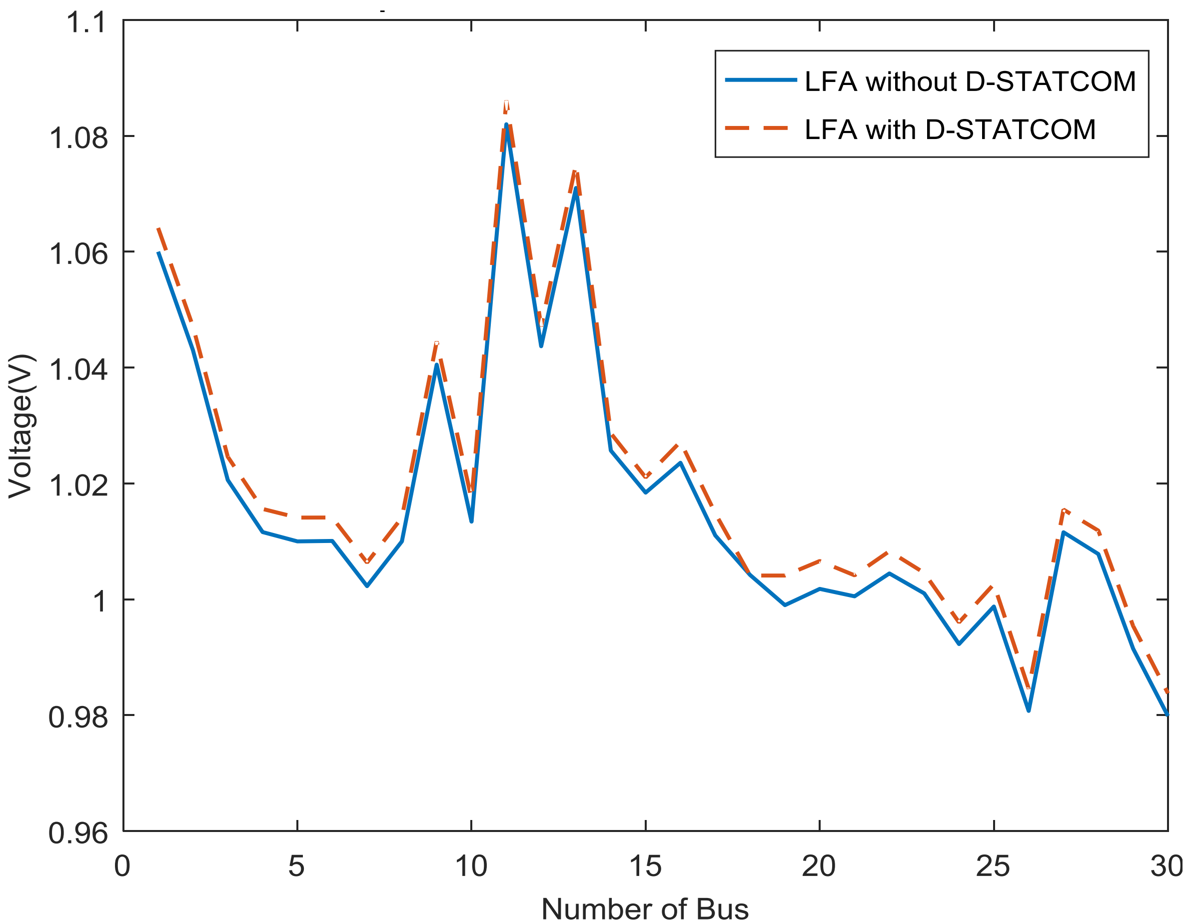

Figure 12. Comparison of LFA with and without D-STATCOM

The comparison of the LFA with D-STATCOM and without D-STATCOM is shown in figure 12. The graph is plotted against the voltage and the number of buses. The backward/forward sweep load flow analysis with D-STATCOM gives better result and the voltage level is the certain increment.

CONCLUSION

In this paper, the GWO algorithm has been described for optimal allocation of D-STATCOM, to the reduction of power loss, improve voltage profile and voltage stability in the distribution system. Load flow analysis (LFA) is utilized for calculating the voltage profile, reactive power and active power in the backward/forward sweep distribution systems. The experimental analysis of the backward/forward sweep method can be presented. The distribution power flows are carryout through the backward and forward propagation iterative equation. The examination of branch power and node power using backwards and forward respectively. Also, IEEE 30-bus radial distribution devices are utilized to check the proposed system.

REFERENCES

[1] Abd-Elazim SM, Ali ES. Coordinated design of PSSs and SVC via bacteria foraging optimization algorithm in a multimachine power system. Int J Electr Power Energy Syst 2012;41(1):44–53.

[2] Abd-Elazim S.M., Ali E.S. Optimal location of STATCOM in multimachine power system for increasing loadability by Cuckoo Search algorithm. Electrical Power and Energy Systems 80 (2016) 240–251.

[3] Abhinav Jain, A.R. Gupta, Ashwani Kumar., An Efficient Method for D-STATCOM Placement in Radial Distribution System. IEEE 2014.

[4] Ali ES, Abd-Elazim SM. Coordinated design of PSSs and TCSC via bacterial swarm optimization algorithm in a multimachine power system. Int J Electr Power Energy Syst 2012;36(1):84–92.

[5] Ali ES, Abd-Elazim SM. TCSC damping controller design based on bacteria foraging optimization algorithm for a multimachine power system. Int J Electr Power Energy Syst 2012;37(1):23–30.

[6] Balasubramaniyan S., Sivakumaran T.S., “Optimal Location Of Facts Devices For Power Quality Issues Using Pso And Bat Algorithm”Journal of Theoretical and Applied Information Technology., Vol. 64 No.1, June 2014.

[7] Balavar M. Using neural network to control STATCOM for improving transient stability. J Artif Intell Electr Eng 2012;1:26–31

[8] Bindu Priya M, Srijan Kumar M. Optimal Power Flow of the Multi-type FACTS Controllers using Genetic Algorithm. International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 4, Issue 4, April 2015.

[9] Dhal PK, Ranjan CCA. Analysis of transient stability based STATCOM for neural network controller in cascaded multilevel inverter. In: 4th International conference, SEMCCO 2013, Chennai, India; December 19–21, 2013. p. 342–53.

[10] El-Saady G, El-Nobi A. Ibrahim Mohamed A. Hendy., Optimal Choice and Allocation of FACTS Devices for Security- Constrained Economic Dispatch. Innovative Systems Design and Engineering, Vol.6, No.4, 2015.

[11] Escobar G., Stankovic A.M., and Mattavelli P., "An adaptive controller in stationary reference frame for D-STATCOM in unbalanced operation," IEEE Trans. Ind. Electron., vol. 51, no. 2, pp. 401–409, Apr. 2004.

[12] Kumkratug P. STATCOM control strategy based on lyapunov energy function and fuzzy logic control for improving transient stability of multimachine power system. WSEAS Trans Circuits Syst 2012;11(5):159–68.

[13] Liu C.-H. and Hsu Y.-Y., "Design of a self-tuning PI controller for a STATCOM using particle swarm optimization," IEEE Trans. Ind. Electron., vol. 57, no. 2, pp. 702–715, Feb. 2010.

[14] Ray Daniel Zimmerman," Comprehensive Distribution Power Flow:Modeling, Formulation, Solution Algorithms and Analysis" Cornell University 1995.

[15] Sumathi S, Bansilal S. Artificial Neural Network for coordinated control of STATCOM, generator excitation and tap changing transformer. Electr Power Energy Syst 2015;64:536–41.

[16] Venugopal D., Jayalaxmi A., Optimal Location of Thyristor Controlled Series Capacitor Using Bat Algorithm. International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-4 Issue-4, April 2015.

[17] Ahmed, E. R., Islam, M. A., Alabdullah, T. T. Y & bin Amran, A. (2018). Proposed the pricing model as an alternative Islamic benchmark. Benchmarking: An International Journal, Vol. 25, no. 8, pp. 2892-2912.

[18] Alabdullah, T. T. Y., Ahmed, E. R., &Thottoli, M. M. (2019). Effect of Board Size and Duality on Corporate Social Responsibility: What has Improved in Corporate Governance in Asia?. Journal of Accounting Science, Vol. 3, no.2, pp. 121–135.

[19] Desfiandi, A., Suman Rajest, S., S. Venkateswaran, P., Palani Kumar, M., & Singh, S. (2019). Company Credibility: A Tool To Trigger Positive Csr Image In The Cause-Brand Alliance Context In Indonesia. Humanities & Social Sciences Reviews, 7(6), 320-331. https://doi.org/10.18510/hssr.2019.7657

[20] Dwiputra, I. M. A., & Astika, I. B. P. (2019). Ability of organizational commitment and emotional intelligence moderating effect of role stress on turnover intention. International Research Journal of Management, IT and Social Sciences, 6(4), 44-53. https://doi.org/10.21744/irjmis.v6n4.641

[21] Gawale, K., Chaudhari, H., Kandesar, V. and Sakharwade, S. (2016). Digital Audio Watermarking using EMD for Voice Message Encryption with Added Security. International Journal of Advanced Engineering, Management and Science, 2(4), pp.218-222.

[22] H. Anandakumar and K. Umamaheswari, "A bio-inspired swarm intelligence technique for social aware cognitive radio handovers," Computers & Electrical Engineering, vol. 71, pp. 925–937, Oct. 2018. doi:10.1016/j.compeleceng.2017.09.016

[23] Haldorai and A. Ramu, "An Intelligent-Based Wavelet Classifier for Accurate Prediction of Breast Cancer," Intelligent Multidimensional Data and Image Processing, pp. 306–319.

[24] Haldorai, A. Ramu, and S. Murugan, "Social Aware Cognitive Radio Networks," Social Network Analytics for Contemporary Business Organizations, pp. 188–202. doi:10.4018/978-1-5225-5097-6.ch010

[25] Jain, R., Chaudhary, S., & Kumar, R. (2017). Green Approach for Next Generation Computing: A Survey. International Journal Of Advanced Engineering Research And Science, 4(1), 078-082.

[26] K. Prechanon, K. (2016). Application of STATCOM for Enhancing Steady and Dynamic Performance of Distribution System with DFIG Wind Power Generation. International Journal of Advanced Engineering, Management and Science, 2(4), pp.215-217.

[27] K.B. Adanov, S. Suman Rajest, Mustagaliyeva Gulnara, Khairzhanova Akhmaral (2019), "A Short View on the Backdrop of American's Literature". Journal of Advanced Research in Dynamical and Control Systems, Vol. 11, No. 12, pp. 182-192.

[28] Kasiselvanathan, M., Sangeetha, V., & Kalaiselvi, A. (2020). Palm pattern recognition using scale invariant feature transform. International Journal of Intelligence and Sustainable Computing, 1(1), 44. doi:10.1504/ijisc.2020.104826

[29] M. Suganya and H. Anandakumar, "Handover based spectrum allocation in cognitive radio networks," 2013 International Conference on Green Computing, Communication and Conservation of Energy (ICGCE), Dec. 2013.doi:10.1109/icgce.2013.6823431. doi:10.4018/978-1-5225-5246-8.ch012

[30] Malar, E., & Gauthaam, M. (2020). Wavelet analysis of EEG for the identification of alcoholics using probabilistic classifiers and neural networks. International Journal of Intelligence and Sustainable Computing, 1(1), 3. doi:10.1504/ijisc.2020.104822

[31] Mandala, I. G. N. A. K., & Astika, I. B. P. (2019). Effect of work environment, quality of system and work culture on satisfaction of accounting information system user. International Research Journal of Management, IT and Social Sciences, 6(4), 37-43. https://doi.org/10.21744/irjmis.v6n4.633

[32] Md. Salamun Rashidin, Sara Javed, Bin Liu, Wang Jian, Suman Rajest S (2019), "Insights: Rivals Collaboration on Belt and Road Initiatives and Indian Recourses" in Journal of Advanced Research in Dynamical and Control Systems, Vol. 11, SI. 04, Page No.: 1509-1522.

[33] Mohamed, S. R., & Raviraj, P. (2020). Optimisation of multi-body fishbot undulatory swimming speed based on SOLEIL and BhT simulators. International Journal of Intelligence and Sustainable Computing, 1(1), 19. doi:10.1504/ijisc.2020.104825

[34] Mukherjee, D., & Reddy, B. V. R. (2020). Design and development of a novel MOSFET structure for reduction of reverse bias pn junction leakage current. International Journal of Intelligence and Sustainable Computing, 1(1), 32. doi:10.1504/ijisc.2020.104824

[35] N. Uwaezuoke, N., K.C. Igwilo, K., S.I. Onwukwe, S., & B. Obah, B. (2017). Effects of Temperature on Mucuna solannie Water-Based Mud Properties. International Journal Of Advanced Engineering Research And Science, 4(1), 083-092.

[36] R. Arulmurugan and H. Anandakumar, "Early Detection of Lung Cancer Using Wavelet Feature Descriptor and Feed Forward Back Propagation Neural Networks Classifier," Lecture Notes in Computational Vision and Biomechanics, pp. 103–110, 2018. doi:10.1007/978-3-319-71767-8_9

[37] R. Arulmurugan and H. Anandakumar, "Region-based seed point cell segmentation and detection for biomedical image analysis," International Journal of Biomedical Engineering and Technology, vol. 27, no. 4, p. 273, 2018.

[38] Rajest, S. S., Suresh, D. (2018). The Deducible Teachings of Historiographic Metafiction of Modern Theories of Both Fiction and History. Eurasian Journal of Analytical Chemistry, 13(4), emEJAC191005.

[39] Rao, A. N., Vijayapriya, P., Kowsalya, M., & Rajest, S. S. (2020). Computer Tools for Energy Systems. In International Conference on Communication, Computing and Electronics Systems (pp. 475-484). Springer, Singapore.

[40] S, D., & H, A. (2019). AODV Route Discovery and Route Maintenance in MANETs. 2019 5th International Conference on Advanced Computing & Communication Systems (ICACCS). doi:10.1109/icaccs.2019.8728456

[41] S. Karpe, V., E. Patekar, J., D. Bagul, M., Khole, O., & K. Mali, P. (2017). Design and Development of Garlic Peeling Machine by Human Powered Flywheel Motor Concept for Rural Dwellers Development. International Journal Of Advanced Engineering Research And Science, 4(1), 075-077.

[42] Selvaraj, J., & Mohammed, A. S. (2020). Mutation-based PSO techniques for optimal location and parameter settings of STATCOM under generator contingency. International Journal of Intelligence and Sustainable Computing, 1(1), 53. doi:10.1504/ijisc.2020.104827

[43] Suartawan, I. G. N. P. A., & Artini, L. G. S. (2019). A comparative study on domestic and foreign equity funds in Indonesia. International Research Journal of Management, IT and Social Sciences, 6(4), 54-61.

[44] Tewari, D. (2016). Rural Development through Women's Health. International Journal of Advanced Engineering, Management and Science, 2(4), pp.223-227.

[45] Wijaya, I. K. A. D., & Suprapti, N. W. S. (2019). Building customer loyalty for light steel products "Kencana Truss" in Bali. International Research Journal of Management, IT and Social Sciences, 6(4), 156-168.