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Analysis and Mitigation of PQ Disturbances in Grid Connected System using Grey Wolf Optimization Technique

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***Abstract*—Significant simulation work was done in this paper to investigate the efficient operation of Distribution Static Synchronous Compensator (D-STATCOM) and Grey Wolf Optimization (GWO). D-STATCOM and GWO simulation models are displayed using MATLAB SIMULINK. The simulation findings for (a) three phase issue (b L-L-G issue (c) L-G issue for voltage dip and fair L-L-L fault for current swell were discovered. Using D-STATCOM and GWO, the aforementioned three types of faults for voltage sag and current swell were discovered, compared, and removed. The new optimization technique GWO was applied to D-STATCOM, yielding new and improved results. A novel optimization technique known as GWO has been adopted to get better the working effectiveness of the Distribution System. The results of employing GWO have been quite positive, with further reductions in voltage dip and current rises in the load system.**

***Keywords*— GWO, MATLAB SIMULINK, D-STATCOM, optimization technique.**

I. INTRODUCTION

Economic Load Dispatch (ELD), technique is dependent on grey wolf behavior. Furthermore, while searching for an optimal solution, The GWO approach requires no knowledge about the gradient of the goal function. Because the GWO technique is used to solve nonlinear ELD problems, it is regard as a dependable and robust optimization approach. The result is highly positive and proves that the GWO proven to be an efficient optimization tool for solving several ELD difficulties. In this case, an efficient and relatively new method, GWO, is used to solve the problems while taking into account slope time constraints, disqualified in use zones, several fuels, and regulator point load effects. The suggested GWO has the advantage of imposing no convexity constraints on unit attributes while they are being created. Numerical results reveal that, when compared to other algorithms, the GWO technique has more advantages, such as a stable convergence characteristic, ease of application, avoidance of early convergence, less computational exertion, and toughness.

A. Grey Wolf Optimization Technique

This paper relates to system modelling and simulation, an attempt has been made to decrease the difficulty of dip of the voltage in designed power system with D-STATCOM. This device is to upgrade the voltage dip in the power grid. The D-STATCOM has been further used with advanced GWO technique to get more efficient outcome. The strength, model and imitation of the power system are evaluated by MATLAB.

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The outcomes are more efficient and prove that GWO technique is an more powerful optimization technique in power system. The problem of voltage sag has been discussed for L-L-G fault and L-G fault. The current swell problem has been discussed for three phase fault only.Total Harmonic Distortion results are obtained for L-L-G fault, three phase fault and L-G fault for voltage dip and for L-L-L fault for current rise. The comparison of outcomes for above faults for voltage dip and current rise is carried out with and without D-STATCOM and GWO. The results related to THD have also been discussed with and without D-STATCOM and GWO. Comparison of other optimization techniques is carried out with GWO to establish the effectiveness of GWO in mitigating the power significance issues of voltage dip.This approach is used to improve the ELD operating scheme based on the behavior of grey wolves. Furthermore, while searching for an optimum solution, the GWO approach requires no knowledge about the gradient of the objective function. The GWO technique is designed to solve nonlinear ELD problems, making it a dependable and resilient optimization approach. The results are highly positive, and they demonstrate that the GWO is an effective optimization strategy
for tackling a variety of ELD issues. Here, an effective and relatively innovative method, GWO is utilized to resolve challenges while accounting for ramp rate limits, banned operating zones, various fuels, and valve point loading effects. The suggested GWO has the benefit of imposing no bulginess limits on unit attributes as they are formed. Numerical findings reveal that, when compared to other algorithms, the GWO approach has more advantages, such as steady combining, simplicity of application, avoidance of premature convergence, reduced computing attempt and resilience.

B. Research Work Carried Out

In this work, research is carried out to decrease the problem of dip of the voltage by using D-STATCOM. It is used with newly discovered GWO technique. The strength, model and imitation of the power system are evaluated by MATLAB. The solution thus get have shown similarity with the show of DSTATCOM in decreasing the dip of voltage. The solution is encourag that GWO technique is a helpful for finding power quality issues effectively.

II. WHY GWO TECHNIQUE IS USED

This approach in complicated multimodal optimization issues does not attach to a local optimum point, and it enables a more diverse exploration of the solution space for addressing difficult ELD problems. Fig.1 represent the flow chart for GWO.

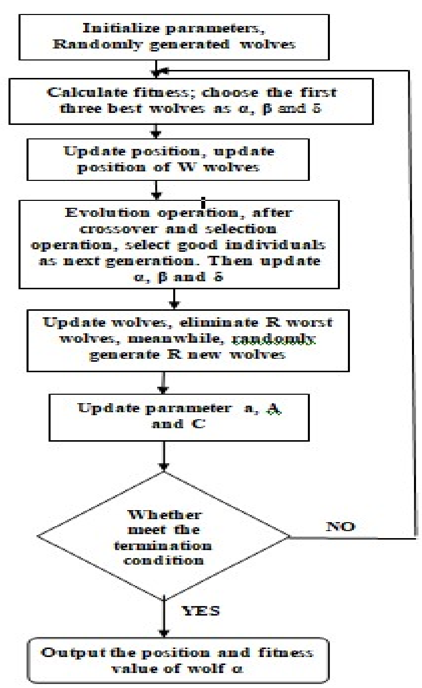

Figure 1 Flow Chart of GWO [5]

III. GREY WOLF OPTIMIZATION ALGORITHM

Mirjalili et al. (2014) presented GWO a novel population-dependent meta-heuristic algorithm. This model fig.3 depicts the grey wolf's social order and hunting activities. The GWO technique identifies the leadership hierarchy as alpha, beta, delta, and omega.

The difficult element is determining the most cost-effective amount of habitat preservation for a fragile animal population while remaining within a viability restriction.

A greater likelihood of reaching a population size objective is a prerequisite for a viability restriction. Additionally, the alpha, beta, and delta estimate the victim's position before updating their position at random in the victim's vicinity. Lastly, the final position characterized by the search space positions of alpha, beta, and delta is shown as a circle. The utilization of GWO is dependent on the behavior of grey wolves, with each pack member traveling in a multidimensional search space in search of prey.

A variety of position variables are used to represent the gray wolves' positions, and the distances between the prey and the grey wolves show the fitness value of the objective function. Furthermore, every grey wolf can adjust their position as well as better position is acquired by them. Moreover, best solutions are saved by GWO that were acquired through iterations' course.

The goal of this algorithm is to take the quickest path to the prey. The four mechanisms that affect each person's mobility are as follows:

Hunting down and investigating prey

Prey wrapping itself

Pursing

Attacking the prey (exploitation)

The brief explanation of GWO algorithm is shown in figure 2

Step 1: Population size is represented by number of search agents or grey wolves.

Step 2: Initializing the search agents' position vectors for prey search as well as encircle in grey wolves' lower and upper boundary area. Also, initialization of iterations' maximum number is also done.

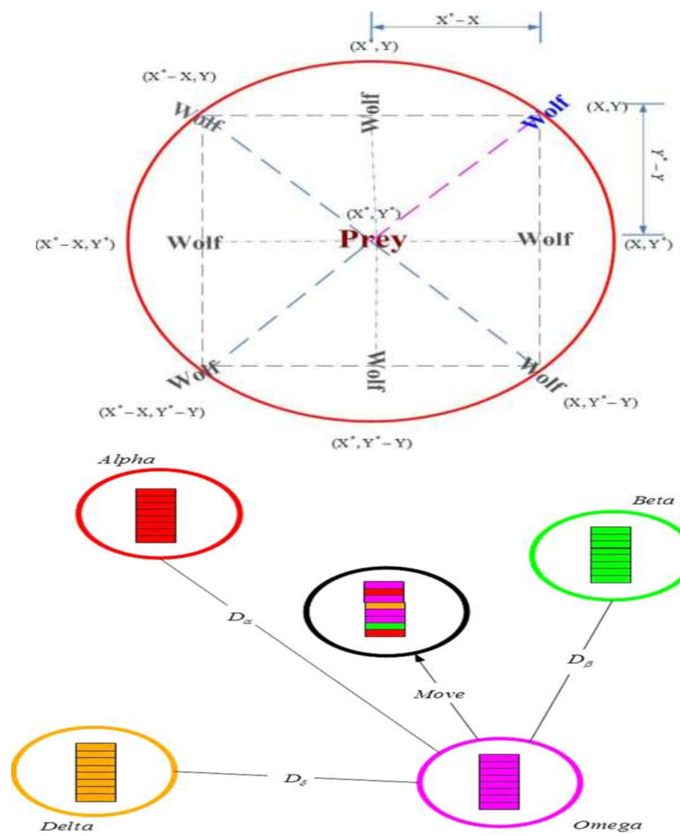

Figure 2 The GWO algorithm [11]

Step 3: Evaluating the individual solution's fitness values. Every fitness value presents prey distance from the individual wolf. 3 best wolves are recognized as a, b and d wolves, depending on fitness value. For achieving prey, grey wolf's several categories' hunting behavior is modified.
Step 4: Updating the search agents' position.
Step 5: Repeating step 3–4 till prey is reached.
Step 6: After specific iterations, it is terminated.

IV. MODEL OF GWO

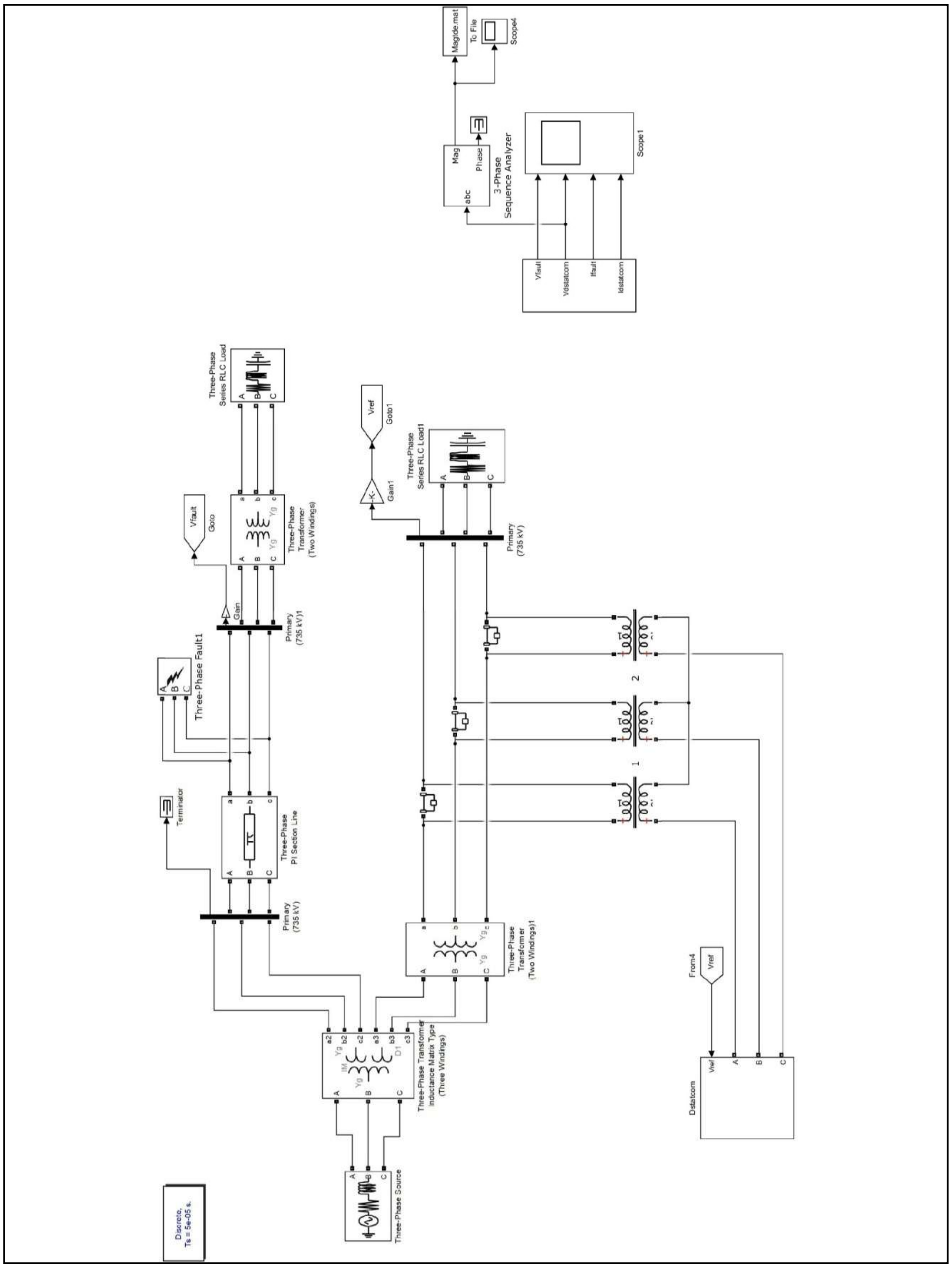

Fig.3 Model for GWO [2]

V. VOLTAGE DIP RESULTS FOR L-L-L FAULT USING GWO

The results demonstrate that when a L-L-L fault occurs using In D-STATCOM, the voltage drops from 1 p.u. to 0.8 p.u fig 4.

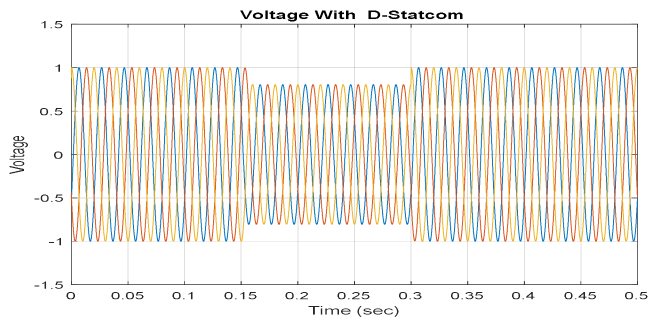

Fig.4 D-STATCOM result for voltage dip with L-L-L fault [1]

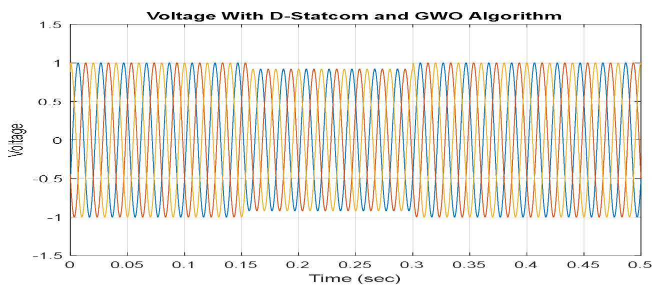

Fig.5 GWO result for voltage dip with L-L-L fault [1]

When the GWO approach is apply, the Voltage Dip is reduced to 0.92 p.u in the similar frame fig 5.

VI. R.M.S. VOLTAGE DIP USING GWO FOR L-L-L FAULT

The findings show that 0.8 p.u. is the rms voltage dip for an L-L-L fault using D-STATCOM fig 6.

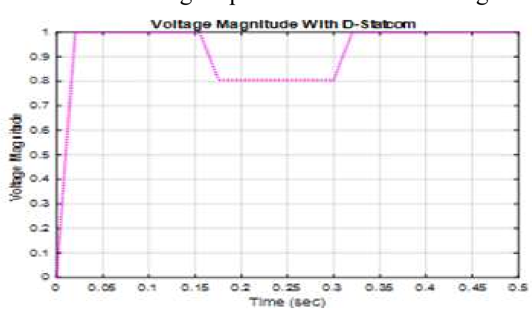

Fig.6 R.M.S voltage dip result for L-L-L fault using D-STATCOM [1]

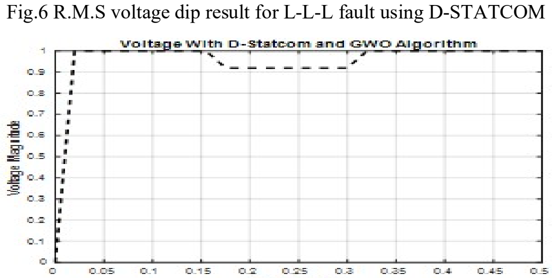

Fig. 7 GWO result for R.M.S voltage drop for L-L-L fault [2]

Using the GWO approach reduces the rms voltage drop from 0.8 to 0.92 p.u fig 7.

VII. VOLTAGE DIP RESULTS FOR L-L-G FAULT USING GWO

When a L-L-G fault occurs with D-STATCOM, the results show a voltage dip to 0.8 p.u. from 1 p.u.fig 9.

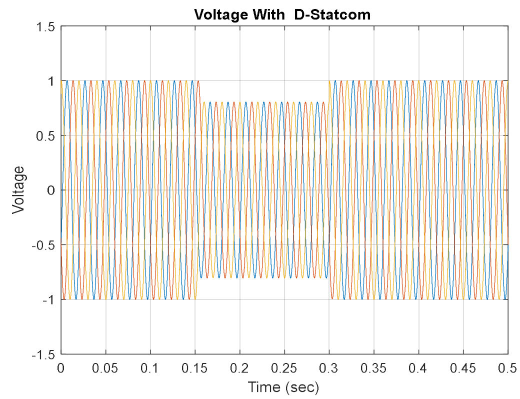

Fig. 9 Voltage dip result for a L-L-G fault using D-STATCOM [3]

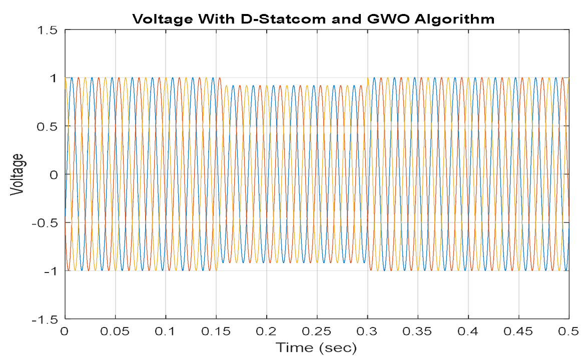

Fig. 10 GWO simulation of voltage dip for a L-L-G fault [3]

In relation to the GWO technique, the voltage drop is minimized to 0.95 p.u.fig 10.

VIII. R.M.S VOLTAGE DIP RESULT FOR L-L-G FAULT USING GWO

When a D-STATCOM L-L-G fault occurs, the findings reveal an rms voltage decrease to 0.8 p.u. from 1 p.u. for durations ranging from 0.15 to 0.34 seconds. fig 11.

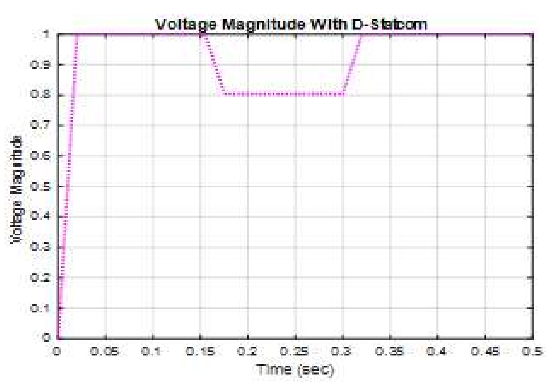

Fig.11 R.M.S voltage result for a L-L-G fault with D-STATCOM [2]

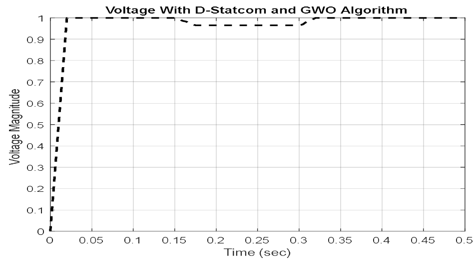

Fig.12 R.M.S voltage result for a L-L-LG fault with GWO [2]

When the GWO approach is applied, the voltage dip is reduced to 0.95 p.u fig 12.

IX. VOLTAGE DIP RESULT FOR L-G FAULT USING GWO

The results reveal that the voltage dips to 0.85 p.u. from 1 p.u. when an L-G fault replaces a voltage dip using D-STATCOM fig 14.

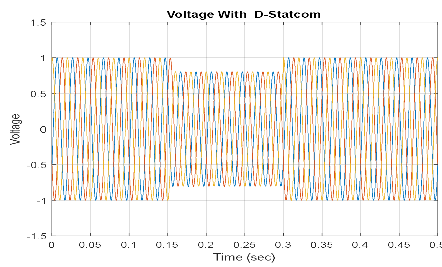

Fig.14 Voltage dip result for a L-G fault] using D-STATCOM [2]

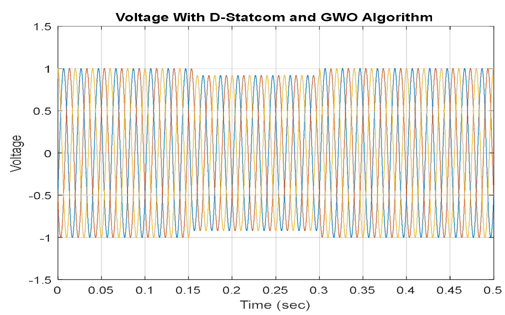

Fig.15 Voltage dip result for a L-G fault using GWO [2]

Utilizing the GWO method lowers the voltage dip to 0.97 p.u fig 15.

X. R.M.S VOLTAGE DIP RESULTS FOR L-G FAULT USING GWO

The results show that when an L-G fault is detected using D-STATCOM, the rms voltage reduces from 1 p.u. to 0.85 p.u fig 16.

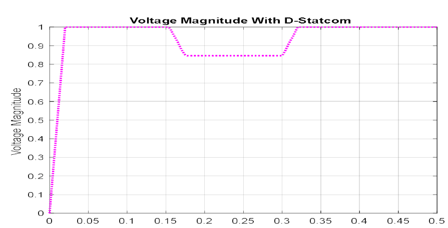

Fig.16 R.M.S voltage result for a L-G fault D-STATCOM

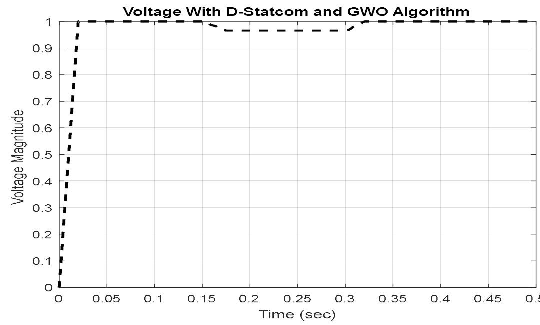

Fig.17 GWO result for R.M.S voltage for L-G faultwith

Applying the GWO approach reduces the voltage dip to 0.97 p.u.fig 17.

XI. CONCLUSION

It is observed from the results obtained with simulation that the voltage sag, current swell, total harmonic distortions have been considerably reduced with UPQC when compared with the results obtained with the use of D-STATCOM and application of GWO on D-STATCOM. The L-L-L fault, L-L-G fault, L-G fault for voltage sag and balanced L-L-L fault for current swell have also been removed with UPQC more efficiently when compared with D-STATCOM and GWO. The results obtained have been shown in comparison tables with fault under normal condition, with D-STATCOM, with GWO and with UPQC. The results obtained with UPQC are close to the reference value and it has been proved that UPQC is one of the most efficient FACTS controllers for enhancement of power quality.

The findings obtained using MATLAB SIMULATION demonstrated how the usage of D-STATCOM on L-L-L fault, L-L-G, and L-G fault resulted in voltage dip mitigation. On a balanced L-L-L fault, the application of D-STATCOM has decreased distribution side current swell. When applied to D-STATCOM, Grey Wolf, a unique optimization technique, achieves much improved results for voltage dip and current swell issues.

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