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Improvement In Quality Of Power By PI Controller Hybrid PSO Using STATCOM

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ABSTRACT: *This paper presents an overview of one of the FACT device D-STATCOM, in mitigating power quality problem for an instance say voltage sag and to reach a more optimal solution within set parameters by using hybrid PSO technique to maximize the chances of having best power quality which lead to reduction in cost.*

The above device is studied and analyzed. And also the control strategy to control the device is presented in this project to obtain a best optimal solution. The proposed control strategy is simulated in MATLAB SIMULINK environment and the results are presented. An improved result based on the performance of device in obtaining a better optimal solution is presented.

Key Words: **Power quality, Power quality issues, PI controller D-STATCOM ,PSO ,Optimized PSO**

1. INTRODUCTION

Among different forms of energy available to human kind .As in present time the electrical power is most popular and efficient form of energy and the development of industries as well as of civilization is largely dependent on it, so the smooth supply of electric power which would be free from all sorts of power quality issues is must for better growth of an economy. Also the life and performance of the utility equipment also depend upon the quality of supply it would get and the quality of power is of utmost importance for the proper functioning of the utility equipment. Many of the loads which are employed for commercial as well as for industrial purpose require continuous supply of power which is free from all sorts of disturbances and power quality issues..so requirement of both quality and continuity of electric power is of importance for us.

.Now the power supply continuity is affected mainly due to the faults which occur at different locations in the system thus to make possible the regularity in delivering best quality of power it is required to clear the fault as early as possible and for this the protection and switchgear circuit should be designed as such to operate without any time lag or almost with zero time lag.

The quality of power is affected due to many problems which encountered in transmission system and distribution system. Some of the power quality issues which led to the change in quality of power from a good one to a bad one are like- voltage sag, swell ,harmonics ,transients etc. These problems led to the improper functioning of power utility equipment.. In order to enhance the behavior of the power system, these all problems should be eliminated.

With the developments that took place in nowadays in electronic devices which are primarily used in power systems recent, now it is possible to achieve the smooth operation in power systems and thus we can reduce many of the problems related to the efficient operation of power systems. One of the method is to employ the custom power devices and Flexible AC Transmission System (FACTS) devices. The implementation of these devices in the power system helps in improving the efficiency and reliability of the whole power system. In this project the mitigation of power quality problems like voltage sag using one of the FACT devices - D STATCOM is studied and analyzed using a hybrid concept iterative method of PSO to reach at a more acceptable optimal solution within a given set parameters of available power quality to reduce its cost and improve its efficiency and performance thus reducing the overall cost.

1.1 ABOUT PSO

Particle Swarm Optimization (PSO) is an optimization method based on the principles of natural selection and genetics. This method can look for more solutions simultaneously. PSO generates random initial particles in the first step and then it applies velocity vectors to update the particles until a process stop condition is satisfied.

The particle swarm concept originated as a simulation of simplified social system. The original intent was to graphically simulate the choreography of bird of a bird block or fish school. However, it was found that particle swarm model can be used as an optimizer.

The velocity on that dimension is limited to Vmax. Each particle moves according to its velocity. At each iteration, the particle movement is computed as follows:

$$xi(t + 1) = xi(t) + vi(t); \quad (1)$$

$$vi(t + 1) = wvi(t) + c1r1(pbesti(t) - xi(t)) + c2r2(gbest(t) - xi(t))$$

…… (2)

Equations (1) and (2), xi(t) is the position of particle i at time t, vi(t) is the velocity of particle i at time t, pbesti(t) is the best position found by particle itself so far, gbest(t) is the best position found by the whole swarm so far, ! is an inertia weight scaling the previous time step velocity, c1 and c2 are two acceleration coefficients that scale the influence of the best personal position of the particle (pbesti(t)) and the best global position (gbest(t)), and r1 and r2 are random variables within the range of 0 and 1.

Equations (3) and (4) denotes how the personal and global best values are updated at time t, respectively. It is assumed below that the swarm consists of s particles and the objective function f is used to calculate the fitness of the particles with a minimization task.

pbesti(t + 1) = { pbesti(t) if f(pbesti(t)) ≤ f(xi(t + 1)) (3)

xi(t + 1) if f(pbesti(t)) > f(xi(t + 1)) (4)

gbest(t + 1) = min f(y); f(gbest(t))

where; y € fpbest0(t); pbest1(t); : : : pbests(t)g

The pso algorithm:

Initialize a population of particles with random positions and velocities in the search space.

While(termination of particles with random positions and velocities in the search space.

While (termination conditions are not met)

{ for each particle i do {

Update the position of particle I according to equation(1)

Update the position of particle I according to equation(2)

Map the position of particle I in the solution space and evaluate its fitness value according to the fitness function

Update pbest(t) and gbest(t) if necessary according to equations(3) and (4)

1.2HYBRID PSO

In this scheme, a new hybrid particle swarm optimization along with the genetic algorithm is proposed to minimize a simplified model of the voltage function variation of the model. The proposed algorithm is called Hybrid Particle Swarm Optimization an (HPSO) along with genetic algorithm characters or simply hybrid particle swarm optimization. The HPSOGA is based on three different mechanisms.

The initial or first mechanism is applying the particle swarm optimization to balance between the exploration and the exploitation process in the proposed algorithm.

PSO with Gaussian mutation (GPSO) whose global searching ability is more efficient than the standard PSO, is proposed by Natsuki and Hitoshi. Ling proposed a hybrid PSO with wavelet mutation named HWPSO, in which a tuning mutating method is used.

In HWPSO, by performing mutation operation on the selected particle, the solution space should be explored more efficiently ,and premature convergence is more likely to be avoided. Although different mutation operators have been applied to enhance the achievements of PSO, the new mutation process needs to be further investigated so as to achieve better balance between global and local searching abilities and preserving the most important advantages of PSO when compared with GA, which is easy to implement, and there are few parameters to adjust.
The pseudo code for HPSOM algorithm/COPSO

Begin

Create and initialize

While(stop condition is false)

Begin

Evaluation

Update velocity and position

Mutation

End

2. VOLTAGE SAG

Definition:It can be defined as per IEEE standards 1346-1998 as the decrease in voltage value or current in rms at the power frequency for durations of 0.5 cycle to 1 min.The voltage sag is characterized by its magnitude, duration and phase angle jump

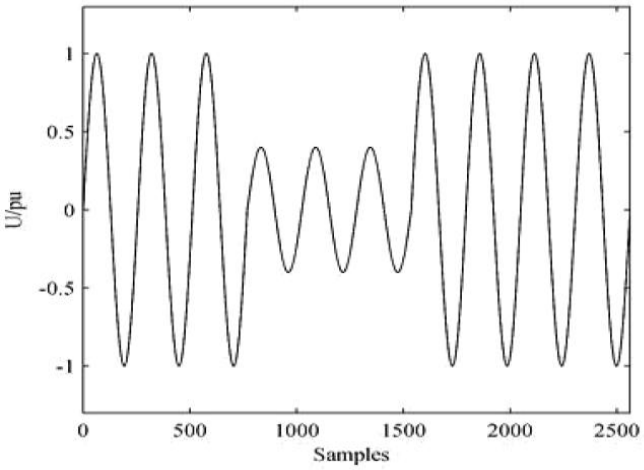

Fig. Voltage sag

2.1 DURATION OF SAG

Table-I Classification of Sag

Type of Sag	Duration	Magnitude
Instantaneous	0.5 - 30 cycles	0.1 - 0.9 pu
Momentary	30 cycles - 3 s	0.1 - 0.9 pu
Temporary	3 s - 1 min	0.1 - 0.9 pu

2.2 **SYSTEM DESIGN EXPLANATION:** The system which we have designed in simulink has been examined on unlike or dissimilar abnormal conditions with different types of load. The system has a supply source which is of three phase in nature The system design of the whole system includes various subsystems which includes the PI controller , STATCOM different transformer and other connecting circuitry in simulink then we minimize the cost problem to show the improvement in power quality .

The PI controller used in the design have some parameter which can be tabulated as follows:

System parameters used for PI controller are tabulated as follows:

Table-II (System parameters used for PI controller)

Proportional gain (k_p)	0.5
Integral gain (k_i)	500
Output links upper	$1e^6$
Output links lower	$-1e^6$
Output initial value	0
Sample time	$50e^{-6}$

The different parameter used in PI controller are based on hoit and trial method which is the best method for proper tuning.

3. RESULTS AND DISCUSSION

CASE I: At start when particles try to overlap and in search for best possible result

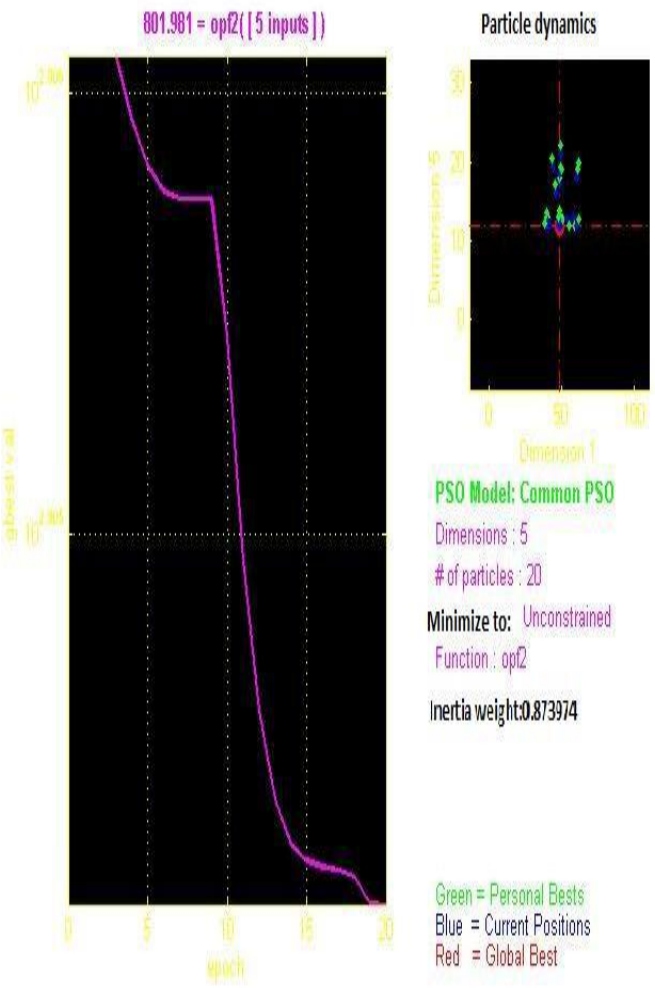

Fig. 1 **At start when particles try to overlap and in search for best possible result**

In the fig 1, Out of different possible cases we observed the case when we have the present best position values of particle start to obtain the global optimum values i.e. the values are start to overlap with global best.

CASE II: Simulation Results Using STATCOM With PSO (**gbest value with best fitness in voltage regulation and improving weight inertia).** The result in this case shows the improvement in inertia weight from about 0.87 to 0.85 approximately which is of almost an improvement of about 0.02 in inertia weight which leads us to the conclusion that we have an improved result with the technique which we have used here. Also from this we concluded that we have the improved gbest fitness in voltage regulation with improved weight inertia.

CASE III: Simulation Results Using STATCOM With COPSO/Hybrid PSO (**Final Improved weight with maximum coverage of voltage with copso).** Now we utilized the concept of COPSO which gives us the further improved results. In the below fig.3 now again we have obtain the dimensional plot of the system which we have design to obtain the particle dynamics with COPSO which we have with 5 dimensions and now as we have the inertia weight in the above result as close to 0.83 which is an improved version from the previous case which is more than the result of inertia weight obtained in this so in this case we obtained the gbest fitness in voltage regulation with improved weight inertia.

Table III Comparative Study

Optimization technique	Inertia wt. values
At start of overlapping with PSO	0.873974
At end of overlapping with PSO	0.85396
At end of overlapping with COPSO	Close to 0.83396

3. CONCLUSION

Thus in this paper we present the MATLAB SIMULINK simulation results of Hybrid PSO using D-STATCOM. The device performance in mitigating voltage sag and other power quality problems is studied and analyzed. A comparative study is also made based on the THD and other parameters as needed of the load voltage after compensation. From the comparative study it can inferred that the hybrid particle swamp optimization is efficient in mitigating the voltage sag and other power quality problems and allow us to arrive us a more suitable acceptable solution close to global best.

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