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# Power Quality Enhancement by PI Controller through Distributed Particle Swarm Optimization using STATCOM

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**Abstract-**The power quality resources have continuously played an important role in the growth of human livings. PSO tuned PI controller are compared and a mark reduction in total harmonic reduction is with number of generations. PI Controller distributed Generation units that encompass a portion of an electric power distribution system and may rely on different energy sources. Functionally, the PI controller is required to provide adequate levels and quality of power to meet load demands. The issue of power quality is significant as it directly affects the characteristics of the PI controller operation. This problem can be defined as an occurrence of short to long periods of inadequate or unstable power outputs by the PI controller. In a stand-alone operation mode, the system voltage and frequency must be established by the PI controller; otherwise the system will collapse due to the variety in the PI controller component characteristics. In our proposed scheme is to define the global and local best fitness for the STATCOM in order to improve power quality and minimize power losses in the grid with PI controller and RLC branch, using Particle Swarm Optimization algorithm and we also comparing with base Genetic algorithm which implement programming and Simulinkdesign in MATLAB tool.

Keywords-Distribution Static Synchronous Compensator,Instantaneous Reactive Power Theory, Total Harmonic Distortion, Particle Swarm Optimization, Proportional Integral

## Introduction

Theparticle swarm optimization (PSO) is a computational method that optimizes a problem by iteratively trying to improve a candidate solution with regard to a given measure of quality. It solves a problem by having a population of candidate solutions, here dubbed particles, and moving these particles around in the search-space according tosimple mathematical formulae over the particle's position and velocity. The algorithm was simplified and it was observed to be performing optimization. The book by Kennedy and Eberhart describes many philosophical aspects of PSO and swarm intelligence.

Let *S* be the number of particles in the swarm, each having a position $x_i \in \mathbb{R}^n$ in the search-space and a velocity $v_i \in \mathbb{R}^n$. Let $p_i$ be the best known position of particle *i* and let g be the best known position of the entire swarm. A basic PSO algorithm is then:

for each particle *i* = 1, ..., *S*do
Initialize the particle's position with a uniformly distributed random vector: $x_i \sim U(b_{lo}, b_{up})$
Initialize the particle's best known position to its initial position: $p_i \leftarrow x_i$
if$f(p_i) < f(g)$ then
updatethe swarm's best known position: $g \leftarrow p_i$
Initialize the particle's velocity: $v_i \sim U(-|b_{up}-b_{lo}|, |b_{up}-b_{lo}|)$

While a termination criterion is not met do:
Foreach particle $i$ = 1, ..., $S$do
foreach dimension $d$ = 1, ..., $n$do
Pick random numbers: $r_p$, $r_g$ ~ $U$(0,1)
Update the particle's velocity: $v_{i,d} \leftarrow \omega\, v_{i,d} + \phi_p r_p (p_{i,d}-x_{i,d}) + \phi_g r_g (g_d-x_{i,d})$
Update the particle's position: $x_i \leftarrow x_i + v_i$
if$f(x_i) < f(p_i)$ then
Update the particle's best known position: $p_i \leftarrow x_i$
if$f(p_i) < f(g)$ then
Update the swarm's best known position: $g \leftarrow p_i$

The values $b_{lo}$ and $b_{up}$ are respectively the lower and upper boundaries of the search-space. The termination criterion can be number of iterations performed, or a solution with adequate objective function value is found.
In this Thesis Power quality enhancement by pi controller distributed particle swarm optimization (D-PSO) using statcom is analyzed. The pi controller will suffer from power quality issues. The proposed system will give better solution to the power quality issues. The D-pso is used to control scheme for to produce switching signal of STATCOM. In the proposed system the STATCOM is connected to point of common coupling with energy storage system. The control scheme of STATCOM connected to grid with energy generation system is simulated using MATLAB/SIMULINK

The main aim of this thesis is to improve the quality of the power supply in a PI controller scenario through new power control strategy based on the distributed Particle Swarm Optimization technique. In both PI controller operation modes: islanding and grid-connected, there are many types of disturbances that impact power quality. Therefore, pursuing following specific objectives should help achieve the main aim of this thesis.
1. Implementing an optimization technique for a real-time self-tuning method for the proposed power controller.
2. Controlling the PI controller voltage and frequency in the islanding operation mode.
3. Regulating the active and reactive power flows in the grid-connected operation mode, in order to halve the load between the PI controller and utility.
4. Achieving an appropriate power sharing among the (Distributed Generation) DG units in the islanding operation mode, in addition to ensuring appropriate voltage and frequency regulation.
5. Investigating the system's stability under the proposed power controller, and also examining sensitivity to the control parameters, in order to validate the proposed power controller.

## RESULTS AND DISCUSSION

In this thesis work, Simulink model test system is analyzed. In this test model two similar loads with different feeders are considered. One of the feede is connected to DSTATCOM and the other is kept as it is. This test system is analyzed under different fault conditions. System is also analyzed with non linear load under same fault conditions. The control technique implements a PI controller which starts from the difference between the injected current (DSTATCOM current) and reference current (identified current) that determines the reference voltage of the inverter (modulating reference signal).
In parameters of the system themodeled system has been tested on different fault conditions with linear as well as non linear load. The system is employed with three phase generation source with configuration of 25KV, 50 Hz. The source is feeding two transmission lines through a three phase, three windings transformer with power rating 250MVA, 50 Hz.

Winding 1: V1rms (ph-ph) = 25 KV, R1 = .002 (pu), L1 = .08002 (pu).

Winding 2: V2rms (ph-ph) = 11 KV, R2 = .002 (pu), L2 = .08002 (pu).

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Winding 3: V3rms (ph-ph) = 11 KV, R3 = .002 (pu), L3 = .08002 (pu).

The basic OPF problem can described mathematically as a minimization of problem of minimizingthe total fuel cost of all committed plants subject to the constraints.

$$Minimize \sum_{i=1}^{n} F_i(P_i)$$

$F(P_i)$ is the fuel cost equation of the 'i'th plant. It is the variation of fuel cost ($ or Rs) with generated power (MW).Normally it is expressed as continuous quadratic equation.

$$F_i(P_i) = a_i P_i^2 + b_i P_i + c_i, \quad P_i^{\min} \leq$$

The total generation should meet the total demand and transmission loss. The transmission loss can be determined from power flow.

$$\sum_{i=1}^{n} P_i = D + P_l$$

$$P_l = real(\sum_{j}^{n} V_i Y_{ij}^{*} V_j), i = 1,2,..n$$

$$Q_l = imag(\sum_{j}^{n} V_i Y_{ij}^{*} V_j), i = 1,2,..n$$

$V_i^{min} \leq Vi \leq V_i^{max}$

(A6)

$LF_{ij} \leq$ Line flow limits

(A7)2.

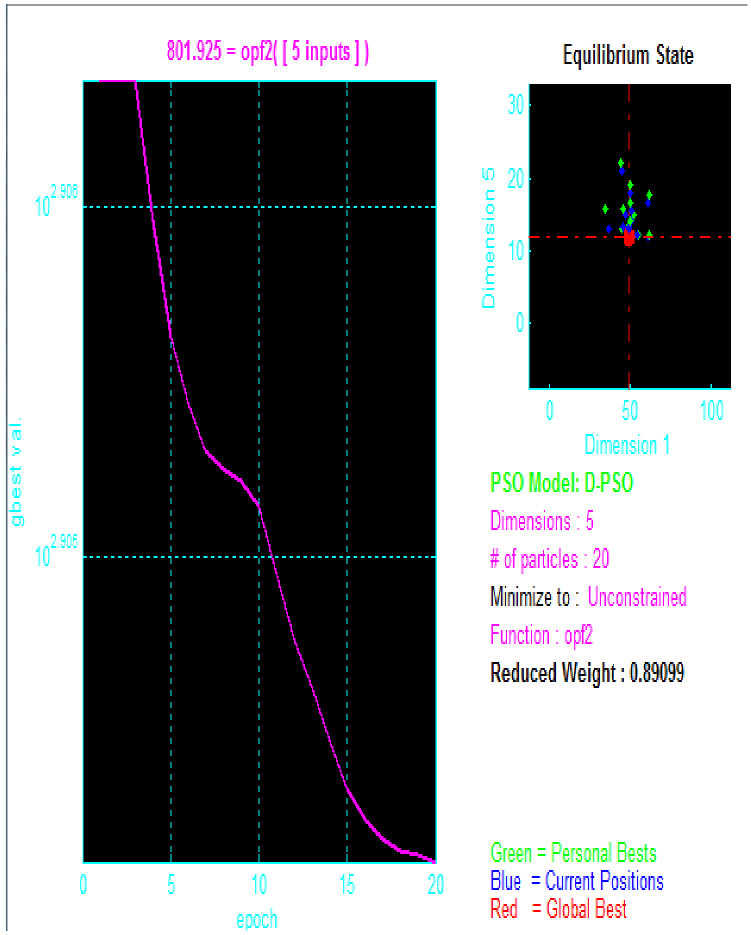


Figure 5.1: gbest value with best fitness in voltage regulation and improving weight inertia i.e 0.89099

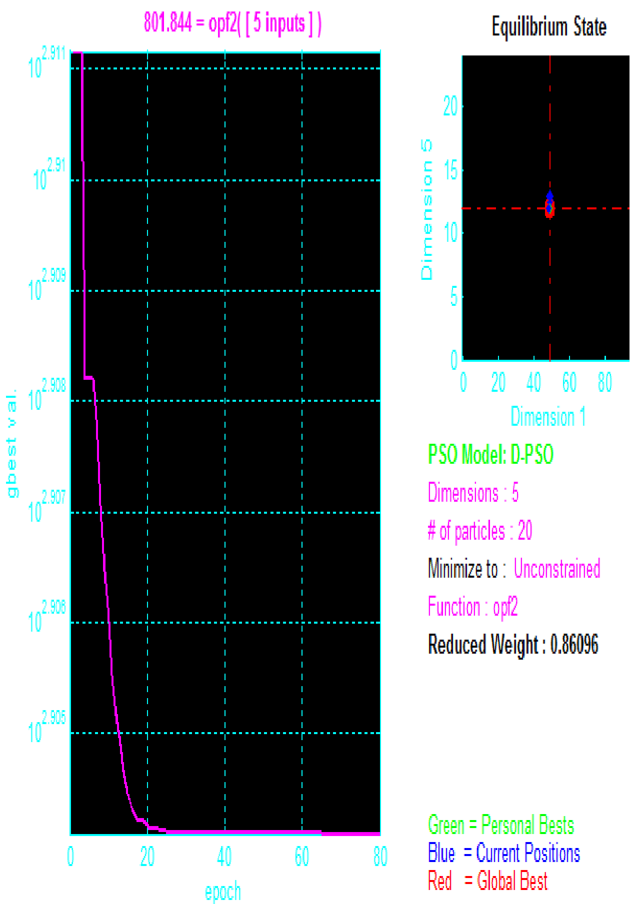


Figure 5.2: gbest value with best fitness in voltage regulation and improving weight inertia i.e 0.86906

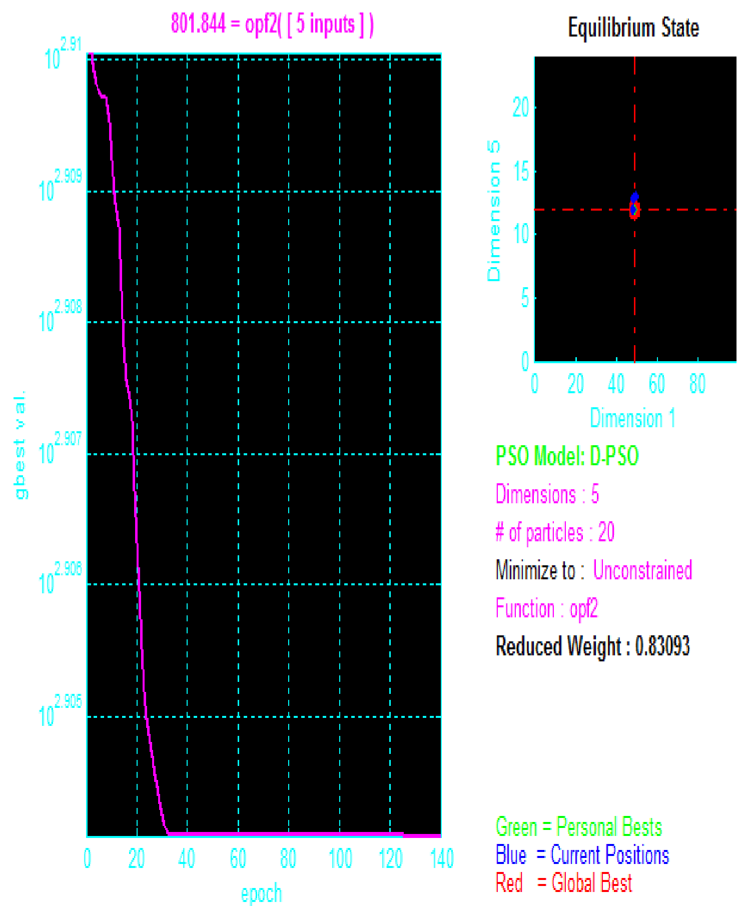


Figure 5.3: gbest value with best fitness in voltage regulation and improving weight inertia i.e 0.83093

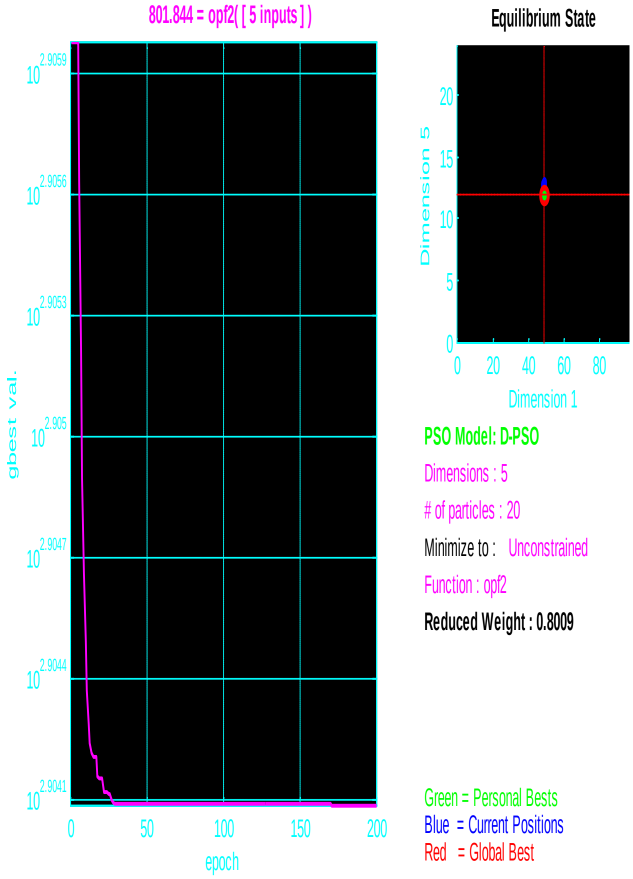


Figure 5.4 Final Improved weight with maximum coverage of voltage

Discussion

Tuningof PI controller play significant role in Power electronics. There are many approaches proposed for obtaining the parameters of Kp and Ki. Based on Ziegler Nichols method of tuning the parameters of Kp and Ki were chosen. The THD value is nearly 8.38% ,but the IEEE standard of THD value is less than 5% is recommended. So a new problem is formed by minimization of power and load consumption value in the time domain simulation. The samples of STATCOM in D-PSO is taken at 0.641 sec and the mean value of THD data is achieved from time domain simulation and the values are passed to D-PSO solver as objective function. The Kp and Ki values are randomly populated and the minimization of objective function is made. The PSO gives better results compared to Ziegler Nichols method and it makes the THD value less than the IEEE standard value.

CONCLUSION

In this work, the investigation on the role of STATCOM is carried out to improve the power quality in distribution networks with static linear and non-linear loads. PI controller is used with the device to enhance its performance. Test system is analyzed and results are presented in the previous chapter. Conditions and it can be concluded that STATCOM effectively improves the power quality in distribution networks with linearstatic. It would result in a power stability improvement and each STATCOM.decreasea risk of critical events caused by those sources. Using STATCOM, we are able to control the voltage at the node to which this device is connected and at the same time it is possible to reduce active power losses and provides information for STATCOM design and placement in power grids. Applying Particle Swarm Optimization showed the potentials to use this method in power grids to improve their operation and selected criteria.

FUTURE SCOPE

In this thesis work it is shown that DSTATCOM can compensate harmonics in current. The work can be expanded in the following area:

Other advanced controllers like fuzzy controller, adaptive fuzzy controller can be employed with DSTATCOM to increase the effectiveness of DSTATCOM in distribution networks.

Dynamic loads can be considered in future work and the effect of DSTATCOM with them can be studied

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