power electronic based system and other static equipment that provide control of one or more AC transmission system parameters to enhance controllability and increase power transfer capability".

"A Static synchronous compensator is a shunt-connected static VAR compensator whose capacitive or inductive output current can be controlled independent of the ac system voltage".The concept of STATCOM was proposed by Gyugyi in 1976. Power Converter employed in the STATCOM mainly of two types i.e. is Voltage Source Converter and Current Source Converter. In Current source Converter direct current always has one polarity and the power reversal takes place through reversal of dc voltage polarity while In Voltage Source Converter dc voltage

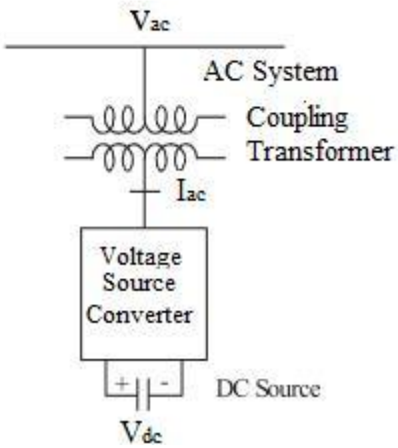

Figure 2: Basic Structure of STATCOM

always has one polarity, and the power reversal takes place through reversal of dc current polarity. The power semiconductor devices used in current source converter requires bidirectional voltage blocking capability and for achieving this Characteristic an additional diode must be connected in series with a semiconductor switch which increased the system cost and its becomes costlier as compared to voltage source converter moreover Voltage source converter can operate on higher efficiency in high power applications. STATCOM is made up of a coupling transformer, a VSC and a dc energy storage device. STATCOM is capable of exchanging reactive power with the transmission line because of its small energy storage device i.e. small dc capacitor, if this dc capacitor is replaced with dc storage battery or other dc voltage source, the controller can exchange real and reactive power with the transmission system, extending its region of operation from two to four quadrants.

2. Phillips Heffron Model

For the study of single machine infinite bus system a Phillips Heffron model can be obtained by linearizing the system equations around an operating condition. The obtained hefffron model is as shown in figure below

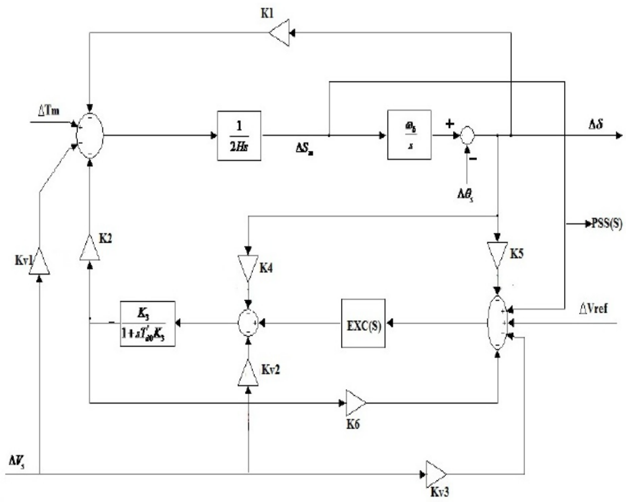

Figure 3: Phillips Heffron model

3. PSO

In computer science, particle 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. PSO optimizes a problem by having a population of candidate solutions, here dubbed particles, and moving these particles around in the search-space according to simple mathematical formulae over the particle's position and velocity. Each particle's movement is influenced by its local best known position but, is also guided toward the best known positions in the search-space, which are updated as better positions are found by other particles. This is expected to move the swarm toward the best solutions. PSO algorithm is an optimization technique inspired by the natural movement and intelligence of bird flocks and fish schooling. It was first introduced by Eberhart and Kennedy in 1995 to graphically simulate the graceful and unpredictable choreography of a swarm .

The basic idea of the PSO consists in moving a pre-defined number of particles troughout the searching space in order to find the best solution. The movement pattern of the particles towards the best solutions is defined by the social interaction between the individuals from the population.

In Fig. 4 are represented the main steps for implementing the PSO algorithm. For mathematical representation of the flock, the particles are modeled as vectors in a multi-dimensional search space. The optimization process starts by randomly generating the population and the velocities of the particles. To assign a certain measure of performance, the particles are evaluated according to an objective function. In this way, the personal best of each particle as well as the global best of the entire population are determined. With this information, the velocity of every individual is computed taking into account its previous velocity, personal best and global best . The new positions of the individuals are then updated by adding the computed velocities to the actual position according to .(1)

$$v_i^{k+1}=wv_i^k+c_1.rand.(pbest_i-s_i^k)+ c_2.rand.(gbest_i-s_i^k)$$

where:

*c*1 , *c*2 Weighting coefficients
$pbest_i$ Personal best of the *ith* particle
gbest Global best of the population
s_i^k Position of the *ith* particle at iteration *k*

$$S_i^{k+1} = S_i^k + V_i^{k+1} \quad \ldots\ldots\ldots \quad (1)$$

where:
s_i^{k+1} The position of the *ith* particle at iteration *k+1*

v_i^{k+1} Velocity of the *ith* particle at iteration *k+1*

The searching process is continued until a relatively unchanged position has been encountered or computational limits are exceeded. An important aspect of the PSO is that the ratios of the three elements that influence the particle velocity in the optimization process can be modified. Therefore, the particle performance toward the optimal solution can be enhanced controlling the weighting coefficients.

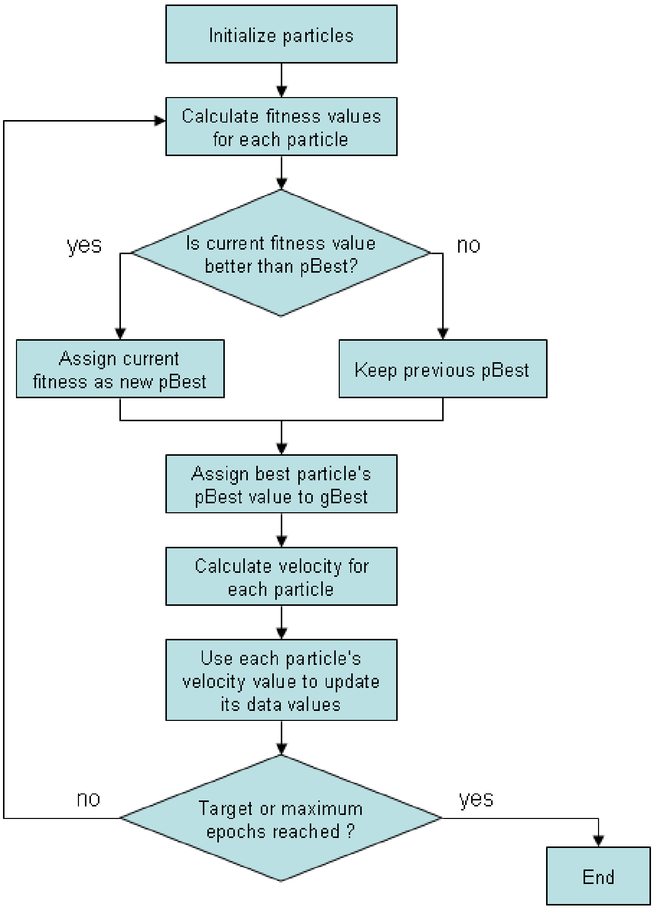

Figure 4: Block diagram of PSO algorithm

4. Simulation Methodology

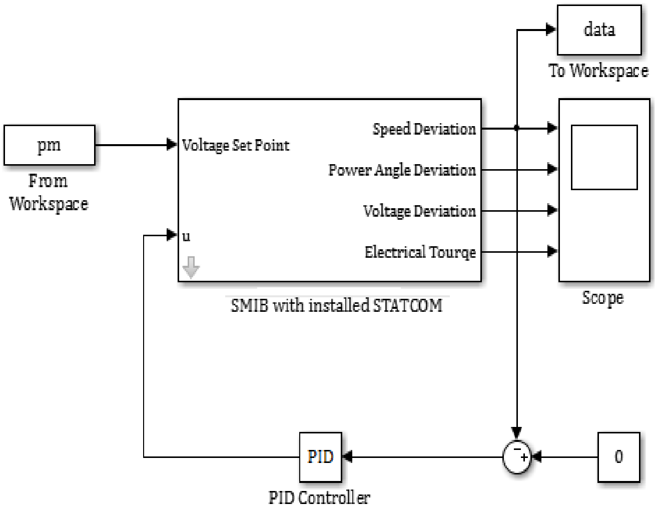

Figure 5: Proposed model in simulink

5. Conclusion

Solving an optimization problem is one of the common scenarios that occur in most engineering applications. The above issues are of particular importance when solving optimization problems in a power system. As a highly nonlinear, nonstationary system with noise and uncertainties, a power network can have a large number of states and parameters. Implementing any of the classical analytical optimization approaches might not be feasible in most of the cases. On the other hand, PSO can be an alternative solution. It is a stochastic-based search technique that has its roots in artificial life and social psychology, as well as in engineering and computer science. It utilizes a "population," called particles, which flows through the problem hyperspace with given velocities; in each iteration, velocities are stochastically adjusted considering the historical best position for the particle itself and the neighborhood best position (both of them defined according to a predefined fitness function). Then, the movement of each particle naturally evolves to an optimal or near-optimal solution.This paper has described the basic concepts of PSO along with its numerous variants that can be employed in different optimization problems. In addition, a review of the applications of PSO in power systems-based optimization problems is presented to give the reader some insight of how PSO can serve as a solution to some of the most complicated engineering optimization problems.

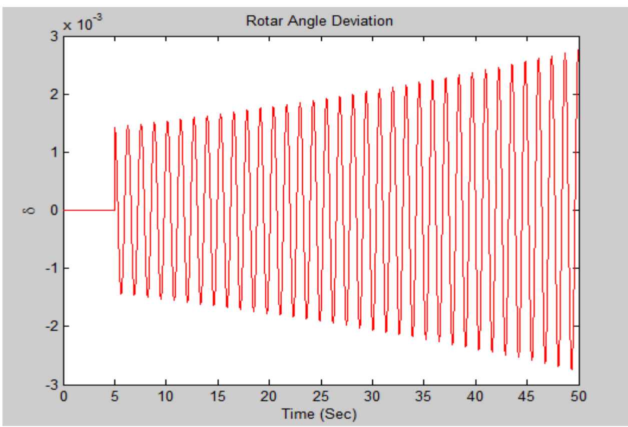

Figure 6: Rotor angle deviation without statcom

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