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PSO-UPFC Based Effiecient Power Controller For AC Transmission

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Abstract* - Controllability and flexibility are important concepts for planning the operation and the expansion of the transmission system. In the operation context of the system, controllability refers to the ability to implement a direct or indirect control over relevant physical quantities to the network operation. These quantities are principally the line reactance and also the power flows in the circuits. Flexibility is the ability to accommodate different operating conditions (generation and load scenarios, network topology, etc.), using the existing resources in the network in order to maintain the adequacy of power supply and respect operating limits. Therefore, the controllability brings the flexibility. Recent technological advances have revealed new devices that have as primary objective to increase the controllability and consequently the flexibility of the transmission system. The proposed work is based on PSO PUFC particle swarm algorithm to optimize the above issues and enhance the performance of the system.

***Index Terms*- Flexible AC Transmission Systems (FACTS), Unified Power Flow Controller (UPFC), Transformer-less, Cascade Multilevel Inverter.**

I. INTRODUCTION

In conventional AC transmission system, the ability to transfer AC power is limited by several factors like thermal limits, transient stability limit, voltage limit, short circuit current limit etc. These limits define the maximum electric power which can be efficiently transmitted through the transmission line without causing any damage to the electrical equipments and the transmission lines. This is normally achieved by bringing changes in the power system layout. However this is not feasible and another way of achieving maximum power transfer capability without any changes in the power system layout. Also with the introduction of variable impedance devices like capacitors and inductors, whole of the energy or power from the source is not transferred to the load, but a part is stored in these devices as reactive power and returned back to the source. Thus the actual amount of power transferred to the load or the active power is always less than the apparent power or the net power. For ideal transmission the active power should be equal to the apparent power. In other words, the power factor (the ratio of active power to apparent power) should be unity. This is where the role of Flexible AC transmission System comes.

A Flexible AC transmission System alludes to the framework comprising of energy electronic gadgets alongside power framework gadgets to upgrade the controllability and strength of the transmission framework and increment the power exchange abilities. With the innovation of thyristor switch, opened the entryway for the improvement of energy gadgets known as Flexible AC transmission frameworks (FACTS) controllers. Essentially the FACT framework is utilized to give the controllability of high voltage side of the system by joining power electronic gadgets to present inductive or capacitive power in the system.

Control frameworks today are exceedingly mind boggling and the prerequisites to give a stable, secure, controlled and monetary nature of energy are winding up plainly fundamentally critical with the fast development in mechanical zone. To meet the requested nature of energy in a power framework it is fundamental to expand the transmitted power either by putting in new transmission lines or by enhancing the current transmission lines by including new gadgets.

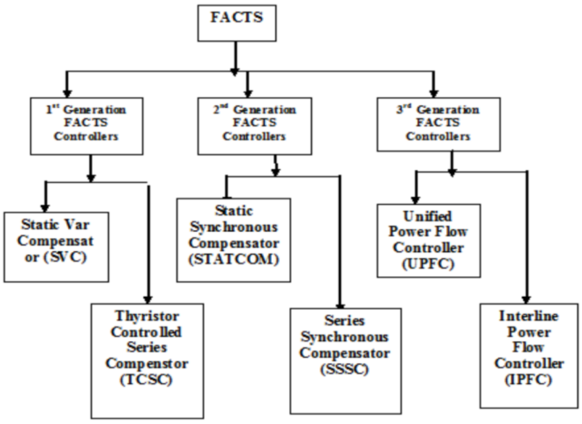

Figure 1.1 Block Diagram of FACTS Controllers.

Establishment of new transmission lines in a power framework prompts the innovative complexities, for example, financial and ecological contemplations that incorporates cost, delay in development as so on. Considering these elements control framework engineers thought the exploration procedure to change the current transmission framework as opposed to developing new transmission lines. Later they concocted the idea of using the current transmission line just by including new gadgets, which can adjust transitory framework conditions at the end of the day, control framework ought to be adaptable.

II. PROPOSED SYSTEM

Figure 2.1 demonstrate the simulink model of proposed PSO – UPFC system. Any problem of constrained optimization can be solved with the help of numbers of conventional and modern heuristic optimization techniques. Unified power flow controller (UPFC) is one of the FACTS devices, which can control power system parameters such as terminal voltage, line impedance and phase angle. Therefore, it can be used not only for power flow control but also for power system stabilizing control. Unified power flow controller (UPFC) is a combination of static synchronous compensator (STATCOM) and a static synchronous series compensator (SSSC) which are coupled via a common dc link, to allow bi-directional flow of real power between the series output terminals of the SSSC and the shunt output terminals of the STATCOM and are controlled to provide concurrent real and reactive series line compensation without an external electric energy source. The UPFC, by means of angularly unconstrained series voltage injection, is able to control, concurrently or selectively, the transmission line voltage, impedance and angle or alternatively, the real and reactive power flow in the line. The UPFC may also provide independently controllable shunt reactive compensation.

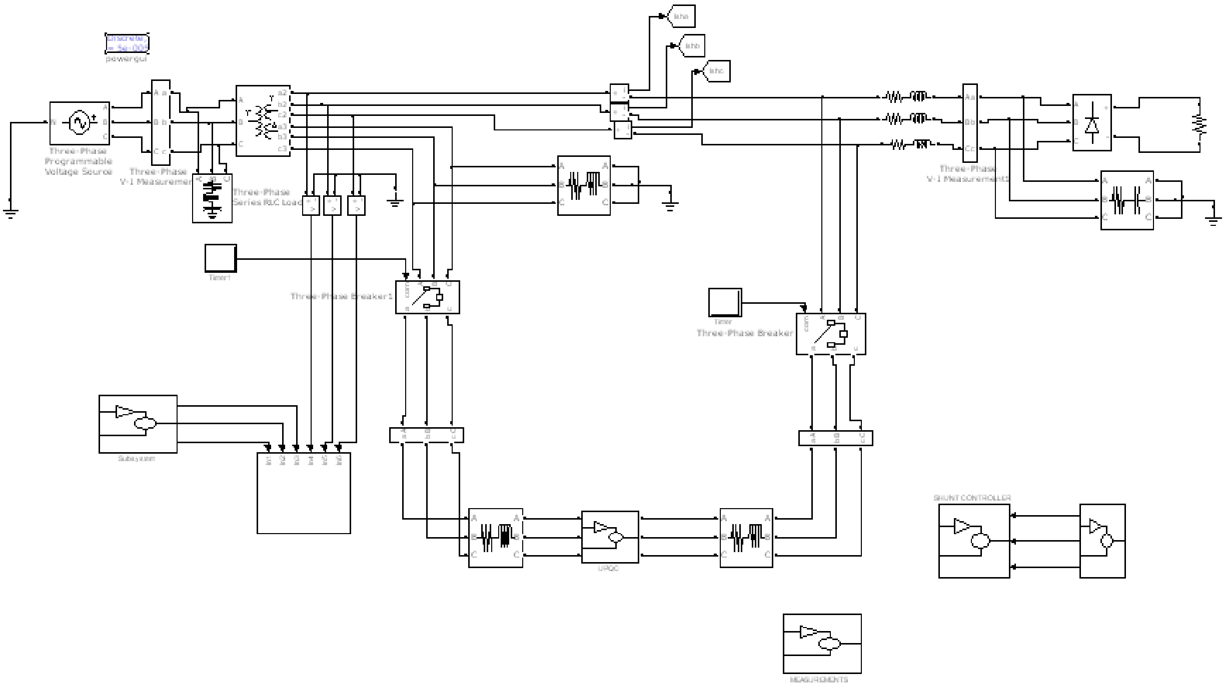

Figure 2.1 Simulink model of PSO UPFC.

A. PSO - UPFC

The particle swarm algorithm begins by creating the initial particles, and assigning them initial velocities.

It evaluates the objective function at each particle location, and determines the best (lowest) function value and the best location.

It chooses new velocities, based on the current velocity, the particles' individual best locations, and the best locations of their neighbors.

It then iteratively updates the particle locations (the new location is the old one plus the velocity, modified to keep particles within bounds), velocities, and neighbors.

Iterations proceed until the algorithm reaches a stopping criterion.

Here are the details of the steps.

B. Initialization

By default, particle swarm creates particles at random uniformly within bounds. If there is an unbounded component, particleswarm creates particles with a random uniform distribution from –1000 to 1000. If you have only one bound, particleswarm shifts the creation to have the bound as an endpoint, and a creation interval 2000 wide. Particle i has position x(i), which is a row vector with nvars elements. Control the span of the initial swarm using the InitialSwarmSpan option.

Similarly, particle swarm creates initial particle velocities v at random uniformly within the range [-r,r], where r is the vector of initial ranges. The range of component i is min(ub(i) - lb(i),InitialSwarmSpan(i)).

particleswarm evaluates the objective function at all particles. It records the current position p(i) of each particle i. In subsequent iterations, p(i) will be the location of the best objective function that particle i has found. And b is the best over all particles: b = min(fun(p(i))). d is the location such that b = fun(d).

particleswarm initializes the neighborhood size N to minNeighborhoodSize = max(1,floor(SwarmSize*MinNeighborsFraction)).

particleswarm initializes the inertia W = max(InertiaRange), or if InertiaRange is negative, it sets W = min(InertiaRange). particleswarm initializes the stall counter c = 0.

For convenience of notation, set the variable y1 = SelfAdjustmentWeight, and y2 = SocialAdjustmentWeight,
where SelfAdjustmentWeight and SocialAdjustmentWeightare options.

C. Iteration Steps

The algorithm updates the swarm as follows. For particle i, which is at position x(i):

1. Choose a random subset S of N particles other than i.
2. Find fbest(S), the best objective function among the neighbors, and g(S), the position of the neighbor with the best objective function.
3. For u1 and u2 uniformly (0,1) distributed random vectors of length nvars, update the velocity

   v = W*v + y1*u1.*(p-x) + y2*u2.*(g-x).

   This update uses a weighted sum of:

- The previous velocity v
- The difference between the current position and the best position the particle has seen p-x
- The difference between the current position and the best position in the current neighborhood g-x

4. Update the position x = x + v.
5. Enforce the bounds. If any component of x is outside a bound, set it equal to that bound.
6. Evaluate the objective function f = fun(x).
7. If f < fun(p), then set p = x. This step ensures p has the best position the particle has seen.
8. If f < b, then set b = f and d = x. This step ensures b has the best objective function in the swarm, and d has the best location.
9. If, in the previous step, the best function value was lowered, then set flag = true. Otherwise, flag = false. The value of flag is used in the next step.
10. Update the neighborhood. If flag = true:
    a. Set c = max(0,c-1).
    b. Set N to minNeighborhoodSize.
    c. If c < 2, then set W = 2*W.
    d. If c > 5, then set W = W/2.
    e. Ensure that W is in the bounds of the InertiaRange option.

    If flag = false:

    f. Set c = c+1.
    g. Set N = min(N + minNeighborhoodSize,SwarmSize).

III. SIMULATION OUTCOME

Simulation of proposed work has done on MATLAB Simulink Simulator. Outcome of proposed work has given below.

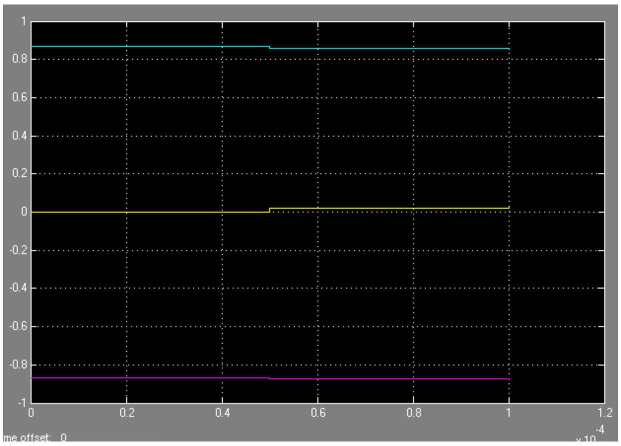

Figure 3.1 Voltage vectors.

Voltage vector waveform is shown in figure 3.1 figure 3.2 demonstrate power factor of the system and maximum line current in case 1 for different values of α. figure 3.4 shows the waveform, of load voltage. Figure 3.5 shows the power factors of the system and maximum line currents. Power factors of the system and maximum line currents in case 2, shown in figure 3.6. Figure 3.7 load voltage. Waveform of UDC and power factor is shown in figure 3.8 and 3.9 respectively.

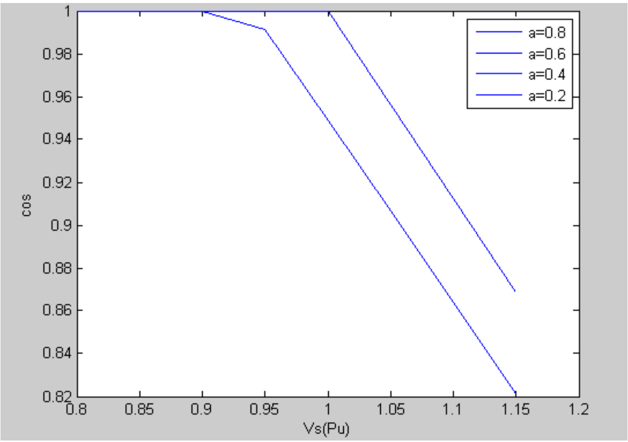

Figure 3.2 Power factors of the system and maximum line currents in case 1, for different α values.

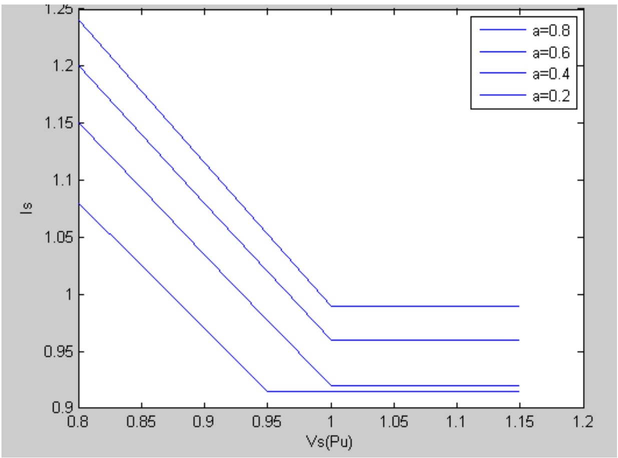

Figure 3.3 Power factors of the system and maximum line currents in case 2, for different α values. Power factor will be varining in between 0.9 to 1 according to pso principal it should not be variable according to time

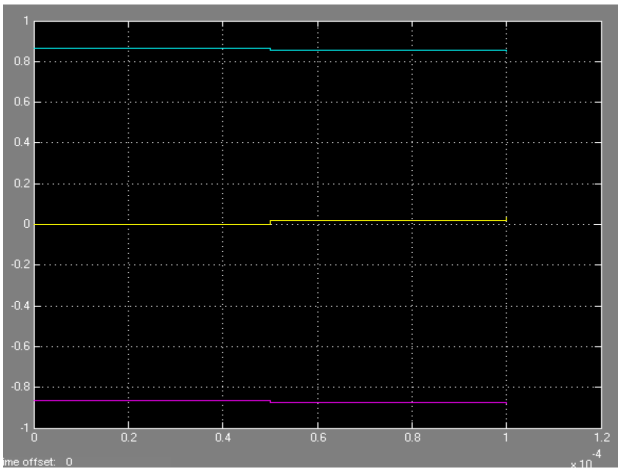

Figure 3.4 Load voltages.

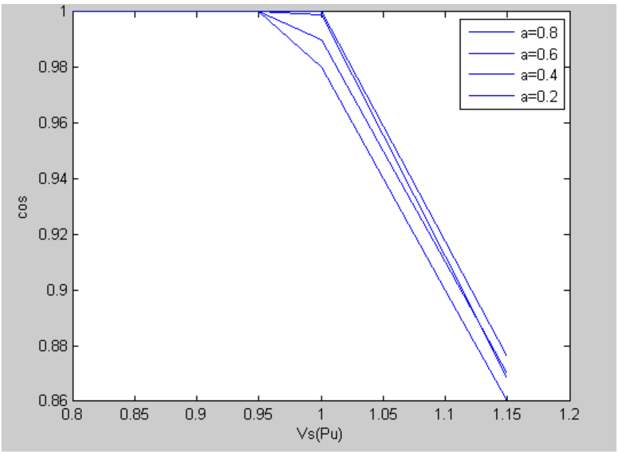

Figure 3.5 Power factors of the system and maximum line currents

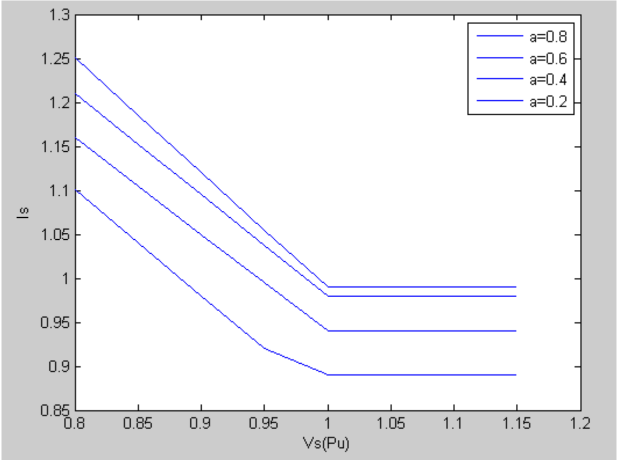

Figure 3.6 Power factors of the system and maximum line currents in case 2, for different α values.

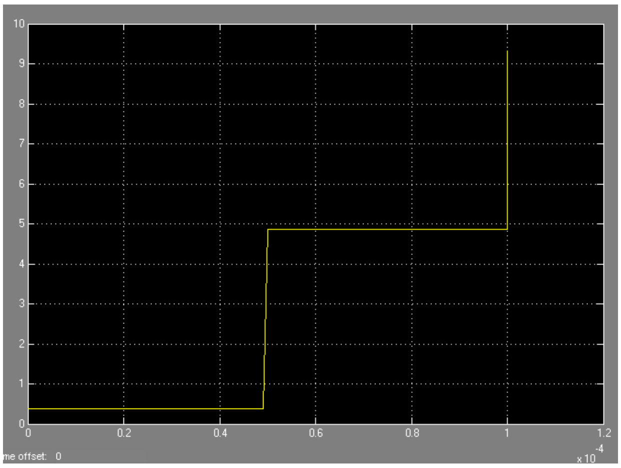

Figure 3.7 load voltage

Voltages should be in incremental order so that it should be constantly increasing .which is only possible by PSO

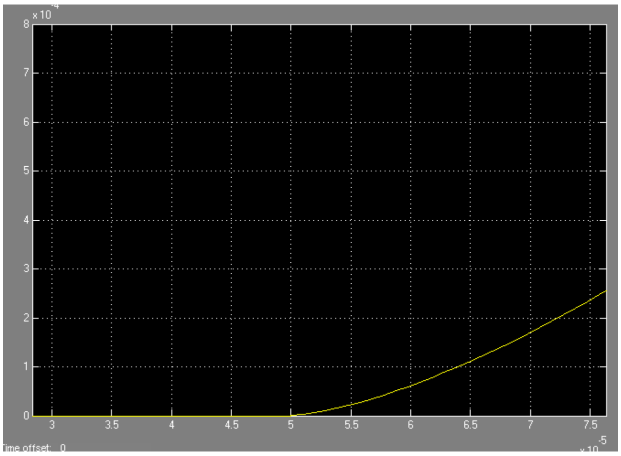

Figure 3.8 UDC.

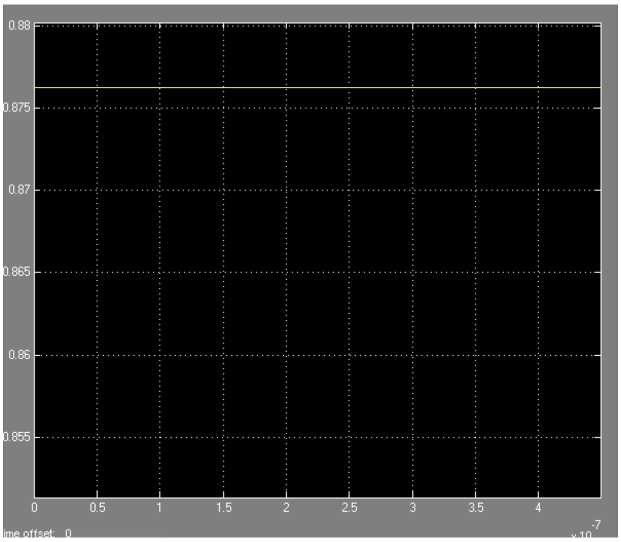

Figure 3.9 power factors.

IV. CONCLUSION

In this work, the particle swarm algorithm for the incorporation of the devices which enable power flow controllability and flexibility to the transmission expansion planning problem have been proposed. The family of Flexible AC Transmission System (FACTS) has been adopted in generation, transmission and distribution systems. These power flow control solutions include, but not limited to, series reactor, phase shifting transformer, static synchronous compensator (STATCOM), static series synchronous compensator (SSSC), unified power flow controller (UPFC). FACTS have the principal role to enhance controllability and power transfer capability in ac systems. It involves conversion and/or switching power electronics in the range of a few tens to a few hundred megawatts. Proposed PSO UPFC system has simulated on MatLab. Simulation outcome waveform of the proposed system shows that the proposed technique reduced the transmission cost function and also improved voltage stability with reduced power loss.

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