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RESEARCH ARTICLE
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Calculation Of Multi Machine Infinite Bus System (Mmib) Optimal Points For Facts Controller Using Ga And Comparing With Other Facts Controllers

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ABSTRACT

This paper introduces Flexible AC Transmission System (FACTS) devices in the power system which is a successful opportunity for using transmission lines. Assembling of FACTS controllers at the best area in the system is the major investigation. The UPFC is also one of the controllers in combined FACTS controller. This kind of controller is a very classy controller and it is providing the amount come of its preparation. With wide selection of working and blame situations, the enactment calculation of various FACTS controllers has been completed. Then UPFC controller of power system load or power flow control characteristics are compared with different FACTS controllers. These FACTs controllers are having the better- quality. The distinguishing HPFC proposals are anticipated or dedicated on a MMIB bus. Hybrid Power Flow Controller (HPFC) which can be planned utilizing the current VAR compensator/controller has the favorable position that it is financially savvy and is an execution proportionate option of UPFC. With utilizing or limiting circumstances capabilities are produced in UPFC and HPFC of the power system. In this paper has newly introduced Genetic Algorithm method using the Hybrid Power Flow Controller (HPFC) with multi machine power system. Then simulation results are compared with rest of the controllers of Power system using IEEE 62 Bus and IEEE 118 Bus Test System.

Keywords: *Neuton-Raphson Algorithm, Load Flow, Unified Power Flow Controller (UPFC), Hybrid Power Flow Controller (HPFC), Flexible Alternating Current Transmission Systems, Genetic Algorithm, Static VAR Compensator and Thyristor controlled switched capacitor (TCSC)*

INTRODUCTION

In this manuscript is described the mathematical presenting of HPFC controllers. These controllers have completed its performance in Multi Machine Infinite Bus (MMIB) power system bus. To meet the electric market requests new lines ought to be added to the power system bus. However ecological reasons the establishments of electrical power system transmission lines are normally restricted.

Consequently the functions are obligated to be contingent and also it authoritatively prevailing infra-structure as divergent to constructing new power system transmission lines. With the help of variation of load and transmission losses of power system, the reactive power of power system demand also varies. Even though this demands are affecting voltage at the nodes of the transmission bus system.

The Various power system transmission features can be organized by the fast response of reactive power compensators installed in the power system transmission lines. Depending on using power electronic device the variable impedance method and VSC based systems are required. The main aim or achievement of power system bus is giving quality of the customer's fulfillment.

The Genetic Algorithm based optimization techniques are commonly used to find the type and size of FACTS controllers. These FACTs controller of reducing the all losses are affected with the help of power system losses, voltage sags and generation cost. The Genetic Algorithm has been created for finding out optimal solutions and sizing parameters of FACTs devices. With the help of Newton-Raphson method the power flow solutions are calculated and to investigate the optimal points of UPFC and HPFC controllers. Here this paper illustrates mainly about the steady state operation has been considered with changes of UPFC and HPFC using Genetic Algorithm.

(I) Variable impedance compose, and (ii) VSC based compose, contingent upon the kind of intensity electronic gadgets utilized. The variable impedance compose controller depends on thyristor exchanged and thyristor controlled capacitors or reactors. These gadgets are Static VAR compensator (SVC), Thyristor Controlled Series Capacitor (TCSC) and Thyristor-Controlled Phase Shifting Transformer (TCPST). These have restricted execution, constrained usefulness, and substantial impression. The VSC based FACTS controllers have better execution due than flexible usefulness and littler impression. These incorporate STATCOM, SSSC, IPFC, and UPFC

Like this among Voltage Source Converter based FACTS devices, UPFC has to be control stream limits of power transmission line as wanted [3]. Nevertheless of its best accomplishment abilities, UPFC establishments around the globe are restricted when contrasted with the quantity of establishments of SVC and TCSC. This is principally because of its staggering expense as Voltage Source Converters are limited for the transmission voltage level.

A Graphical User Interface (GUI) in light of a GA has been created to locate the ideal areas and measuring parameters of multi-type FACTS gadgets on vast power frameworks, known as-FACTS Placement Toolbox in MATLAB. An ideal area of numerous multi-sorts of FACTS gadgets for clog administration in the lines is proposed. A GA improved Fuzzy Logic Controller (GA-FLC) has been created to control UPFC for damping low-recurrence motions which demonstrated to have preferred execution over PSS and PI controlled UPFC for damping LFO [11]. Less work has been done on building up a streamlining calculation for HPFC. This influenced the analyst to take a shot at this theme. MATLAB program is followed to actualize the UPFC and HPFC in the Newton-Raphson (NR) control stream program. It is done to explore the ideal area of UPFC and HPFC with the goal of minimization of genuine power misfortune and age cost. The impacts of UPFC and HPFC at ideal designation on control framework in enduring state task have been examined.

The physical points of HPFC controllers are considered below:

Enhanced operational execution abilities

Constant utilization of power electronic devices and its applications

Reduced size and creation of nature work.

Concept of HPFC

The HPFC controller is consist of an arrangement connected with TCSC and two shunt of VSC As well as two voltage source controllers are presented in the TCSC. The two VSCs segments are connected and it's inspires in the interchange of dynamic power between them. The ranking of each and every VSC is having the huge portion or area calculated size of shunt converter of UPFC. The synchronization between the two VSC's and the TCSC's are controlled responsive power of transmission line [6].

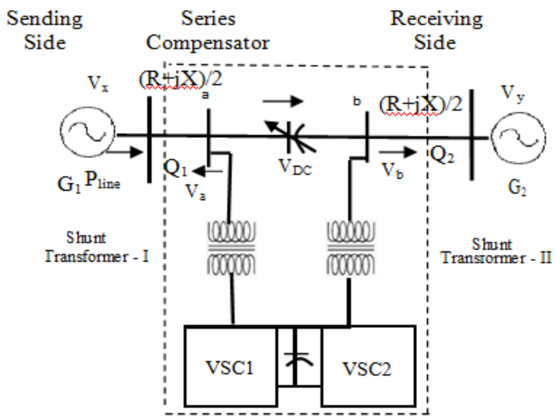

FIG 2: Structure of HPFC

The two shunt devices are connected with VSC control the voltage sizes of Va and Vb and also TCSC with the achievement permeate voltage at a variable point θDc. The size of VDc is varied with changeable impedance of the compensator TCSC. The Hybrid power flow controller of shunt converter has to produce or absorbing reactive power and it delivers the active power of this controller. By means of flowing level and place point of the permeated voltage VDc,is shown in above figure. The Va and Vb are well-ordered VAR of the two VSC's of allowing for a dependable bus voltage Va and a detail permeated voltage range VDc. TheθDc of imparted voltage will be changing bus voltage Vb.

Genetic Algorithm

The Genetic Algorithm is normally distributes top indentation arrangements. Then Genetic Algorithm pursues from a general population with a lonely argument and it inventions a collectively supreme point. The policy for asymmetrical development is employed to detect an ultimate arrangement from the number of populations in GA. The existing general population is controlled upon through the production, hybrid and modification to make another age of higher authorities. The GA develops objective capability's approval of data and not affiliates or additional collaborator evidence.

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Generation of Cost function

The deep age unit costs are huge a nonlinear and arrangement work. The age cost capability can be described as

$$f(x) = \sum_{i=1}^{ng}(x_i + y_i P_{Gi} + z_i P_{Gi}^2) \quad (1)$$

where xi about to reimbursement, pay rates, reduction, conspiracy, formation cost,

yi about to fuel cost,

zi about a quantity of transmission troubles,

ng is the number of generators together with the slack bus,

Active power loss

It is characterized such as the entire of dynamic or active power losses of altogether transmission lines of the power system. The numerical sum of sending end power and receiving end power is occurred with active power loss in a transmission line between two buses are shown in equation 2.

$$p_l = \sum_{m=1}^{Nl} G_m\left[V_l^2 + V_j^2 - 2V_l V_j \cos(\theta_i - \theta_j)\right] \quad (2)$$

Nl - Aggregate number of transmission line

Gm- Conductance of mth line.

Constraints

The changed equivalence and dissimilarity limitations are considered in addition with GA optimization as given in below:

Equality constraints

The similarity limitations are considered in the transmission line power flow equations. It expresses about each and every bus in the power system, the generation, load and powers. These powers are replaced via transmission elements connecting to the respective bus. Both of the active and reactive powers are presented must be add zero if the transmission lines connected in the power system. This is shown in by (3) and (4)

$$P_{Gi} - P_{im} - \sum_{i=1}^{a} P_m^{ical} = 0 \quad (3)$$

$$Q_{Gi} - Q_{im} - \sum_{i=1}^{a} Q_m^{ical} = 0 \quad (4)$$

where

PGi, PLi are genuine power age and load, and

QGi, QLi are responsive power age and load at transport k separately.

Pi, Qi is active and reactive power changed by bus k with bus I of the system. For an uncompensated framework, it is given by (5) and (6).

$$P_m^{ical} = \sum_{i=1}^{n} V_m^2 G_{mm} + V_m V_i [G_{mi}\cos(\theta_k - \theta_i) + B_{mi}\sin(\theta_k - \theta_i)] \quad (5)$$

$$Q_m^{ical} = \sum_{i=1}^{n} V_m^2 B_{mm} + V_m V_i [G_{mi}\sin(\theta_k - \theta_i) + B_{mi}\cos(\theta_k - \theta_i)] \quad (6)$$

The uniformity imperative conditions with UPFC and HPFC are planned with advancement of dynamic and receptive power stream conditions between transport k and transport I and substituted in (3) and (4) with dynamic and responsive intensity of age and load at the transport.

Concept of Genetic Algorithm

Here Genetic algorithm is starting from initialization of chromosome people or population and not starts from single point of this algorithm. It is having generally natural selection mechanism and also it is giving the best high level solution. Fitness function value is minimized or maximized for the every chromosome. Fitness continued existence is used acceptable for the upcoming generation to get optimal solution. Then reproduction also it is giving better performance for fitness function using the selection operators. Upcoming generation of cross over target is presented to construct fittest offspring. Finally mutation is operating randomly to change the gene on chromosome of diversity population. As well as new chromosomes are produced after removed old population and this process is repeated continuously to get optimal solution.

Power flow of UPFC

It establishes a power system model of UPFC is working with active power and this power is operated with dc boundary by shunt converter. These shunt converter and series conveter dc link must be a similar ie. Re($V_{sh}I_{sh)} = Re(V_{se}I_{se})$.

At sending end the dynamic and responsive power of UPFC is shown by (7) and (8) individually and at accepting end is given by (9) and (10) separately.

$$P_m = V_m^2 G_{mi} + V_m V_i [G_{mi}\cos(\theta_m - \theta_i) + B_{mi}\sin(\theta_m - \theta_i)] + V_{sh} V_m [G_{sh}\cos(\theta_m - \theta_{sh}) + B_{sh}\sin(\theta_m - \theta_{sh})] + V_{se} V_m [G_{se}\cos(\theta_m - \theta_{se}) + B_{se}\sin(\theta_m - \theta_{se})] \quad (7)$$

$$Q_m = -V_m^2 G_{mi} + V_m V_i [G_{mi}\sin(\theta_m - \theta_i) + B_{mi}\cos(\theta_m - \theta_i)] + V_{sh} V_m [G_{sh}\sin(\theta_m - \theta_{sh}) + B_{sh}\cos(\theta_m - \theta_{sh})] + V_{se} V_m [G_{se}\sin(\theta_m - \theta_{se}) + B_{se}\cos(\theta_m - \theta_{se})] \quad (8)$$

At bus i

$$P_i = V_i^2 G_{ii} + V_i V_m [G_{ii}\cos(\theta_i - \theta_m) + B_{ii}\sin(\theta_i - \theta_m)] + V_{se} V_i [B_{ii}\cos(\theta_i - \theta_{se}) + G_{ii}\sin(\theta_i - \theta_{se})] \quad (9)$$

$$Q_i = -V_i^2 B_{ii} + V_m V_i [G_{ii}\sin(\theta_i - \theta_m) - B_{ii}\cos(\theta_i - \theta_m)] + V_{se} V_i [B_{ii}\sin(\theta_i - \theta_{se}) - G_{ii}\cos(\theta_i - \theta_{se})] \quad (10)$$

The shunt VSC is connected through coupling transformer with susceptance of Bse and Bsh and with zero conductance (Gse=Gsh=0).

Power flow equations of HPFC

The power stream model of HPFC arrangement is utilized for exploration as appeared in Fig.5. These HPFC controller is depends on the establishing strength of power system models of STATCOM and TCSC. Approximating UPFC controller can be developed to its terminal voltages as well as active and reactive power and voltage long as the power remain stays inside [10].

At Bus- m

$$P_m = V_m V_i B_{mi} \sin(\theta_m - \theta_i) + V_m V_{sh1} G_{sh1} \cos(\theta_m - \theta_{sh1}) \quad (11)$$

$$Q_m = -V_m^2 B_{mm} - V_m V_i B_{mi} \cos(\theta_i - \theta_m) - V_m^2 B_{sh1} + V_m V_{sh1} B_{sh1} \cos(\theta_m - \theta_{sh1}) \quad (12)$$

At Bus- i

$$P_i = V_m V_i B_{mi} \sin(\theta_i - \theta_m) + V_m V_{sh1} G_{sh2} \cos(\theta_m - \theta_{sh2}) \quad (13)$$

$$Q_i = -V_i^2 B_{ii} - V_m V_i B_{im} \cos(\theta_i - \theta_m) - V_i^2 B_{sh1} + V_i V_{sh2} B_{sh2} \cos(\theta_m - \theta_{sh2}) \quad (14)$$

The genuine and responsive forces is infused because of HPFC at the sending end is given by (11) and (12) and at getting end is given by (13) and (14).

In these conditions, Bmm=Bii = (- 1/XTCSC), Bmi = Bim= (1/XTCSC), Vsh1, θsh1, Vsh2, θsh2, are STATCOM voltage extents and points associated at bus m and I, Vm, θm, Vi, θi are voltage sizes and edges at bus m and i separately. The two shunt VSC are associated through coupling transformers with susceptance of Bsh1 and Bsh2 and with zero conductance (Gsh1=Gsh2=0). The active power is controlled by TCSC commitment of STATCOM at bus m and bus i is taken as zero. The reactive power is filled in the line that is because of both TCSC and STATCOM.

The optimal allocation of multi-machine power system FACTS controllers from hybrid-PSO of IEEE 118-bus system.

Types of FACTS Controllers	TCSC	SVC	UPFC using GA		HPFC using GA
Parameter of FACTS Controller	XS	αP	αD	Vu	Qv
	0.0482	0.0418	0.0512	0.0586	0.0185
Location	LINE 71	LINE 14	LINE 11		BUS 18

The optimal allocation of multi-machine power system FACTS controllers from hybrid-PSO of IEEE 62-bus system.

Types of FACTS Controllers	TCSC	SVC	UPFC using GA		HPFC USING GA
Parameter of FACTS Controller	XS	αP	αD	Vu	Qv
	0.0303	0.315	0.0424	0.0512	0.0142
Location	LINE 40	LINE 25	LINE 51		BUS 32

CONCLUSION

The HPFC controller of Genetic Algorithm has been used to this paper for calculate optical allocation in Multi Machine Power system of FACT's devices. Here results are shown in IEEE 62 bus and IEEE 118 Bus Test System with presents of line parameters, generator, load and transformer evaluations. Genetic Algorithm objective function of power system is mainly concentrated. The optimal allocation multi-machine power system of FACTS controller IEEE 118 and IEEE 62 bus system results are calculated in this paper. From this conclusion the IEEE results from 118 bus HPFC controller reactive powers Qr is the best one comparing IEEE 62 bus test system. The TCSC, SVC and UPFC controller also used in this paper even though using the HPFC controller. So these values are calculated with the help of or using the Genetic Algorithm. After comparing all values the HPFC controller is better than other controller for improving the performance.

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