Real Genetic Algorithm Based Fuzzy–AHP Approach to Congestion Relief via UPFC

H.Iranmanesh, M.Rashidi-Nejad

Abstract— Power systems may not capable of utilizing full transmission capacity. Restructuring of electricity industry may need some management criteria in order to improve technical as well as economical efficiency. Under the new scheme of power markets, congestion management is a crucial problem that is needed to be considered. One of the most important issues related to restructured power systems is congestion transmission. Congestion relief can be handled using FACTS devices, where transmission capability may be improved. The optimal location of UPFC (Unified power flow controller) to relieve congestion in the network is proposed. In congestion management, the objective function is nonlinear hence for solving this function real genetic algorithm (RGA) is used for optimization process while analytical hierarchy process (AHP) with fuzzy sets is implemented to evaluate RGA fitness function. The above method is tested on modified IEEE 5-bus system.

Keywords- Congestion Relief, Transmission Capability, Real Genetic Algorithm, Fuzzy Sets, UPFC

I. INTRODUCTION

Electricity industry restructuring and reregulation may dictate maximum power transfer using the existing facilities under transmission open access scheme. Procuring electricity contracts associated with market participants' requirements can cause more challenges considering energy management systems. Reregulation will impose new necessities to power systems such as transmission open access as well as non-discrimination access to the information. Transmission congestion management is an important mechanism in order to solve power transfer bottleneck both in the operation and planning horizons [1]. There are two issues with regards to applying transmission open access that should be considered, the so-called: transmission losses and transmission congestion. Congestion is dependent to the network constraints that may show the ultimate transmission capacity, while it can restrict the concurrent electric power contracts [2]. It can be said that, under congestion conditions the price of transferring electricity will be increased. In fact, congestion management is an overall as well as particular systematic way of improving electricity transfer in which power systems planning and operating can be regarded.

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Transmission congestion is dealing with some restrictions of electricity transfer via transmission network. These restrictions are increased in the presence of open access considering electricity restructuring environment[3].Under new conditions of power market, more constraints such as: economical, environmental problems and transmission rights as financial contracts will be added to technical limitations of transmission capacity [1]. Congestion relief is such a solution to release some blocked capacity of transmission network. In literature, there are some techniques suggested to increase the available transfer capability (ATC). Among the proposed solutions for ATC enhancement, the use of FACTS devices is reported considerably [4]. It can be said that the application of FACTS devices should be based upon the investigation of capital investment as well as operating costs and the impacts of these devices of ATC improvement [5]. On the other hand, the optimum placement of FACTS devices is an important issue in terms of planning horizon [4], especially considering different types of these devices. While from operating point of view the coordination among these devices is much of interest both by researchers and operation engineers.

II. TRANSMISSION CONGESTION MATHEMATICAL MODELLING

In order to study congestion problem, it is needed to define mathematical statements as a proposed model. Mathematical modeling that is implemented in this paper is based upon a multi-objective optimization problem in which some new constraints are added to a conventional optimization model that can be found in literature. In fact, the model includes different terms for objective function such as: improvement of voltage profile, reducing transmission losses and minimizing capital investment for FACTS devices incorporating ATC enhancement. The optimum location as well as the capacity of UPFC can be derived considering the role of these elements.

The study is carried out by implementing a performance index that can be defined as follow:

$$PI = \sum_{m=1}^{N} \frac{W_m}{2n} \left[\frac{PL_m}{PL_m^{\max}} \right]^{2n} \tag{1}$$

Where: Pl_m is real power transfer in line m, Pl_m^{max} is the maximum transfer capacity of line m, N is the number of lines in the network. Wm is a non-negative real number to show the importance of m^{th} transmission line that can be defined as weighting factor and n is defined as an operating index that is usually less that one. When all transmission lines work at their permissible conditions (non-congestion situation) PI is very low, while if one or more lines are congested it will be increased considerably. To calculate the real power transfer in line m, DC power flow is applied that is shown in the following relationship:

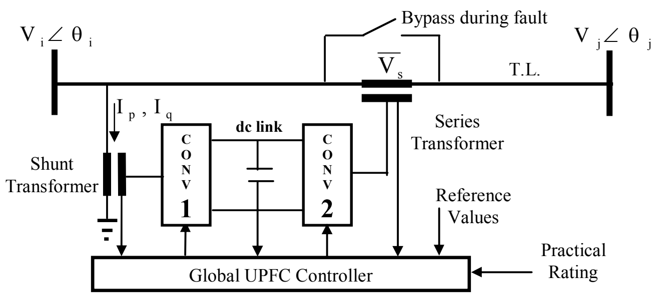
$$Pl_m = \left\{ \begin{array}{l} \sum_{n=1, n\neq s}^{N} S_{mn} P_n : m \neq k \\ \sum_{n=1, n\neq s}^{N} S_{mn} P_n + P_j : m = k \end{array} \right\} \quad (2)$$

The coefficients of S_{mn} is the mn^{th} component of matrix S that is used in DC power flow and P_n is the real power injected at bus n [6,7].

A. UPFC Mathematical Models

The UPFC, shown in Fig. 1, consists of two switching converters operated from a common DC link. Converter 2 performs the main function of the UPFC by injecting an AC voltage with controllable magnitude and phase angle in series with the transmission line. The basic function of Converter 1 is to supply or absorb the active power demanded by Converter 2 at the common DC link. This is represented by the current . Converter 1 can also generate or absorb controllable reactive power and provide independent shunt reactive compensation for the line. This is represented by the current . A UPFC can regulate active and reactive power simultaneously. In principle, a UPFC can perform voltage support, power flow control and dynamic stability improvement in one and the same device.

As shown in Fig 2, the two-voltage source converters of UPFC can modeled as two ideal voltage sources one connected in series and other in shunt between the two buses. The output of series voltage magnitude V_{se} controlled between the limits $V_{se\max} \leq V_{se} \leq V_{se\min}$ and the angle θ_{se} between the limits



$0 \leq \theta_{se} \leq 2\Pi$ respectively.

Figure 1. UPFC schematic diagram

The shunt voltage magnitude V_{sh} controlled between the limits $V_{sh\max} \leq V_{sh} \leq V_{sh\min}$ and the angle between $0 \leq \theta_{sh} \leq 2\Pi$ respectively. Z_{se} and Z_{sh} are considered as the impedances of the two transformers one connected in series and other in shunt between the transmission line and the UPFC as shown in the Fig 2 which is the UPFC equivalent circuit [8].

The ideal series and voltage source from the Fig 2 can written as

$$V_{se} = V_{se}(\cos\theta_{se} + j\sin\theta_{se}) \quad (3)$$

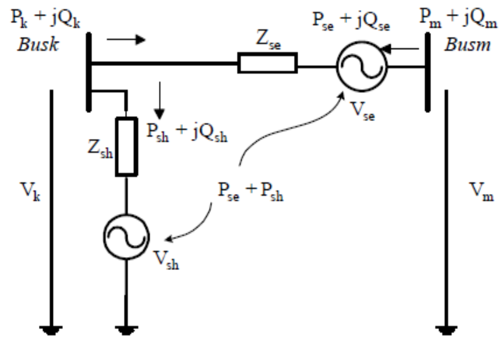


Figure 2. Equivalent circuit of UPFC [8]

$$V_{sh} = V_{sh}(\cos\theta_{sh} + j\sin\theta_{sh}) \quad (4)$$

The magnitude and the angle of the converter output voltage used to control the power flow mode and voltage at the nodes as follows:

1) The bus voltage magnitude can be controlled by the injected a series voltage V_{se} in phase or anti-phase.

2) Power flow as a series reactive compensation controlled by injecting a series voltage V'_{se} in quadrature to the line current.

3) Power flow as phase shifter controlled by injecting a series voltage of magnitude V''_{se} in quadrature to node voltage θ_m [9].

Based on the equivalent circuit as shown in Fig 2, the active and reactive power equations can be written as follows [6, 8]:

At node k:

$$\begin{aligned} P_k &= V^2{}_k G_{kk} + V_k V_m (G_{km}\cos(\theta_k - \theta_m) + B_{km}\sin(\theta_k - \theta_m)) \\ &+ V_k Vse(G_{km}\cos(\theta_k - \theta_{se}) + B_{km}\sin(\theta_k - \theta_{se})) \\ &+ V_k V_{sh}(G_{sh}\cos(\theta_k - \theta_{sh}) + B_{sh}\sin(\theta_k - \theta_{sh})) \end{aligned} \quad (5)$$

$$\begin{aligned} Q_k &= -V^2{}_k B_{kk} + V_k V_m (G_{km}\sin(\theta_k - \theta_m) - B_{km}\cos(\theta_k - \theta_m)) \\ &+ V_k V_{se}(G_{km}\sin(\theta_k - \theta_{se}) - B_{km}\cos(\theta_k - \theta_{se})) \\ &+ V_k V_{sh}(G_{sh}\sin(\theta_k - \theta_{sh}) - B_{sh}\cos(\theta_k - \theta_{sh})) \end{aligned} \quad (6)$$

At node m:

$$P_m = V^2{}_m G_{mm} + V_m V_k (G_{mk} \cos(\theta_m - \theta_k) + B_{mk} \sin(\theta_m - \theta_k)) + V_m V_{se} (G_{mm} \cos(\theta_m - \theta_{se}) + B_{mm} \sin(\theta_m - \theta_{se})) \quad (7)$$

$$Q_m = -V^2{}_m B_{mm} + V_m V_k (G_{mk} \sin(\theta_m - \theta_k) - B_{mk} \cos(\theta_m - \theta_k)) + V_m V_{sh} (G_{mm} \sin(\theta_m - \theta_{se}) - B_{mm} \cos(\theta_m - \theta_{se})) \quad (8)$$

Series converter:

$$P_{se} = V^2{}_{se} G_{mm} + V_{se} V_k (G_{km} \cos(\theta_{se} - \theta_k) + B_{km} \sin(\theta_{se} - \theta_k)) + V_{se} V_m (G_{mm} \cos(\theta_{se} - \theta_k) + B_{mm} \sin(\theta_{se} - \theta_m)$$

$$Q_{se} = -V^2{}_{se} B_{mm} + V_{se} V_k (G_{km} \sin(\theta_{se} - \theta_k) - B_{km} \cos(\theta_{se} - \theta_k)) + V_{se} V_m (G_{mm} \sin(\theta_{se} - \theta_m) - B_{mm} \cos(\theta_{se} - \theta_m)) \quad (9)$$

Shunt converter:

$$P_{sh} = -V^2{}_{sh} G_{sh} + V_{sh} V_k (G_{sh} \cos(\theta_{sh} - \theta_k) + B_{sh} \sin(\theta_{sh} - \theta_k) \quad (10)$$

$$Q_{sh} = V^2{}_{sh} B_{sh} + V_{sh} V_k (G_{sh} \sin(\theta_{sh} - \theta_k) - B_{sh} \cos(\theta_{sh} - \theta_k)) \quad (11)$$

Where

$$Y_{kk} = G_{kk} + jB_{kk} = Z^{-1}{}_{se} + Z^{-1}{}_{sh} \quad (12)$$

$$Y_{mm} = G_{mm} + jB_{mm} = Z^{-1}{}_{se} \quad (13)$$

$$Y_{km} = Y_{mk} = G_{km} + jB_{km} = -Z^{-1}{}_{se} \quad (14)$$

$$Y_{sh} = G_{sh} + jB_{sh} = -Z^{-1}{}_{sh} \quad (15)$$

Assuming a free converter loss operation, the active power supplied to the shunt converter P_{sh} equals to the active power demanded by the series converter P_{se} [8].

$$P_{se} + P_{sh} = 0 \quad (16)$$

Furthermore if the coupling transformers are assumed to contain no resistance then the active power at bus k matches the active power at bus m; that is,

$$P_{sh} + P_{se} = P_k + P_m = 0 \quad (17)$$

A multi-objective optimization model is represented as a compact form of Equations (7) [6,8].

$\min \dfrac{P_{ij}}{P_{ij\max}}$ Subject to the followings:

$$P_{gi} - P_{li} - \sum_{j=1}^{n} |V_i||V_j|(G_{ij-FACTS} \cos\delta_{ij} + B_{ij-FACTS} \sin\delta_{ij}) = 0$$

$$Q_{gi} - Q_{li} - \sum_{j=1}^{n} |V_i||V_j|(G_{ij-FACTS} \sin\delta_{ij} - B_{ij-FACTS} \cos\delta_{ij}) = 0$$

$$|V_i|_{\min} \le |V_i| \le |V_i|_{\max}$$

$$P_{ij} \le 0.8 P_{ij\max}$$

$$P_{gi\min} \le P_{gi} \le P_{gi\max} \quad (18)$$

$$P_{SVC} = 0$$

$$Q_{gi\min} \le Q_{gi} \le Q_{gi\max}$$

$$Q_{sh\min} \le Q_{sh} \le Q_{sh\max}$$

$$-0.5 X_{mn} \le X_{se} \le 0.6 X_{mn}$$

Where: P_{ij} is the real power flow through transmission line ij; $P_{ij_{\max}}$ is the maximum capacity of line ij; P_{li} is the actual real load supply at bus i; N is bus number of the system; P_{gi} is the real power generation at bus i; Q_{gi} is the reactive power generation at bus i; Q_{li} is the actual reactive load supply at bus i; |Vi| is the voltage magnitude at bus i; $G_{ij-FACTS}$, $B_{ij-FACTS}$ are the real/reactive part of the ijth element of the admittance matrix, which may be a function of the reactance of UPFC; δ_{ij} is the angle difference between the voltage at bus i and that at bus j; $Q_{gi_{mion}}, Q_{gi_{\max}}$ are the minimum/maximum reactive power generation at generation bus i ; $|V_i|_{\min}$, $|V_i|_{\max}$ are the minimum/maximum voltage magnitude at bus I; X_{se} is the reactance of UPFC; X_{mn} is the reactance of the line where UPFC has been installed; P_{sh} is the real power generation of UPFC; $Q_{sh_{\min}}, Q_{sh_{\max}}$ are the minimum/maximum reactive power generation of UPFC [9].

III. Solution Algorithm

Heuristic methods may be used to solve complex optimization problems. They are able to give a good solution of a certain problem in a reasonable computation time, but they do not assure to reach the global optimum. GA is a global evolutionary search technique that can result a feasible as well as optimal solutions. GA starts with a random initial population in order to select the best individuals. Crossover and mutation and selection all together are the functions of associated with GA to handle the evolutionary search reaching the best solution. Ordinary (binary) GA can be modified using real codes as real-GA (RGA), in which decoding is not needed to be done, while it may increase the speed and the accuracy of search process. The major issues of RGA can be addressed in crossover as well as mutation and selection stages. In the following those stages are explained in details [10,11].

A. Crossover

Crossover is one of the main features of RGA that makes it different from binary GA. Three kinds of convex crossover technique are used in this paper based on the following formulas [10]:

$$\begin{aligned} O_1 &= \lambda P_1 + (1-\lambda) P_2 \\ O_2 &= \lambda P_2 + (1-\lambda) P_1 \qquad \lambda \in \{0,1\} \end{aligned} \tag{19}$$

$$\begin{aligned} O_1 &= \lambda_1 P_1 + (1-\lambda_1) P_2 \\ O_2 &= \lambda_2 P_2 + (1-\lambda_2) P_1 \qquad \lambda_1, \lambda_2 \in [0,1] \end{aligned} \tag{20}$$

$$\begin{aligned} O_1 &= \lambda P_1 + (1-\lambda) P_2 \\ O_2 &= \lambda P_2 + (1-\lambda) P_1 \qquad \lambda \in [-0.25, 1.25] \end{aligned} \tag{21}$$

Where: P_1, P_2 are the two parents, O_1, O_2 are two their offspring and λ_1, λ_2 are two random numbers.

B. Mutation

Mutation is for introducing artificial diversification in the population to avoid premature convergence to a local optimum. An arithmetic mutation operator that has proved successful in a number of studies is dynamic or non-uniform mutation. It is designed for fine-tuning aimed to achieve a high degree of precision and applied in this paper. For a given parent P, if the gene P_k is selected for mutation, then the resulting gene is selected with equal probability from the two following choices:

$$\begin{cases} O_K = P_K - r(P_K + a_k)(1-\frac{t}{T})^b \\ O_K = P_K + r(b_k - P_K)(1-\frac{t}{T})^b \end{cases} \tag{22}$$

Where: a_k and b_k are lower band and upper band of P_k and r is a uniform random number chosen from (0,1). t is the number of current generation ,T is the maximum number of generation and b is the parameter determining the degree of non-uniformity, that is assumed to be 3. It can be said that non-uniformity decreases as the number of generations increases [10].

C. Selection

In general, selection is based upon a random choosing process, where one of the selection methods is known as roulette-wheel. Individuals are mapped to the adjacent segments of a line as it is shown in Figure 3. The length of each segment on this line corresponds to the fitness value of each individual. A random number will be generated and the individual whose segment spans the random number will be selected (trial). This technique is analogous to a roulette wheel with each slice proportional in size to the fitness value [10]. In the following fitness evaluation through hybrid technique is presented.

D. Evaluation of fitness value via Fuzzy AHP

The proposed technique for multi-objective goal function will include fuzzy sets theory (FST) [12] which characterized variable O on X by its membership as $\mu o(x)$: X→ [0,1]

And analytic hierarchy process (AHP) procedures as following

•FST to conform to mainly qualitative nature of decision factors.

•AHP is for determine importance degree of each alternative.

E. Calculation of exponential weighting values using AHP

Analytical hierarchy process (AHP) [13,14] is a method used to support complex decision-making process by converting qualitative values to numerical values. AHP's main concept of priority can be defined as the level of strength of one alternative relative to another. This method assists a decision-maker to build a positive reciprocal matrix of pair wise comparison of alternatives for each criterion. A vector of priority can be computed from the eigenvector of each matrix. The sum of all vectors of priorities forms a matrix of alternative evaluation. The final vector of priorities can be calculated by multiplying the criteria weighted vector by matrix of alternative evaluation. The best alternative has the higher priority value. Here a pair wise comparison matrix is constructed to evaluate the relative importance of the variable. The relative importance of each objective or constraints can be obtained using paired comparison of the elements taken two at a time [14]. This method can be used to obtain the exponential weighting values that properly reflect the relative importance of the objective criteria and constraints entering a problem. For the purpose of determining variable importance, the paired comparison matrix P with the following properties is performed: A squared matrix of order equal to the sum of constraints number. The diagonal elements are 1and $p_{ij} = \frac{1}{p_{ji}}$

The off-diagonal elements are specified by looking at the table of impotence scale [15]. For example, if object i is less important than object j then p_{ij} =3, while if it is absolutely more important, then p_{ij} =9, and so on. To compare a set of N objects in pairs according to their relative weights, the pair wise comparison matrix can be expressed as:

$$P = [p_{ij}] = \left[\frac{w_i}{w_j} \quad i = 1,2,..., N \quad j = 1,2,..., N \right] \tag{23}$$

Where $\frac{w_i}{w_j}$ refers to the ij[th] entry of P which indicates how element i is compared to element j. In order to find the vector of weights w= $[w_1\ w_2\ .\ .\ .\ w_N]^T$ we multiply matrix P by the vector W to get:

$$PW = \left[\frac{w_i}{w_j} \right] [w_i] = \left[\sum_{i=1}^{N} w_i \right] = N[w_i] \tag{24}$$

$$\therefore PW = NW \quad \& \quad (P - NI) = 0$$

The nontrivial solution of the last equation is obtained by solving this eigenvalue problem. Moreover, P has a rank of one because columns (rows) are really dependent on the first column (row), which concludes that all eigenvalues are zero except a nonzero eigenvalue referred as to λ_{max}. The estimates of weights for the compared elements can be found by normalizing the eigenvector corresponding to the largest eigenvalue [15].

F. Constraints with unequal importance

In case where constraints are of unequal importance it should be ensured that alternatives with higher levels of importance and consequently higher memberships are more likely to be selected. The positive impact of the levels of importance, w_i, on fuzzy set memberships is applied through the proposed criterion. It can be realized by associating higher values of w_i to constraints. For example, the more important alternative the higher the value associated with it. For example to evaluate fitness function in RGA, it should have higher value for important alternative for this case above process applied as below:

$$Fitness = \mu_{c_1}^{w_1}(x) + \mu_{c_2}^{w_2}(x) + \ldots + \mu_{c_N}^{w_N}(x) \quad (25)$$

IV. Case Study and Results Analysis

A modified IEEE 5-bus system including 3 generators and 2 loads is selected to implement the proposed methodology for congestion management. This system is simulated using Power World software and MATLAB R2010b software. where the base MVA and base voltage are assumed to be 100 MVA (Appendix1). In order to enhance power transfer in the congested line, firstly the best location of FACTS devices is derived and control parameters of the allocated devices are then adjusted. All the Algorithm is shown in the flowchart given in Appendix 2.

A. Modified IEEE 5-Bus System with Congestion

As it can be seen in Figure (3), under normal condition, maximum real power is transferred through line 2-1 by amount of 87% of the permissible line capacity.

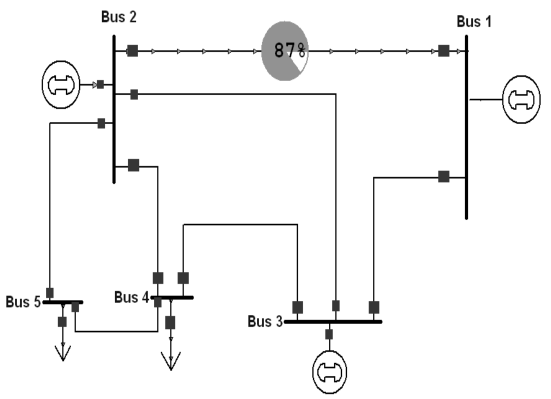


Figure 3. Modified IEEE 5-Bus System with Congestion

Voltage profile of modified IEEE 5-bus system is shown in Figure (4), where at bus 5 the magnitude of bus voltage is 0.9647 pu. Congestion can be taken into account if real power transfer increases 80% of the line thermal capacity [16]. By considering congestion condition, it can be said that from congestion point of view there is no security violation while from voltage profile point of view this system needed to be compensated.

B. Voltage Profile Improvement and Congestion Relief Using UPFC

In this case goal function includes three objectives: voltage profile, Congestion value and series and parallel capital costs. Optimization process tries to relief congestion besides improving voltage profile considering less cost. Multi-objective optimization is handled via fuzzyfying objective function terms. In this respect, membership functions of objective terms are needed to be defined. Typical membership function for voltage of each bus is depicted in Figure (5), while Figure(6) shows congestion membership.

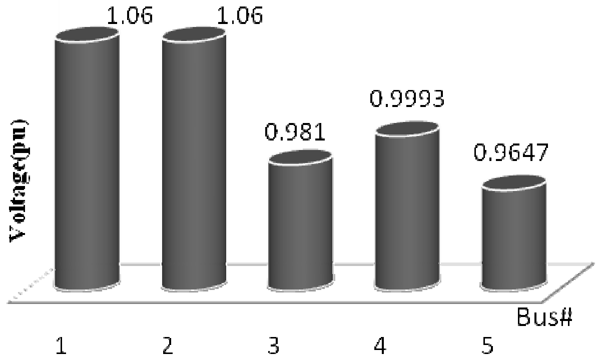


Figure 4. Buses Voltage Profile

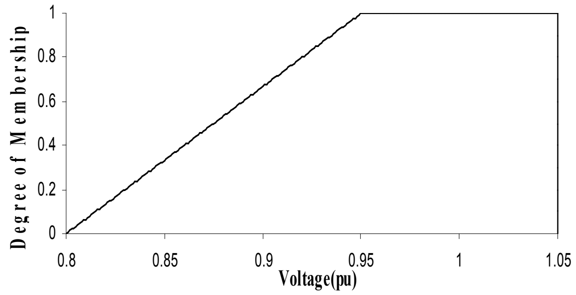


Figure 5. Membership of Bus Voltages

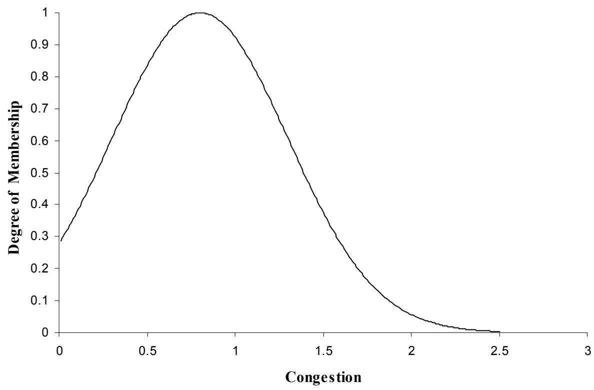


Figure 6. Membership of Congestion value

The membership of capital costs for UPFC are assumed as shown in Figures (7) and (8) respectively.

In fact, congestion should be relived satisfying minimum capital costs of UPFC while reaching best voltage profile. Moreover, considering AHP criterion, priority factors of objective terms should be derived. It is assumed that congestion is very strong important than voltage profile, while it is absolutely important than the costs of FACTS devices. It can be interpreted that: P_{12}=7, P_{21}= $\frac{1}{7}$,.P_{13}=9, P_{31}= $\frac{1}{9}$

The statement "voltage profile is highly more important than costs of UPFC "indicates:

P_{23}=5, P_{32}=1/5. In this study the priority matrix is evaluated as following:

$$P = \begin{bmatrix} 1 & 7 & 9 \\ \frac{1}{7} & 1 & 5 \\ \frac{1}{9} & \frac{1}{5} & 1 \end{bmatrix}$$

The following weighting (W) vector is obtained via some matrix manipulations.

W=En= [0.97337 0.21867 0.068775]T

Fitness value of RGA can be evaluated using Fuzzy-AHP as: $\text{Fitness} = \left\{C_1^{w_1}(x) + C_2^{w_2}(x) + C_3^{w_3}(x)\right\}$

Where C_i is the membership of i^{th} alternative and W_i is exponential weight of i^{th} alternative.

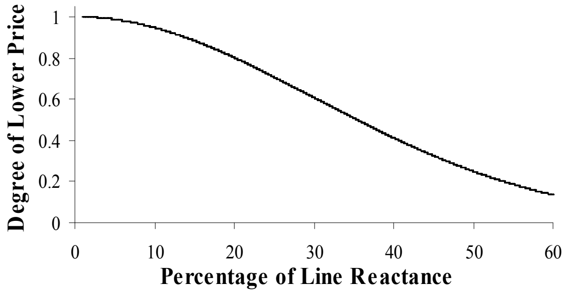


Figure 8. Membership of Series Capital Costs

This procedure can determine the fitness of RGA for each chromosome considering the importance of each constraint as well as objective term. Recombination rate of 76%, mutation rate of 3% and regeneration of 21% considering ellipsis is Maximum eigenvalue of this matrix is λmax =3.0803 which is approximately equals to the number of three variables. Implementing RGA with the recombination rate of 76%, mutation rate of 3% and regeneration of 21% considering ellipsis is applied as it is depicted in Figures(9) and(10). These figures show the best solution is obtained after 58 generation.. It can be realized that line 3-4 is the candidate for UPFC locations. In this regards the best capacity of those FACTS device is 47.6% of line reactance which is equal to 0.01428 pu and 15.61 MVAr for respectively.

By installing UPFC at their location, power transfer at line 2-1 decreases to 63% of its maximum capacity and the worst voltage is 0.9803 which belongs to bus 5, while it is improved significantly. (Appendix 3)

Figure (11) shows bus voltage profile using the allocated FACTS device

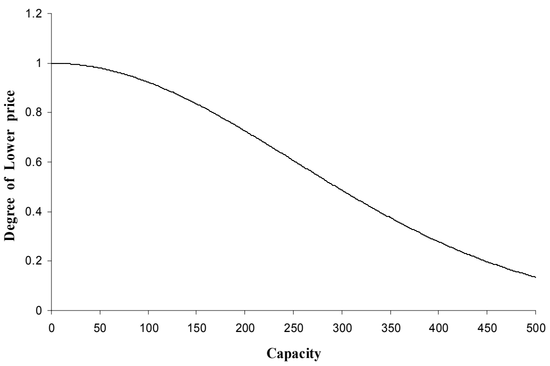


Figure 7. Membership of Shant Capital Costs

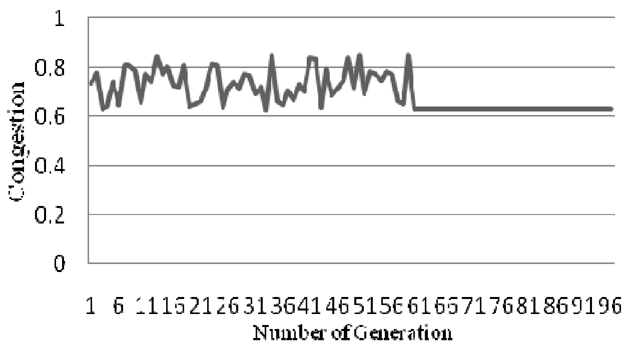


Figure 9. Congestion Variations versus Number of RGA Generation

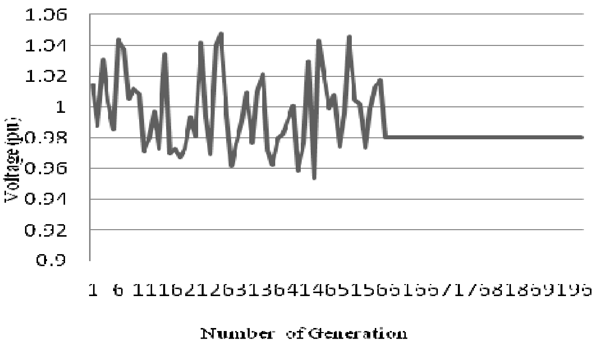


Figure 10. Voltage Variations versus Number of RGA Generation

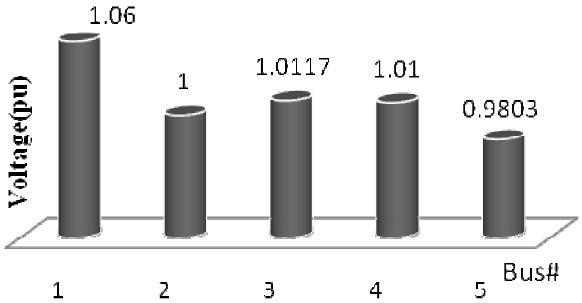


Figure 11. Buses Voltage Profile Using proposed UPFC

V. CONCLUSIONS

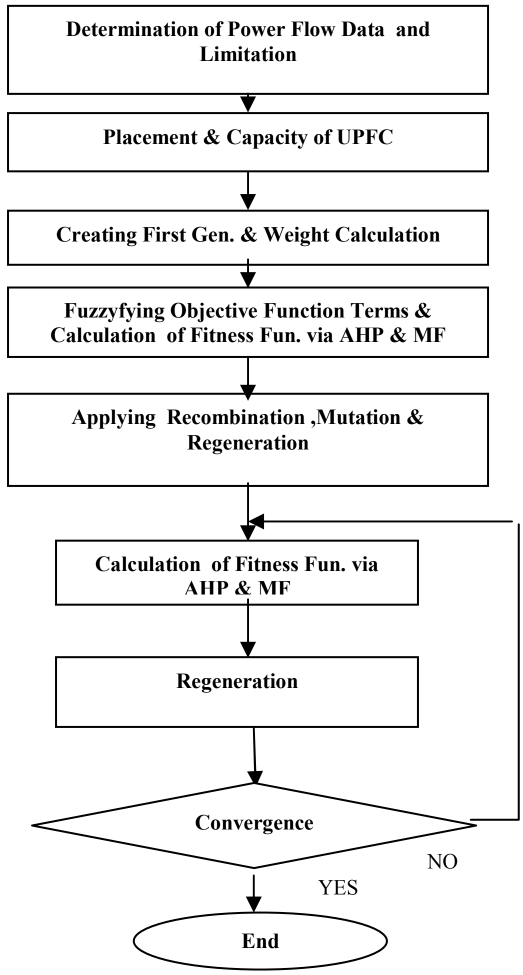
Congestion management is an important issue in the reregulated environment of power systems. Congestion should be relieved in order to use the maximum capacity of transmission networks. It is well known that FACTS technology can control voltage magnitude, phase angle and circuit reactance clearly. Using these devices may redistribute the load flow associated with regulating bus voltages. Therefore, it is worthwhile to investigate the effects of FACTS controllers on the congestion management.

UPFC is the main commercially available FACTS controllers. This paper presents an implementation of the RGA associated with Fuzzy-AHP to determine the location and capacity of these devices. The proposed methodology is employed incorporating dimensional serialization valuing mechanism. Case studies and the obtained results show the effectiveness of the suggested criterion significantly.

APPENDIX 1

Line Index	From	To	R(pu)	X(pu)
1	1	2	0.00244	0.06
2	1	3	0.00101	0.24
3	2	3	0.01473	0.18
4	2	4	0.01473	0.18
5	2	5	0.00204	0.12
6	3	4	0.00110	0.03
7	4	5	0.00101	0.24

APPENDIX 2



APPENDIX 3

Line	From	To	Congestion without UPFC	Congestion with UPFC
1	1	2	%87	%63
2	1	3	%40	%22
3	2	3	%25	%9
4	2	4	%28	%20
5	2	5	%54	%51
6	3	4	%20	%40
7	4	5	%5	%9

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