Improvement in Voltage Stability with UPFC Using Bees Algorithm, Neuro-Fuzzy and NN

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Abstract
To maintain power stability in transmission line, We go for external device to maintain and to regulate voltage. FACTS device plays vital role in the power flow control and system stability optimization in the transmission line. Unified Power Flow Controller (UPFC) is a common FACTS device whose performance is based on the controller used in the Specified bounds " Maintaining Voltage Stability With UPFC Using Bees Algorithm, Neuro-Fuzzy and NN" addresses the allocation optimization based on the Voltage stability to place UPFC in power system and rated using bee and Neural Network in optimization method. Here, the Neural network (NN) is used to identify the prime location for fixing FACTS controller. Neuro-fuzzy is used to Filter the output from NN and find the optimizes result for fixing facts controller. Bees algorithm or Bee colony is used to calculate the amount of voltage and angle to be injected in the system. The results obtained using Bees algorithm, Neuro Fuzzy and Neural Network. Simulation carried out on an IEEE - 9 bus system on different load condition.

Key words: Bees algorithm, Neuro-fuzzy, Neural Network (NN), UPFC

1. Introduction

Electric-power transmission is the bulk transfer of electrical energy, from generating power stations to substations located near demand centers. This is distinct from the local wiring between high-voltage substations and consumer, which is normally referred to as electric power distribution. Transmission lines, when interconnected with each other, become transmission networks. The combined transmission and distribution network is known as the "power grid", the network is known as the "National Grid". Transmission lines are complex and can contribute to voltage regulation in a significant way. A longish transmission line is a combination of inductance, capacitance, conductance and resistance. The longer the line, the higher the values of these parameters. The inductance is due to current flow (basically an effective 'single turn'); the capacitance is less for aerial wires but much higher for cables. Conductance can be very low for aerial wires but can be affected by surface leakage on insulating posts. The result of these distributed parameters can be dramatic. So to maintain voltage stability and to reduce losses, we use FACTS devices[1].

FACTS (FLEXABLE AC TRANSMISSION SYSTEM) is one aspect of the power electronics revolution that is taking place in all areas of electric energy FACTS devices can be an alternative to reduce the flows in heavily loaded lines, resulting in an increased loadability, low system loss, improved stability of the network, reduced cost of production and fulfilled contractual requirement by controlling the power flows in the network [2]. FACTS technology, namely Static Var Compensator (SVC), Static Synchronous Compensator (STATCOM), Thyristor Controlled Series Capacitor (TCSC), Thyristor Controlled Phase Shifter (TCPS), Static Synchronous Series Compensator (SSSC) and Unified Power Flow Controller (UPFC) etc., the bus voltages, line impedances and phase angles in the power system are controlled swiftly and flexibly[3] [4].
Unified Power Flow Controller (UPFC) is an electrical device for providing fast-acting reactive power compensation on high-voltage electricity transmission networks. It uses a pair of three-phase controllable bridges to produce current that is injected into a transmission line using a series transformer. The controller can control active and reactive power flows in a transmission line. The UPFC uses solid state devices, which provide functional flexibility, generally not attainable by conventional thyristor controlled systems. The UPFC is a combination of a static synchronous compensator (STATCOM) and a static synchronous series compensator(SSSC) coupled via a common DC voltage link. The UPFC allows a secondary but important function such as stability control to suppress power system oscillations improving the transient stability of power system [5].

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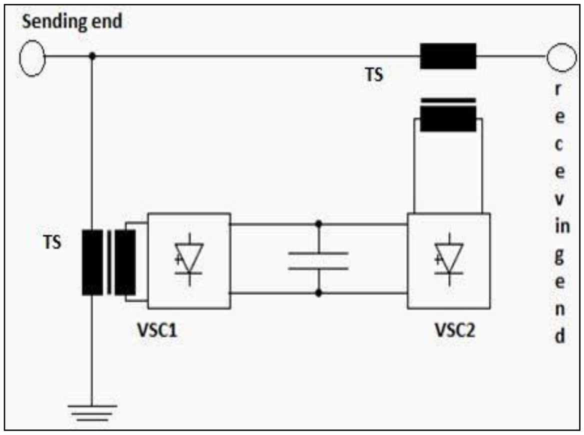

Figure 1: Basic diagram for UPFC

The word "optimization" shares the same root as "optimal", it is rare for the process of optimization to produce a truly optimal system. The optimized system will typically only be optimal in one application or for one audience. Selecting of best element or value in available output from generated system. Two different techniques is used for identifying the locality for fixing FACTS controller in the system and also the amount of voltage and angle to be injected in the system. The rest of the paper is organized as follows: Section 2 reviews the recent related works briefly; Section 3 details the proposed technique; Section 4 discusses the implementation results; and Section 5 concludes thepaper

2. RelatedWork

Marcos Pereira and Luiz Cera Zanetta et al [6], deals with an alternative proposition for the steady state modeling of unified powerflow controller (UPFC).Since current limitations are determinant to FACTS apparatus design, the proposed current based model (CBM) assumes the current as variable, allowing easy manipulation of current restrictions in optimal powerflow evaluations. The power injection model (PIM) is compared through a Quasi-Newton optimization approach. Two operating situations of a medium size network with 39 busbars were studied from the point of view of optimization and current limits, observing the performance of the UPFCmodelling

K. VENKATESWARLU et al [7], presents a GA and PSO analysis based allocation algorithm for Unified Power Flow Controller (UPFC) considering Cost function of UPFC device, Voltage stability indices(VSI) for optimal placement, Improvement of voltage profile and Reduction of power system losses. Proposed algorithm is tested on a IEEE- 5 bus and IEEE-30 bus test power system for optimal allocation of UPFC device.

Satakshi Singh et al [8], has made a new techniques using UPFC in OPF .UPFC allows the control of active and reactive powers and voltage magnitude simultaneously. It can also be set to control one or more of these parameters in any combination or to control none of them. Considerable progress has been achieved in UPFC modelling intended for conventional load flow studies but here more complex issue of UPFC modelling intended for OPF (OPTIMAL POWER FLOW) solution is addressed.

P.RAMESH, Dr.M.DAMODARA REDDY et al [9], proposed to reduce Losses through optimal placement of Unified Power-Flow Controller using Firefly Algorithm placing the UPFC, Firefly optimization method is used for finding the rating of UPFC. The Firefly optimization method is compared with Genetic Algorithm. This has shown the proposed method has more advantage in reducing the losses and this has done with IEEE- 14 Bus and IEEE- 30 Bus test system for normal and 150% loading conditions.

Ch.Chengaiah et al [10], A new approach in considered using Fuzzy Logic Controller (FLC) to evaluate the degree of severity of the considered contingency and to eliminate the masking effect. The purpose of Optimal Power Flow (OPF) is to calculate the recommended set points for power system controls to trade-off between security and economy. The Newton Raphson (NR) method is considered to obtain Optimal Power Flow. It can be obtained either in a preventive or corrective mode. The preventive mode of OPF is used to provide suggested improvements for selected contingency cases. The selection of suitable locations for UPFC, use the criteria on the basis of improved system security and Optimized Power flow. The approach is tested on IEEE-14 bus system.

PRAKASH G.BURADE et al [11], proposed a new idea For optimal location of facts devices in the deregulated power system by using GA. The optimization of facts devices in a right location increases the loadability of the system and genetic algorithm can be effectively used for this kind of optimization. This algorithm is suitable to search several possible solutions simultaneously. Further, this algorithm is practical and easy to be implemented into the powersystem

3. ProposedMethod

3.1. BeesAlgorithm

The Bees Algorithm is an optimisation algorithm

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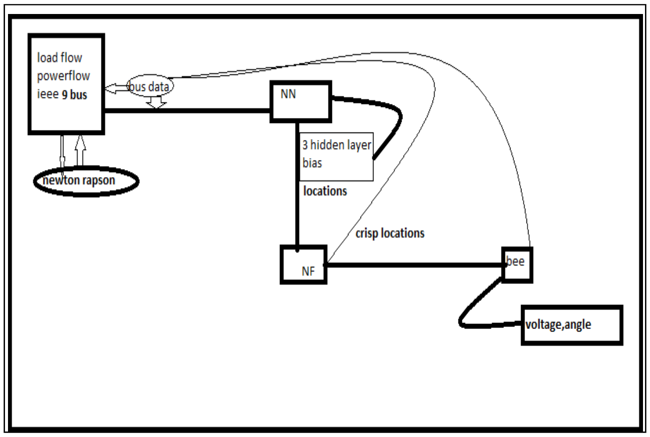


inspired by the natural foraging behaviour of honey bees to find the optimal solution. A colony of honey bees can extend itself over long distances in multiple directions [12].It is used to find the angle and amount of voltage to be injected.

Pseudo code of the algorithm in its simplest form

- Initialise population with randomsolutions.
- Evaluate fitness of thepopulation.
- Select sites for neighborhoodsearch.
- Recruit bees for selected sites and evaluatefitnesses.
- Select the fittest bee from eachpatch.
- Assign remaining bees to searchrandomly.

Bees algorithm is used to identify the amount of voltage and angle to be injected in UPFC [13].

Figure 2: Block Diagram of Proposed Method

3.2. NeuralNetwork

The Optimization is done using bees algorithm, neural network and Neural –Fuzzy. Analysis load flow or power flow with help of newton-raphson method..Neural Network is used to find the optimal location. In neural network by using the singular value decomposition method, a Radial Basis Function (RBF) neural network is trained to map the operating conditions of power systems toa voltage stability indicator and contingency severity indices corresponding to transmission lines. The advantages of RBF neural network are demonstrated by applying it to contingency ranking and voltage stabilityassessment.

The firing rule is an important concept in neural networks and accounts for their high flexibility. A firing rule determines how one calculates whether a neuron should fire for any input pattern. It relates to all the input patterns, not only the ones on which the node was trained the neural network of feed forward technique with one hidden layer is given to neuro-fuzzy. Newton-Raphson Method using load flow. This method cathes scent of the root. It is used

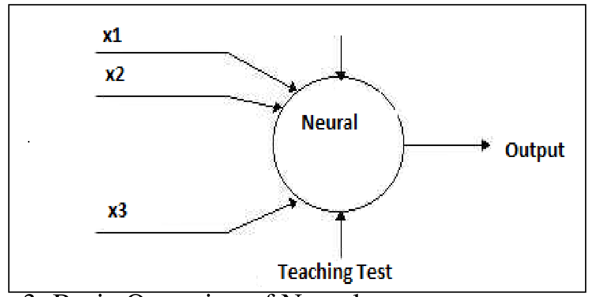


Figure 3: Basic Operation of Neural Network

to finds the perfect value. This method is based on local information namely (f(xn)). Formulate the Newton-Raphson Power-Flow Algorithm.

- Treat all buses as P-Q typebuses.
- Handle bus-type switching (i.e., P-Q to P-V and vice versa) by modifying theJacobian.
- Define the PG-PL=P (injected into thebus).

The real and reactive power balance equations are:

$$0=P_i - V_i\sum_k\left[G_{ik}\cos(\theta_{ik})+B_{ik}\sin(\theta_{ik})\right]V_k$$

$$0=Q_i - V_i\sum_k\left[G_{ik}\sin(\theta_{ik})-B_{ik}\cos(\theta_{ik})\right]V_k$$

Where sending end bus, Vi &Vk are the voltage at i & k bus respectively, k is the receiving end bus, Gij & Gij B are the conductance and susceptance values respectively and θ ij is the angle between i & k bus.

Newton Raphson Method Differs in Dimension

Power flow calculation is the backbone of power system analysis and design. It generates the results that are normally required for further calculation of analysis and design. This is initially performed by formulating the network equation. Node-voltage method, which is the most suitable form for many power system analyses, is

$$x_2 \leftarrow x_1 + f(x_1, y_1) / f_x(x_1, y_1)$$

$$y_2 \leftarrow y_1 + f(x_1, y_1) / f_y(x_1, y_1)$$

$$r_2 = (x_2, y_2)$$

commonly used.

3.3. Neuro-Fuzzy

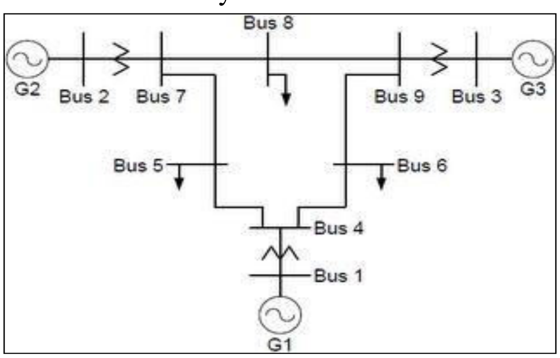
The proposed fuzzy approach uses the NN fit values as post contingent quantity in addition to bus voltage profiles to evaluate contingency ranking. The bus voltage profile and NN fit values are expressed in fuzzy set notation. The fuzzy rules are used to evaluate the severity of each post contingent quantity. The Fuzzy inference structure is tested in MATLAB fuzzytoolbox.

Contingency ranking based reasoning approach has been developed for the fuzzy set in order to eliminate the "Masking Effect". The contingency analysis is carried out using FDLF method. A contingency ranking method for detecting voltage problems is proposed.

4. Experimental Result andDiscussions

The crisp output from Neuro-Fuzzy is given to bees algorithm as input for the angle of voltage, phase angle, magnitude and amount of voltage to be injected is calculated and injected accordingly. In addition greedy selection is deployed to obtain precise output that injects and FACTS Controller (UPFC).

Figure 4: IEEE 9-Bus System



The proposed hybrid technique is implemented in the working platform of mat lab 7.12 and tested using the IEEE 9 bus system. The IEEE 9 bus system is taken from dataset is shown in fig 4.This bus system contains of 9-bus, contains 3 generators, 6 lines, 3 loads and 3 two winding power transformers. Bus 1 is considered as slack bus, buses3, and 2 are considered as the generator bus, and all other buses are load bus. Now we see about the voltage profile (i) for normal load condition, (ii) after sudden increase in the power in bus 4 & 5, .The load conditions considered in the proposed method are sudden load increase in bus 5. Initially, the voltage profile at normal load condition is given and after sudden increase in load in buses 5 individually, the voltage profile of the system getreduced.

Table 1: Result for IEEE 9 Bus System Losses with UPFC

Aspect Total losses with UPFC MW	Norma l Load MW	Sudden increase in Load MW
UPFC Location	4-5	4-5
Genetic algorithm(GA)	12.560	12.17 3
Bees with Neuro-Fuzzy	12.560	11.98 0

Table 2: Voltage in IEEE 9 Bus System for Different Load Condition

BU S NO	NR Method p.u	Sudden increasein bus 5 MW	Proposed Method with UPFC connected Bus 4-5 MW
1	1.630	1.631	1.628
2	1.054	1.053	1.054
3	1.250	1.240	1.260
4	1.400	1.331	1.550
5	1.210	1.190	1.355
6	1.0271	1.0270	1.0271
7	0.992	1.01	1.00
8	1.017	1.017	1.017
9	1.033	1.035	1.033

The Table 2 shows that various results of comparing the voltage at buses with normal load and with sudden increase in load. It is seen that there was a sudden increase in bus 5 for which GA and proposed method is implemented for the distinct result. sudden increase in load power controller using proposed method, the voltage profile becomes decreased while comparing with normal load case, and after connecting UPFC using the propose Then, using the proposed method, the voltage profile in most of the buses remains as stable. Resulting, we see about the total power loss in the system for different load is gradually dercreased when compared to othermethod.

5. Conclusion

The Proposed Technique was implemented in MATLAB and tested for IEEE 9 bus system. The results show that the proposed method improves the load power in the system. An efficient proposed technique was devised to determine the optimal location for placing FACTS controller in the system and to compute the voltage and angle to be injected. The system was tested by sudden increase in load in bus 5 and corresponding readings for analysis with GA and proposed method with normal load and non-linear loads. It is cleary seen that Bees and Neuro-fuzzy, Neural-Network technique has made the system to remain stable by increasing the voltage at all buses and diminishing the total power losses in the system. Finally, the proposed method has identified the FACTS controller used for maintaining the system stability for maintaining the system stability.

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