International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
ISNCESR-2015 Conference Proceedings

# Application of Soft Computing Techniqes (ANN) to Power Systems

Mithilesh Singh
Electronics & Electrical Engg
KITE, Raipur
Chhattisgarh, India

Dr. Shubhrata Gupta
Professor, Electrical Engg
National Institue of Technology, Raipur
Chhattisgarh, India

***Abstract*** **-The achievements of soft computing techniques are massive fast speed, high fault tolerance and adaptive capability. So all these have attraction for controls and power systems fields to artificial neural network solutions to some of their more complicated or unsolved problems. This paper gives a brief overview of ANN and application of power system such as load flow, load forecasting and power quality related issues is shown by modeling and simulation and analysis with feed forward neural network has been tested and results are presented.**

***Keyword: ANN, load flow, load forecasting***

## I. INTRODUCTION

Soft computing techniques have been studied for many years and achieving computational performance. The achievements benefits include massive fast speed, high fault tolerance and adaptive capability. The soft computing techniques include ANN, fuzzy logic, and particle swarm etc.

Artificial neural networks (ANN) applications to power systems can be categorized as regression, classification and combinatorial optimization. Applications involving regression include transient stability analysis, load forecasting, harmonic evaluation Applications involving classifications include harmonic load identification, static and dynamics analysis. The area of combinational optimization includes unit commitment and capacitor control Artificial neural network are made up of simple highly interconnected processing units called neurons each of which perform aggregation of its inputs from other neurons and generation of an output from the aggregated inputs.

A connection between a pair of neurons has an associated numerical strength called synaptic weight. The development of ANN involves two phases: training or learning phase and testing phase. Training of *ANN* is done by presenting the network with examples called training patterns. During training, the synaptic weights get modified to model for that problem. As the network has learnt the problem it may be tested with new unknown patterns and its efficiency can be checked. Depending upon the training Imparted, ANN can be classified as supervised ANN and unsupervised ANN [1-5].

The supervised ANN requires the sets of inputs and the outputs for its training. During the training, the output from the ANN is compared with the desired output (target) and the difference (error) is reduced by employing some learning algorithm. This training is repeated till the actual output acquires an acceptable level. Supervised ANN may be a feed forward or non recurrent network such as Multi Layer Perceptron (MLP), Functional Link Net and Radial Basis Function, or a feedback or recurrent ANN. The capacity of adaptation to system data and the facility to perform new tasks are some of the advantages of these techniques. ANNs are parallel structures that usually require small amounts of memory and processing time. ANNs can store knowledge in a distributed fashion and consequently have a high fault tolerance. Learning algorithms used to train ANNs can be supervised or unsupervised. In supervised learning algorithms, input and output pairs are furnished and the connection weights are adjusted with respect to the error between desired and obtained output.

The artificial neural network which does not require a supervisor or teacher for training is known as unsupervised ANN. In competitive or unsupervised learning units of the output layer compete for the chance to respond to a given input pattern. The examples of unsupervised learning are Kohonen's Self-organizing Feature Map and Adaptive Resonance Theory. The back propagation learning algorithm is the most frequently used method in training the networks, and proposed as an electrical load forecasting methodology in this paper. For the completeness of the paper, the back propagation algorithm will be introduced briefly. The backpropagation learning algorithm is a generalization of the Widrow-Hoff error correction rule. The original Widrow-Hoff technique formed an error signal, which is the difference between what the output is and what it was suppose to be, i.e., the reference or target output. Synaptic strengths, or weights, were changed in proportion to the error times the input signal, which diminishes the error in the direction of the gradient. In a multilayer network (Fig. 2) containing hidden units, that is, units that are neither input nor output units, the problem is much more difficult. The error signal can be formed as before, but many synapses can give rise to the error, not just the ones at the output units. We cannot directly compute the error signal for hidden units because we not know the target outputs of the hidden units [6-7].

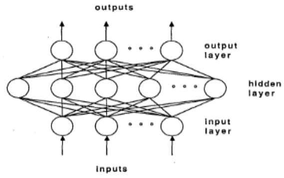


Fig. 1 Feed forward neural network

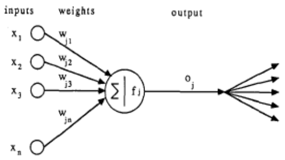


Fig. 2 Mathematical Model of A Artificial Neuron

## II. ANN Applications To Power Systems

Several key features of neural networks techniques are learning by example in real time, distributed memory, fault tolerance and graceful degradation, real time pattern recognition, intelligent association and synthesis.

Load forecasting is a suitable problem for ANN application due to the availability of historical load data on the utility databases. ANN schemes using perceptron network have been successful in short-term as well as long-term load forecasting with impressive accuracy. A combined use of Unsupervised and supervised learning was done for short-term load forecasting. The load data were analyzed and the load patterns were classified. The current load is affected by the past loads and the pattern in which the current load is included.

The total number of training examples depends on the mentioned limits and assumptions, on the network architecture and the expected result error. The learning process of the neural network is performed for different states of the external network, as the states of the internal network are always known. A multi-layer neural network with a backpropagation learning algorithm was used [8-10].

*Load Flow:* LF is a must for solving a large number of power system problems. Load flow method based on MLP model with real and reactive load demands at load Buses as inputs. The output nodes provided $|V|$ and $\partial$ at all PQ buses [11].

*Load forecasting:* Load forecasting is a suitable problem for ANN application due to the availability of historical load data on the utility databases. ANN schemes using perceptron network have been successful in short-term as well as long-term load forecasting with impressive accuracy. A combined use of Unsupervised and supervised learning was done for short-term load forecasting. The load data were analyzed and the load patterns were classified. The current load is affected by the past loads and the pattern in which the current load is included.

Power System Voltage Stability and Voltage Control are emerging as major problems in the day-to-day operation of stressed power systems. For secure operation and control of power systems under normal and contingency conditions it is essential to provide solutions in real time to the operator in Energy Control Center (ECC). The artificial neural networks (ANN) are emerging as an artificial intelligence tool, which give fast, though approximate, but acceptable solutions in real time as they mostly use parallel processing technique for computation. The solutions thus obtained can be used as a guide by the operator in ECC for power system control [12-15].

## III. Power Quality Improvement

The power quality is a major issue in a power system. It is important to develop the equipment that can mitigate the problem of poor power quality generated by non linear loads such as adjustable speed drives, traction drives and power converters have contributed for the deterioration of the power quality and this has resulted in to a great economic loss. Because of poor power quality many damages to the system, and causes economical impact on the utilities and customers. The power filters which reduced or mitigated the problems of harmonics. The harmonics distortion caused by non-linear load and saturation of magnetization of transformer. The current generated by such load which interacts with power system impedance which causes rise to harmonics. Increase of power losses, and malfunction in communication system due to degradation of power quality at the consumer's terminal,

New strategies requires for operation and management of electric grid, to improve the power quality norms because increasing number of renewable energy sources and distributed generator sources. IEC 61400-21 describe the -procedure of determining the power quality characteristics and it stated that the 10 minute average of voltage fluctuation should be within +/- 5% of nominal value. Voltage Dips on the Grid is due to sudden reduction of voltage to a value between 1 % & 90 % of nominal value after a short period of time, conventionally 1 ms to 1 min. By improvement in switching techniques, the voltage and current at the point of common connection can be made in sinusoidal form and at unity power factor so as to improve the power quality at PCC. Power quality issues are voltage fluctuation on grid, switching operation at the grid, voltage dips on the grid, reactive power, and harmonics.

Voltage collapse study aimed to maximize the loading capability of a particular transmission line. Traditionally shunt and series compensators are used to improve transfer capability of a transmission line. To provide steady state voltage control as well as to minimize transmission losses and enhance power system stability by used of reactive power control method. At present different FACTS devices such as Dstatcom, Dvr, Tcsc and Upfc are used to mitigate the power quality problems such as voltage sag, voltage swell. The FACTS devices control the voltage magnitude and phase angle, at chosen buses or line impedances. The artificial neural network detects the power quality problem which applies to Facts devices to mitigate voltage sags or voltage swell [8_13].

## IV. Simulation Model And Results:

The mat lab simulation model given below in fig. 3 consist of 25 KVA, 11/ 33 KV, 50 Hz three phase system and two three phase parallel RLC load 25 KW, 25 KW and 30 MW asynchronous machines are connected . The first simulation is carried out when transition time (sec.) of three phase breaker S1, S2 and S3 are set at 1 so sinusoidal voltage and current wave are obtained in scope fig. 4. The second simulation is carried out to obtain voltage sag, for three phase breaker S1 the transition time(s) set at 0.3 to 0.6s while S2 and S3 are remains set at 1s shown in fig. 4, results voltage sag and is saved in workspace. To obtain voltage swell, transition time (s) of three phase breaker S3 set at 0.4 and 0.7s while S1 and S2 remains same at 1sec., so results obtained voltage swell which saved in workspace.

The results obtained of Voltage sag and swell are inputs for artificial neural network while the pure sinusoidal wave obtained when first simulation is carried out is target to artificial neural network shown in fig.5. The results of voltage sag and voltage swell are input to neural network while sinusoidal voltage and current wave are target output to neural network applied to matlab simulation, there after training of ANN starts. The artificial neural network successfully detects the power quality problem. The neural network view shown in fig 6. The performance plot of Ann after training is shown in fig 7. The training sate is shown in fig.8.

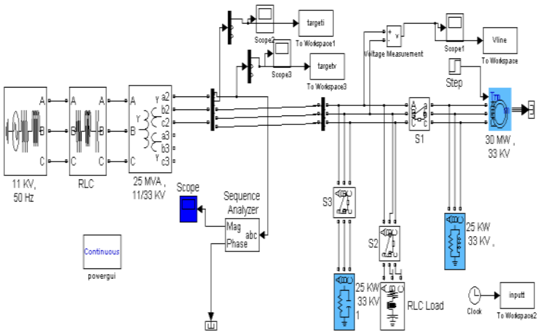

Fig. 3 Mat lab Simulation model for detection of Voltage Sag and Voltage Swell

Here the best validation performance obtained is 0.0018033 at epoch 6.Gradient is 7.3808e-006 at epoch 12 and validation check at epoch 12. The error obtained shown in fig. 9.

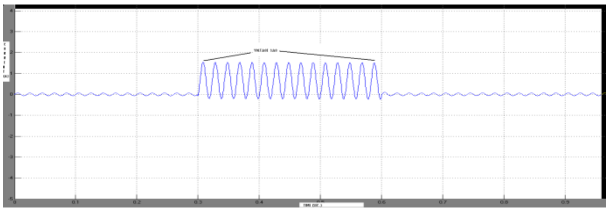

Fig.4 Current wave form as input to ANN

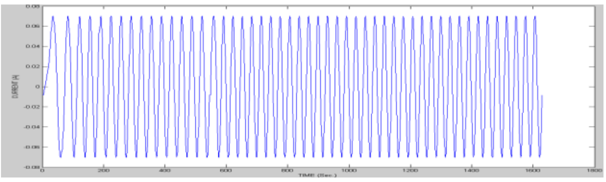

Fig.5 Waveform of current as Target to ANN

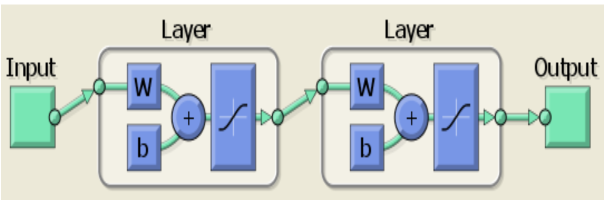


Fig. 6 The Neural Network View

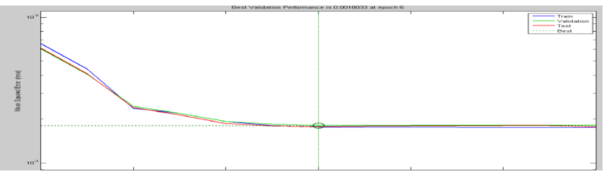

Fig: 7 Training Performance of ANN

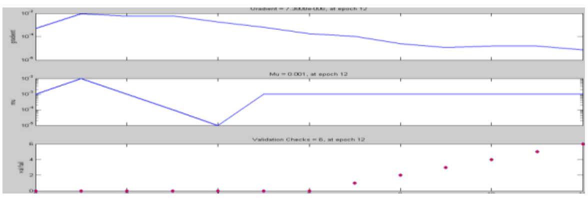

Fig: 8 Training State ( plot train state) of ANN

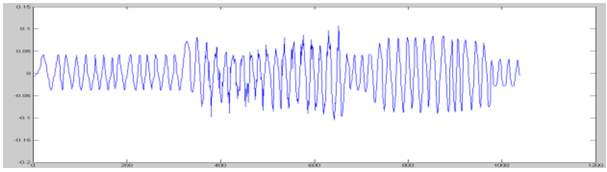

Fig. 9 Training error of ANN

## V. CONCLUSION

Artificial neural networks have been effective for learning functional mappings between input and output variables. This is done by adjusting weights of a set of interconnected neurons by learning rules. The multilayered perceptron model ( MLP) in ANN is applied for applications to power system. The back propagation technique has been applied for training. Over conventional computing system ANN has variety of advantages. These papers reviews and provide solutions to various power system problems which compared and analyzed with ANN. The brief overview of ANN with modeling and simulation are also presented in this paper. Therefore it can be concluded that artificial neural network is suitable for determining the observability of power system.

## REFERENCES

[1] Mr.Sunil and Mr. N. Loganathan “Power Quality Improvement of a Grid-Connected Wind Energy Conversion System with Harmonics Reduction Using FACTS Device” *IEEE- International Conference On Advances In Engineering, Science And Management (ICAESM -2012) March 30, 31, 2012*.

[2] Dipen A. Mistry, Bhupelly Dheeraj, Ravit Gautam, “Power Quality Improvement Using PI and Fuzzy Logic Controllers Based Shunt Active Filter “ World Academy of Science, Engineering and Technology*”, International Journal of Electrical, Robotics, Electronics and Communications Engineering Vol:8 No:4, 2014.*

[3] Amit Jain, Jaeho Choi “ Power system Network Observability determination using feed forward neural networks” *0-7803-7459-2/02 2002 IEEE* .

[4] L. Srivastava, S.N. Slngh and J. Sharma,"ANN Aapphation in Power systems: *An* overview and Key Issues", *Proc. Int. &d. CERA 97, pp. 39743*.

[5] Debs, A.S. (1 975), “Estimation of External Network Equivalents from Internal System Data”, *IEEE Trans. on Power App. and Systems*, Vol. *PAS-94, No. 2, pp. 273-277.*

[6] Dopazo, J.F., Dwarakanath, M.H., Li, J. J. and Sasson A. M. (1977), “An External System

[7] Equivalent Model using Real-Time Measurements for System Security Evalution”, *IEEE Trans. on Power App. and Systems, Vol. PAS-96, No. 2, pp. 43 1-446.*

[8] T. S. Dillan, "Artificial neural network applications to power systems and their relationship to symbolic methods", *International Journal of Electric Power and energy system*, Vol. 2,pp 1533-1536,1993.

[9] I.J. Nagrath and D.P. Kothari,'Power Sytem Engineering", K.P.Singh "Interconnected Power System with Thyristor Controlled Phase Shifter in the Tie Line”. *International Journal of Computer Applications* 41(9):27-30, March 2012

*[10]* M.M. Adibi , “ Power system restoration methodologies and implementation strategies”, *IEEE Press Power Engg. Series, 2000.*

[11] D.P.Kothari,“Application of neural network to Power Systems”, *0-7803-5812-0/00- 2000 IEEE*.

[12] Amit Jain, Jaeho Choi “ Power system Network Observability determination using feed forward neural networks” *0-7803-7459-2/02 2002 IEEE* .

[13] Engr. Badar.Ul Islam Faisalabad “ Comparison of conventional and modern load forecasting techniques based AI & Expert systems”, IJSI, Vol.8, September 2011.

[14] Dopazo, J.F., Dwarakanath, M.H., Li, J. J. and Sasson A. M. (1977), “An External System

[15] Equivalent Model using Real-Time Measurements for System Security Evolution”, *IEEE Trans. on Power App. and Systems, Vol. PAS-96, No. 2, pp. 43 1-446.*