International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 11, November 2015
Available at http://internationaljournalofresearch.org

Neural Networks in power system operation and control

D.Prasad
Associate Professor, Dept. of ECE, Ramanandatirtha Engineering College, Nalgonda.

P.Rahul Reddy
Associate Professor, Dept. of ECE, Ramanandatirtha Engineering College, Nalgonda

Abstract –
This paper focuses on the detection and classification of the faults on electrical power transmission line using artificial neural networks. The three phase currents and voltages of one end are taken as inputs in the proposed scheme. The feed forward neural network along with back propagation algorithm has been employed for detection and classification of the fault for analysis of each of the three phases involved in the process. A detailed analysis with varying number of hidden layers has been performed to validate the choice of the neural network. The simulation results concluded that the present method based on the neural network is efficient in detecting and classifying the faults on transmission lines with satisfactory performances. The different faults are simulated with different parameters to check the versatility of the method.

INTRODUCATION

Artificial Intelligence (AI) techniques are increasingly used in various area due to their capability of handling complex systems specificities. Among the techniques of AI, Artificial Neural Networks (ANN) technique plays an important role. This technique is used in this work to perform important tasks encountered in Photovoltaic systems and in Wind Energy Systems: a) Maximum Power Point Tracking (MPPT) of Photovoltaic Generators; b) and wind energy resource assessment. It is shown how a neural network technique can be used to design an MPPT controller for photovoltaic generators, enabling to improve their efficiency, and how it is possible to assess the available and recoverable wind energy potential of a site, by means of finding an adequate distribution law of the wind speeds based on a neural model. The proposed methods are illustrated by simulation results which exhibit the advantages of using ANN techniques in Renewable Energy Systems.

In the last years, Artificial Intelligence (AI) techniques are increasingly used in various area([1] and [2]). They enable to study complex systems without any knowledge of the exact relations governing their operation. They are able to handle noisy and incomplete data, and once trained, allow performing as complex tasks as prediction, modeling, identification, optimization, forecasting and control. Among the various techniques of AI, Artificial Neural Networks (ANN) are frequently used.

The electrical power system consists of so many different complex dynamic and interacting elements, which are always prone to disturbance or an electrical fault. The use of high capacity electrical generating power plants and concept of grid, i.e. synchronized electrical power plants and geographical displaced grids, required fault detection and operation of protection equipment in minimum possible time so that the power system can remain in stable condition. The faults on electrical power system transmission lines are supposed to be first detected and then be classified correctly and should be cleared in least fast as possible time. The protection system used for a transmission line can also be used to initiate the other relays to protect the power system from outages. A good fault detection system provides an effective, reliable, fast and secure way of a relaying operation. The application of a pattern recognition technique could be useful in discriminating the faulty and healthy electrical power system. It also enables us to differentiate among three phases which phase of a three phase power system is experiencing a fault. The artificial neural networks (ANNs) are very powerful in identifying the faulty pattern and classification of fault by pattern recognition.

VARIOUS NNS APPLICATION IN POWER SYSTEM SUBJECTS

A. Load Forecasting:-

Commonly and popular problem that has an important role in economic, financial, development, expansion and planning is load forecasting of power systems. Generally most of the papers and projects in this area are categorized into three groups:

• Short-term load forecasting:-

over an interval ranging from an hour to a week is important for various applications such as unit commitment, economic dispatch, energy transfer scheduling and real time control. A lot of studies have been done for using of short-term load forecasting with different methods. Some of these methods may be classified as follow: Regression model, Kaman filtering, Box & Jenkins model, Expert systems, Fuzzy inference, Neuron fuzzy models and Chaos time series analysis. Some of these methods have main limitations such as neglecting of some forecasting attribute condition, difficulty to find functional relationship between all attribute variable and instantaneous load demand, difficulty to upgrade the set of rules that govern at expert system and disability to adjust themselves with rapid nonlinear system-load changes. The NNs can be used to solve these problems. Most of the projects using NNs have considered many factors such as weather condition, holidays, weekends and special sport matches days in forecasting model, successfully. This is because of learning ability of NNs with many input factors.

• Mid-term load forecasting that range from one month to five years, used to purchase enough fuel for power plants after electricity tariffs are calculated .

• Long-term load forecasting (LTLF), covering from 5 to 20 years or more, used by planning engineers and economists to determine the type and the size of generating plants that minimize both fixed and variable costs.

B. Fault Diagnosis\Fault:-

Location Progress in the areas of communication and digital technology has increased the amount of information available at supervisory control and data acquisition (SCADA) systems . Although information is very useful, during events that cause outages, the operator may be overwhelmed by the excessive number of simultaneously operating alarms, which increases the time required for identifying the main outage cause and to start the restoration process. Besides, factors such as stress and inexperience can affect the operator’s performance; thus, the availability of a tool to support the real-time decision-making process is welcome.

The protection devices are responsible for detecting the occurrence of a fault, and when necessary, they send trip signals to circuit breakers (CBs) in order to isolate the defective part of the system. However, when relays or CBs do not work properly, larger parts of the system may be disconnected. After such events, in order to avoid damages to energy distribution utilities and consumers, it is essential to restore the system as soon as possible. Nevertheless, before starting the restoration, it is necessary to identify the event that caused the sequence of alarms such as protection system failure, defects in communication channels, corrupted data acquisition. The heuristic nature of the reasoning involved in the operator’s analysis and the absence of an analytical formulation, leads to the use of artificial intelligence techniques. Expert systems, neural networks, fuzzy logic, genetic algorithms (GAs), and Petri nets constitute the principal techniques applied to the fault diagnosis problem .

we see that the major effort to detect and rectify power system faults in 90’s, concentrate on expert system methods. Its main defect is the incapacity of generalization and the difficulty of validating and maintaining large rule-bases. Recently, using model-based systems including temporal characteristics of protection schemes based on expert systems and NNs developed.

C. Economic Dispatch:-

Main goal of economic dispatch (ED) consists of minimizing the operating costs depending on demand and subject to certain constraints, i.e. how to allocate the required load demand between the available generation units [20, 21]. In practice, the whole of the unit operating range is not always available for load allocation due to physical operation limitations. Several methods have been used in past for solving economic dispatch problems including Lagrangian relaxation method, linear programming(LP) techniques specially dynamic programming(DP), Beale’s quadratic programming, Newton-Rap son’s economic method, Lagrangian augmented function, and recently Genetic algorithms and NNs. Because of, economic dispatch problem becomes a non-convex optimization problem, the Lagrangian multiplier method, which is commonly used in ED problems, can not to be directly applied any longer.

Dynamic programming approach is one of the widely employed methods but for a practical-sized system, the fine step size and the large units number often cause the 'curse of dimensionality'. Main drawbacks of genetic algorithm and taboo search for ED are difficulty to define the fitness function, find the several sub-optimum solutions without guaranty that this solution isn't locally and longer search time. Neural networks and specially the Hopfield model, have a well-demonstrated capability of solving combinational optimization problem. This model has been employed to solve the conventional ED problems for units with continuous or piecewise quadratic fuel cost functions. Because of this network's capability to consider all constrained limitation such as transmission line loss and transmission capability limitations, penalty factor when we have special units, control the unit's pollutions and etc., caused increasing the paper proposed recently.

D. Security Assessment:-

The principle task of an electric power system is to deliver the power requested by the customers, without exceeding acceptable voltage and frequency limits. This task has to be solved in real time and in safe, reliable and economical manner. Figure 4 show a simplified diagram of the principle data flow in a power system where real-time measurements are stored in a database. The state estimation then adjusts bad and missing data. Based on the estimated values the current mathematical model of the power system is established. Based on simulation of potential equipment outage, the security level of the system is determined. If the system is considered unsafe with respect to one or more potential outages, control actions have to be taken.

IMPLEMENTATION OF A NEURAL NETWORKS TECHNIQUE FOR WIND ENERGY RESSOURCE ASSESSMENT

The interest towards renewable energies implies a good assessment of the available wind energy potential. The wind potential assessment of a site requires the knowledge of the distribution law of the wind speed measured on the site. The statistical treatment of these measurements makes it possible to have a discrete distribution law. However, a more accurate analysis of the wind potential needs obtaining a continuous distribution law. The Waybill or Rayleigh models are often used. The approach consists in assimilating the distribution law to one of these models and to determine the model parameters so that it gets closest to the discrete law achieved by the statistical treatment of the wind speed measurements. Determining a distribution law for the speeds can be considered as a non linear regression problem, in which the distribution law chosen (Waybill or Rayleigh) is identified so as to get nearer the discrete law. As regards function approximation, however, the techniques based on the artificial neural networks approach have shown that very good performances can be obtained.

OTHER APPLICATIONS

Due to the best ability of other AI techniques such as expert systems, evolutionary computing, fuzzy systems and hybrid system technique of these methods, and widely utilization of these techniques in power systems , in this section we introduce some of these applications and techniques. Because of best capability of genetic algorithm to optimize of process, optimal distribution and structural subject such as unit commitment always can be done with this method . Also genetic algorithm can be used to provide a good set of initial weights for the NN, or can be used to fully train the NN or to find the optimal network structure. Expert systems with complete gather a set of engineering and statistical and historical rule of projects can be used in monitoring of equipment and operational projects. Using the neural expert system hybrids may be increased the speed of recognition. Five different strategies have been developed for integrate neural network and expert systems: stand-alone models, transformational models, loosely coupled models, tightly-coupled models and fully-integrated models .

CONCLUSION

Through this work, importance of using Artificial Neural Networks in Renewable Energy Systems is exhibited. A method for designing efficient neural controller for maximum power point tracking of

PV generators is presented and simulated. The controller enables to find the optimal value of the DC-DC converter's duty cycle, starting from the sensed load voltage, the output values of the short circuit current and the open circuit voltage of monitoring cells which reflect environmental conditions. While classical MPPT controllers search for the location of the maximum power point, neural based controllers know its exact location and try to move the system to that point. There is no oscillations around the maximum power point, even if fast variations of environmental conditions occur. Obtained result from a standalone PV system simulation show fast tracking performance of the designed controller with a low error. A neural-based approach enabling to assess the wind energy potential has also been proposed in the paper. The proposed neural approach enables to accurately determine a site wind energy characteristics: wind speed frequencies, wind speed duration curves, energies available, recoverable and produced by a given wind generator. A comparative study with the method using the Waybill model shows that better results are obtained with the help of the neural model.

In this paper the application of NNs in power system subjects and advantages and drawbacks of using NNs and other conventional methods have been reviewed. Main advantages of using NNs are

• Its capability of dealing with stochastic variations of the scheduled operating point with increasing data.

• Very fast and on-line processing and classification.

• Implicit nonlinear modeling and filtering of system data

However, NNs for power system should be viewed as an additional tool instead of a replacement for conventional or other AI based power system techniques. Currently NNs rely on conventional simulations in order to produce training vectors and analysis the training vectors, especially with noisy data. There are some remain major challenge to be tackled using NNs for power system: training time, selection of training vector, upgrading of trained neural nets and integration of technologies.

REFERENCES

[1] M. T. Vakil, N. Pavesic, A Fast Simplified Fuzzy ARTMAP Network,Kluwer Academic Publisher, pp. 273-316, July 2003.

[2] K. Warwick, A. Ekwure, R. Aggarwal, Artificial Intelligence Techniques in Power Systems, IEE Power Engineering Series 22, Bookcratt Printed, pp. 17-19, 1997.

[3] G. Rolim, J.G. Zurn, Interpretation of Remote Backup Protection for Fault Section Estimation by a Fuzzy Exper System, IEEE PowerTech Conference, pp. 312-315, June 2003.

[4] R. Lukomski, K. Wilkosz, Power System Topology Verification Using Artificial Neural Network Utilization of Measurement Data, IEEE PowerTech Conference, pp. 180-186, July 2003.

[5] T.T. Nguyen, Neural Network Load Flow, IEEE Trans. Of Distribution, Generation and Transmission Conference, pp. 51-58, January 1995.

[6] M. Vasilic, M. Kezunoric, Fuzzy ART Neural Network Algorithm for Classifying the Power System Faults, IEEE Trans. Power Delivery, pp. 1-9, July 2004.

[7] J.P. Park, K. Ganesh, Comparison of MLP and RBF Neural Networks Using Deviation Signals for Indirect Adaptive Control of a Synchronous Generator, IEEE Trans. of Power Delivery, pp. 919-925, March 2004.

[8] K.W. Chan, A.R. Edward, A.R. Danish, On-Line Dynamic Security Contingency Screening Using Artificial Neural Network, IEEE Trans. Power Distribution System, pp. 367-372, November 2000.

[9] G. Chicco, R. Napoli, Neural Network for Fast Voltage Prediction in Power System, IEEE Power Tech Conference, pp. 312-316,September 2001.

[10] M.T. Vakil, N. Pavesic, Training RBF Network with SelectiveBackpropagation, Neurocomputing Elsevier Journal, pp. 39-64, July2004.

[11] H.S. Hippert, C.E. Pedreira, R.C. Souza, Neural Networks for Short-Term Load Forecasting: A Review and Evaluation, IEEE Trans. On Power System, VOL. 16, NO. 1, pp. 44-53, Februrary2001.

[12] W. Charytoniuk, M.S. Chen, Neural Network Design for Short-Term Load Forecasting, IEEE

International Conference of Deregulation of Power System Technologies, pp. 554-551, April 2000.

[13] A.K. Sinha, Short Term Load Forecasting Using Artificial Neural Networks, IEEE Trans. On Power System Distribution, pp. 548-553, 2000.

[14] G. Chicco, R. Napoli, F. Piglone, Load pattern clustering for Short-Term Load Forecasting of anomalous days, IEEE Trans. on Power Tech, pp. 550-556, September 2001.

[15] M. Gavrilas, I. Ciutera, C. Tanasa, Medium-Term Load Forecasting With Artificial Neural Network Models, IEE CIRED Conference, pp. 482-486, June 2001.

[16] M.S. Kandil, S.M. El-Debeiky, N.E. Hasanien, Long-Term Load Forecasting for Fast Developing Utility Using a Knowledge-Based Expert System, IEEE Trans. on Power Systems, Vol. 17, No. 2, pp.491-496, May 2002.

[17] T. Senjyu, P. Mandal, K. Uezato, Next day load curve forecasting using recurrent neural network structure, IEEE Trans. on Power Distribution System, pp. 388-394, March 2003.

[18] T. Saksornchai, W.J. Lee, M. Methaprayoon, J. Liao, Improve the Unit Commitment Scheduling by Using the Neural Network Based Short Term Load Forecasting, IEEE Trans. Power Delivery, pp. 33-39, June 2004.

[19] H. S. Hippert, C.E. Pedreira, Estimating temperature profiles for short-term load forecasting: neural networks compared to linear models, IEE Trans. on distribution and Generation Conference, pp.543-547, January 2004.

[20] N. Kumarappan, M.R. Mohan, S. Murugappa, ANN Approach to Combined Economic and Emission Dispatch for Large-Scale System, IEEE Power Distribution system, pp. 323-327, March 2002.

[21] K. P. Wong, Computational Intelligence Application in Unit Commitment, Economic Dispatch and Power Flow, IEEE Conference in Advance in Power System Control, Operation and Management, pp.54-59, November 97.