A REVIEW OF ADVANCES IN ECONOMIC DISPATCH USING ARTIFICIAL NEURAL NETWORKS

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Abstract: Economic Dispatch Problem (EDP) has been discussed with reference to the developments based on Artificial Neural Networks (ANN) approaches. A selected survey / overview on Economic Dispatch using Artificial Neural Network within the IEE/IEEE publications frame work have been presented.

1 INTRODUCTION

Power Economic Dispatch (ED) is necessary and vital step in power system operational planning. This is non-linear constrained optimization problem and is defined as the process of allocating generation levels to the generating units in the mix, so that the system load may be supplied entirely and most economically (Happ, 1977). It is on-line function, carried out after every 15-30 minutes or on request in Power Control Centers. In this paper efforts have been made to develop brief survey on the advances in Economic Dispatch Problem based on Artificial Neural Network Techniques. The paper is organized as follows: The Economic Dispatch (ED) problem formulation is introduced in Section II. Section III addresses the selected survey on Economic Dispatch Problem based on Artificial Neural Network (ANN) Techniques. Lastly there is conclusion.

2 ECONOMIC DISPATCH PROBLEM

The Economic Dispatch in its simplest form is formulated as:
Minimize

$$C_T = \sum_{i=1}^{N} C_i(P_i) \qquad (1)$$

Where: C_T: Total cost
C_i: generator fuel cost of the ith generating unit.
Subject to equality constraint:

$$P_D + P_L = \sum_{i=1}^{N} P_i \qquad (2)$$

Where: P_D: total load.
P_L: transmission loss given by

$$P_L = \sum_i \sum_j a_{ij} P_i P_j$$

Where: a_{ij}: transmission loss coefficient.
Inequality constraints:

$$P_{i\,(min)} \le P_i \le P_{i\,(max)} \qquad (3)$$

Where: $P_{i(min)}$: the minimum generation power
$P_{i\,(max)}$: the maximum generation power.

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Economic Dispatch Problem (EDP) has been solved by optimization techniques (Chowdhury, 1990).

3 ECONOMIC DISPATCH PROBLEM USING ANN

During the last decade the applications of ANN to various problem of Power system have increased considerably. Economic dispatch problem has been solved by using the Hopfield Neural Network architecture. In the discussion to follow a brief survey / overview on ANN based techniques has been given selectively within the framework of IEE/IEEE publications.

(Matuda, 1989) presented the representation of large numbers in neural networks and its application to economical load dispatching of electric power. This work represents one large number by one neuron which converges finally to any real values by using Hopfield Network. For the validation EDP has been mapped in the proposed model and tested for four node system supplying 30, 000 MW load.

(Park, 1993) presented Economic Load Dispatch for Piecewise Quadratic Cost Function using Hopfield Neural Network. EDP has been mapped into Hopfield neural network with differential synchronous transition model and modified sigmoidal function. The proposed method has been tested for Convex and Non convex economic dispatch problems.

(Fukuyama, 1994) presented an application of neural network to dynamic dispatch using multi processors. Dynamic Economic Dispatch has been carried out by using Gaussian Machine. The modeling has been programmed in parallel C and tested on transputer.

(King, 1995) presented Optimal Environmental Dispatching of Electric Power System via an Improved Hopfield Neural Network model. A simulator has been developed and a criterion for selecting its parameters has been discussed to obtain an optimal dispatch in the minimum amount of iterations.

(Djukanovic, 1996) presented a method for resolving the real-time economic dispatch problem. A suitable topology for the neural-net based on the multi-layered perceptron has been developed and an appropriate training method based on the back propagation algorithm has been used. The proposed method has been applied to two test systems. Hybrid intelligent system consisting of GDR neural-net architecture and Gold Works II based expert system has been proposed for the solution of environmental/economic dispatch problem

(Yalcinoz, 1997) presented Large Scale Economic Dispatch using Improved Hopfield Neural Network. Gee's Hopfield Neural Networks (GHN) has been modified to solve EDP. Proposed model has been tested on 3, 20, 40, 80, 120,160 and 240 units. The execution time and number of iterations have been reduced compared to classical methods.

(Su, 1997) presented a Fast-Computation Hopfield Method to Economic Dispatch of Power Systems. The method employs a linear input-output model for neurons. EDP has been formulated in such a way that direct computation instead of iterations for solving the problems becomes possible. 3 and 13 bus systems have been tested.

(Yalcinoz, 1998) presented Neural Networks Approach for solving Economic Dispatch Problem with Transmission Capacity Constraints. Gee and Prager's (GP) method has been modified in order to solve ED with transmission capacity constraints. The proposed method (PHN) has achieved efficient and accurate solutions for two-area power systems with 3, 4, 40 and 120 units.

(Lee, 1998) developed two different methods --- the slope adjustment and bias adjustment methods, in order to speed up the convergence of the Hopfield Neural Network System. To guarantee and for faster convergence, adaptive learning rates have also been developed by using energy functions and applied to the slope and bias adjustment methods. The results of the traditional, fixed learning rate and adaptive learning rate methods have been compared for economic load dispatch problems.

(Walsh, 1999) presented Augmented Hopfield Network for Constrained Generator Scheduling. This paper presents an augmented Hopfield Neural Network scheduling algorithm that unites the unit commitment and generation dispatch functions. This algorithm successfully considers ramp rate, transmission and fuel constraints in addition to the more common constraints. Model has been tested on system consisting 17 thermal and 2 hydro units.

(Yalcinoze, 1999) presented Security Dispatch using the Hopfield Neural Network. A mapping process has been formulated and a computational method for obtaining the weights and biases has been described using a slack variable technique for handling inequality constraints..

(Liang, 1999) developed re-dispatch approach based on the Hopfield Neural Network considering the dynamic dispatch problem that involve the allocation of system generation optimally among dispatchable generating units while tracking a load curve and observing power ramping response rate limits of the units, system spinning reserve requirements. This method has been successfully applied to utility system.

(Lee, 2000) presented Real Power Optimization with Load Flow using Adaptive Hopfield Neural Network. Instead of using the typical B-coefficient method, actual load flow to compute the transmission loss accurately.

(Su, 2000) presented New Approach with a Hopfield Modeling Framework to Economic Dispatch. The weighting factors associated with the terms of the energy function can be either appropriately selected or directly estimated in the proposed model. The proposed method has been tested on 3-bus and 13-bus system.

(Su, 2000) presented A Hopfield Model to Economic Dispatch having Special Units. This paper presents a Hopfield model with three strategies to solve the economic dispatch (ED) problems having prohibited operating zones. Application of the proposed approach has been demonstrated using a 15-unit system with 4 units having prohibited zones.

(Altun, 2000) presented Constrained Economic Dispatch with Prohibited Operating Zones: A Hopfield Neural Network Approach. A new mapping process has been used and a computational method for obtaining the weights and biases is described using a slack variable technique for handling inequality constraints. The proposed approach has been demonstrated on 18-unit system with 4 units having prohibited zones.

(Hartati, 2000) presents a summary of algorithms that have been proposed for the application of the Hopfield Neural Network to the Economic Load Dispatch problem.

(Bastos, 2002) presented Modified Hopfield Network in which internal parameters of the neural network are computed using the valid-subspace technique, which guarantees convergence to equilibrium points that represent a solution for the ED problem. Simulation results and a comparative analysis involving a 3-bus test system have been presented to illustrate efficiency of the proposed approach.

4 CONCLUSIONS

Artificial Intelligence Tools are being used to solve the EDP. These are gaining popularity over the solution methods based on optimization theory due to their strengths. The Hopfield Neural Network architecture is dominating for the various aspects of EDP. In (Park, 1993) a Hopfield neural network is proposed to solve the classical economic dispatch problem with non-convex cost function. The computation effort for solving the problem is high due to large number of iterations to obtain the optimality. In (Su, 1997) an analytic Hopfield method reducing considerably this computation effort is proposed. However the method is not applied to non-convex cost functions. In (Yalcinoze, 1998) a neural network approach for solving Economic Dispatch with transmission capacity constraints has been proposed. (Su, 2000) is the extension of (Su, 1997) in the sense it incorporates transmission loss. (King, 1995) and (Yalcinoze, 1999) incorporates the environmental and security aspects in Hopfield model respectively. (Lee, 1998) improves convergence and guarantees the convergence. In (Lee, 2000) B coefficients have been replaced by load flow equation. In (Altun, 2000) & (Hartati, 2000) there are Hopfield approaches for dealing the prohibited zones problem in ED. This selected review reveals that the advancement in ANN approaches gradual, systematic and gaining maturity for different aspects of EDP and there is the potential for the use of ANN to deal Economic dispatch problem.

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