Transient Stability Assessment of Power Systems using Probabilistic Neural Network with Enhanced Feature Selection and Extraction

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Abstract: This paper presents transient stability assessment of a large actual 87-bus system and the IEEE 39-bus system using the probabilistic neural network (PNN) with enhanced feature selection and extraction methods. The investigated power systems are divided into smaller areas depending on the coherency of the areas when subjected to disturbances. This is to reduce the amount of data sets collected for the respective areas. Transient stability of the power system is first determined based on the generator relative rotor angles obtained from time domain simulations carried out by considering three phase faults at different loading conditions. The data collected from the time domain simulations are then used as inputs to the PNN. An enhanced feature selection and extraction methods are then incorporated to reduce the input features to the PNN which is used as a classifier to determine whether the power system is stable or unstable. It can be concluded that the PNN with enhanced feature selection and extraction methods reduces the time taken to train the PNN without affecting the accuracy of the classification results.

Keywords: Dynamic security assessment, transient stability assessment, feature selection, feature extraction.

1. Introduction

Transient stability assessment (TSA) is part of dynamic security assessment of power systems which involves the evaluation of the ability of a power system to maintain synchronism under severe but credible contingencies. Methods normally employed to assess TSA are by using time domain simulation, direct and artificial intelligence methods. Time domain simulation and direct methods are considered most accurate but are time consuming and need heavy computational effort.

The use of artificial neural network, for instance multilayer perceptron NN (MLPNN) in TSA has gained a lot of interest among researchers due to its ability to do parallel data processing, high accuracy and fast response. Although successfully applied to TSA, MLPNN implementation requires extensive training process [1]. A major drawback of MLPNN for applications in large sized power systems is that it requires a large number of input features in training the neural network.

The emergence of support vector machines in TSA has addressed these problems [1, 2]. Another method which can be used for TSA is the probabilistic neural networks (PNN) [3], which is a class of radial basis function (RBF) network is useful for automatic pattern recognition, nonlinear mapping and estimation of probabilities of class membership and likelihood ratios [4]. In this paper, the research done in [3] on PNN is continued with bigger and larger power systems, i.e. IEEE 39-bus and 87-bus systems. PNN is used as a classifier for assessing transient stability state of a large sized and practical power system. The power system is divided into smaller coherent areas so as to reduce the amount of input data to the neural networks.

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