



Wavelet-based feature extraction and selection for classification of power system disturbances using support vector machines

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ABSTRACT

This paper presents a new approach for the classification of the power system disturbances using support vector machines (SVMs). The proposed approach is carried out at three serial stages. Firstly, the features to be form the SVM classifier are obtained by using the wavelet transform and a few different feature extraction techniques. Secondly, the features exposing the best classification accuracy of these features are selected by a feature selection technique called as sequential forward selection. Thirdly, the best appropriate input vector for SVM classifier is rummaged. The input vector is started with the first best feature and incrementally added the chosen features. After the addition of each feature, the performance of the SVM is evaluated. The kernel and penalty parameters of the SVM are determined by cross-validation. The parameter set that gives the smallest misclassification error is retained. Finally, both the noisy and noiseless signals are applied to the classifier given above stages. Experimental results indicate that the proposed classifier is robust and has more high classification accuracy with regard to the other approaches in the literature for this problem.

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1. Introduction

Undesirable cases appearing in consequence of power system disturbances fairly affect electric utilities. These disturbances, such as momentary interruptions, voltage sag/swell, harmonic distortion and transients, resulting in switching, fault, lightning strike, etc. bring about poor power quality (PQ). In particular, PQ can be improved by providing the appropriate solutions if signals representing these disturbances are measured by the equipments located into power system sections and their causes are identified [1].

The basis steps of detecting and classifying the power system disturbances are the pre-processing, feature extraction and classification, respectively. The pre-processing and feature extraction of signals can be performed by direct techniques, such as the RMS value [2] of the raw samples, or transformation techniques, such as the Fourier transform (FT) [3] and the wavelet transform [4–7]. The wavelet transform (WT) is used as a powerful tool for the detection, localization and classification of PQ problems, extracting the distinctive information of the disturbance signals simultaneously in both the time and the frequency domains contrary to the FT. The primary characteristic of WT is that it decomposes a disturbance signal into localized components represented by a scaling and a

translating parameter without energy aliasing between them. So, the information of different frequency contained in the disturbance signals is represented by each component individually and high correlation is obtained [8].

Recently, the synergy with the feature extraction techniques of artificial neural networks (ANNs), support vector machines (SVMs) and the other computational intelligence techniques have become popular for solving the problem about the power systems. Spline WT and radial based functional neural networks (RBFNN) have been integrated for PQ data compression in [9]. In [10], wavelet multiresolution analysis (WMRA) and nearest neighbors pattern recognition technique have been proposed for online disturbance classification of different PQ problems. In [11], both FT and WT have been used for extracting features at the proposed fuzzy expert system for classifying PQ disturbances. In [12], the input feature vectors of probabilistic neural networks (PNN), feedforward neural networks (FNN), and RBFNNs have been selected by using both S-transform and WT. In [13], the classification of the disturbances in a real time using ANNs and WT has been presented. ANNs have several important disadvantages such as determining a proper architecture problem, local optimum problem, bad convergence property, over-fit or under-fit problem, etc. although ANNs have very promising pattern recognition and non-linear function approximation capabilities. On the other hand, SVM classifiers have been receiving a big interesting of power systems researchers because of producing single, optimum and automatic sparse solution by simultaneously minimizing both generaliza-

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