



Novel optimization parameters of power quality disturbances using novel bio-inspired algorithms: A comparative approach

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ABSTRACT

Automatic classification of Power Quality Disturbances (PQDs) is a challenging concern for both the utility and industry. In this paper, a novel technique for automatic classification of single and hybrid PQDs is proposed. The proposed algorithm consists of the Discrete Wavelet Transform (DWT) and Probabilistic Neural Network based BAT (PNN-BAT) optimal feature selection of PQDs. DWT with Multi-Resolution Analysis (MRA) is used for the feature extraction of the disturbances. The power quality disturbances are in the form of signals like voltage sag, voltage swell, voltage transients, flicker, voltage imbalance, and harmonics. Such disturbance signals cover a broad frequency spectrum because of its high sampling rate and produce megabytes of data which leads to the requirement of high storage space. In this paper, discrete wavelet transform is used to analyze the power quality disturbance signals and to reduce the storage space required. The PNN classifier is used as an effective classifier for the classification of the PQDs. However, the two critical concerns such as the selection of the optimal features and the spread constant value might affect the performance of the classifier. Hence, these two issues are addressed using a novel technique PNN-BAT based optimal feature selection and parameter optimization for improving the performance of the classification system. The BAT algorithm is used to select optimal features from a large feature set and the optimal value of the PNN spread constantly. The optimal feature selection method retains the useful features and discards the redundant features.

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1. Introduction

The misoperation or failure of any customer equipment may be the result of deviation in the perfect sinusoidal waveform of voltage or current which affects the quality of power. These disturbances are produced due to the application of unbalanced and non-linear loads, switching devices, line faults, industrial grade converters, computers and data processing equipment, usually applied in both the industrial and domestic appliances. These power quality disturbances are in the form of signals like voltage sag, voltage swell, voltage transients, flicker, voltage imbalance, and harmonics. Such disturbance signals cover a broad frequency spectrum because of its high sampling rate and produce megabytes of data which leads to the requirement of high storage space.

Spline wavelet (SW) is an ideal wavelet among the different existing wavelets which has some prevalent properties like normality, best guess, and minimization at a given request over other customary bases. [31] this paper a novel incorporated approach

for power quality information pressure utilizing the SW transform (SWT) and the neural system is displayed and its execution is evaluated as far as pressure proportion (CR), mean square error and rate of vitality held in the recreated signals.

Determination of mother wavelet (MW) could be founded on subjective or quantitative methodologies. The picked database are ten signs (simple and computerized). In this review, distinctive MW with various vanishing minutes were utilized: Symmlet (Sym), Daubechies (Db), Haar, Meyer, and Coiflet (Coif). Rather than utilizing subjective approach, for example, likeness amongst flag and MW, this discourse will be founded on the MSE esteem in the capacity of the MW, i.e. the MSE is registered for every mother wavelet and for every vanishing minute [27].

A model that depicts the progression of the day by day normal temperature precisely with regards to climate subordinates valuing. All the more decisively, we analyze two cutting edge machine learning calculations, in particular wavelet systems and hereditary programming, with the great straight methodologies that are utilized generally in the valuing of temperature subsidiaries in the money related climate advertise, and also with different machine learning benchmark models, for example, neural systems, radial basis functions and support vector regression [29,30].

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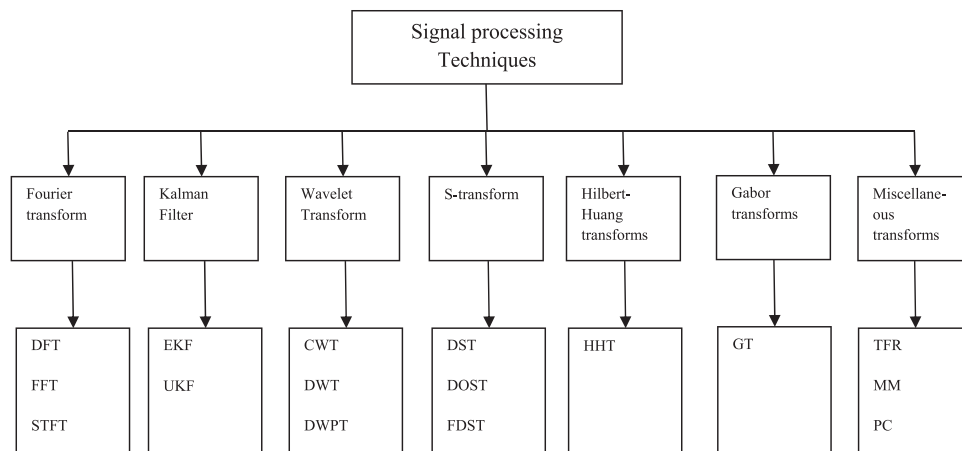


Fig. 1. Taxonomy of feature extraction techniques.

Discrete wavelet transform [32] was utilized as a part of conjunction with the Mann-Kendall test to examine patterns and predominant periodicities connected with the drought variables. Moreover, ceaseless wavelet transform (CWT) based worldwide wavelet range was utilized to investigate noteworthy times of inconstancy connected with the drought variables.

A novel PQ occasion recognition and classification strategy utilizing higher request cumulants as the element parameter, and quadratic classifiers as the characterization technique was proposed in [33,34]. Komarasamy and Wahi [15] examined K-means clustering utilizing BA and inferred that the mix of both K-means and BA can accomplish higher effectiveness and in this way perform superior to anything different calculations tried in their work.

Khan and Sahari exhibited a correlation investigation of BA with PSO, GA and different calculations with regards to e-learning and subsequently recommended that BA obviously has a few points of interest over different calculations. They additionally introduced an investigation of clustering issues utilizing BA and its augmentation as a bisonar streamlining variation, with great outcomes [16,17]. On the other hand, Mishra et al. [21] utilized BA to characterize microarray information, though Natarajan et al. [22] exhibited a correlation investigation of cuckoo scan and BA for Bloom channel advancement. Damodaram and Valarmathi [18] considered phishing Website location utilizing altered BA and accomplished great outcomes [18].

Marichelvam and Prabakaran [20] utilized BA to study hybrid flow shop planning issues in order to limit the makespan and mean flow time [20]. Their outcomes recommended that BA is an effective approach for taking care of hybrid flow shop booking issues. Faritha Banu and Chandrasekar [19] utilized an altered BA to record deduplication as an improvement approach and information pressure strategy. Their outcomes proposed that the adjusted BA can perform superior to hereditary programming [19]. The Mexican Hat Wavelet Differential condition fake neural systems (MHWDEANN) are utilized surprisingly to build a vitality capacity of the framework in an unsupervised way. The tunable parameters of MHWDEANN are prepared with a half and half transformative processing approach: we misuse the quality of Genetic Algorithms (GA) and Sequential Quadratic Programming (SQP) to locate the best weights [28].

1.1. Feature extraction techniques in power quality

The primary parts of the PQ explore include essential ideas and definitions, reenactments and investigation, instrumentation and estimation, causes, impacts and solutions of PQ disturbances

[1]. The feature extraction process is the most critical part of the example acknowledgment framework connected to locate the particular elements from the obtained transform coefficients of the original signals. The PQ unsettling influences can be distinguished and arranged by utilizing a component extraction system. The separated components along these lines can be utilized for the characterization of PQ unsettling influences. Features can either be removed from the original signals or frame at some point recurrence change procedures. Different flag handling strategies have been utilized for the feature extraction, for example, Fourier transforms, Wavelet transforms, Stockwell transforms, Hilbert change, Kalman channel, Gabor change, and their half and halves. A condition-of-craftsmanship scientific classification of the flag preparing strategies utilized for the element extraction of the PQ disturbances appears in Fig. 1.

These transformations are utilized to acquire data in time and recurrence spaces. The determination of the most appropriate features of the PQ occasions is of extraordinary significance so as to accomplish the most elevated precision of the arrangement [2]. In any case, the execution of a classifier relies on the separated component vector [3]. In this manner, rather than outlining an entangled classifier, the particular features of the examples are the fundamental concentration of the example acknowledgment frameworks. The measurable parameters of the changed coefficients of the PQ disturbances can be figured so as to decrease the information estimate and to get unmistakable elements of the PQ unsettling influences. The most broadly utilized measurable parameters for the order of PQ unsettling influences are energy, entropy, minimum, maximum, standard deviation, mean, RMS value, etc. and their mix.

1.2. Implementing optimal feature selection technique

1. Essential components are kept and immaterial features are disposed of, in this way a typical and basic classifier can be utilized.
2. The Optimal component choice may likewise be utilized to get the greatest classification precision of a classifier.
3. The computational unpredictability is lessened to some degree.

This paper is organized into five sections, which are as follows: in Section 2 Power quality disturbance is presented. Section 3 describes the wavelet transform in detail. In Section 4, explain the Probabilistic Neural Network (PNN) and their corresponding classification, feature extraction using neural network based optimization. The results of signals are presented and discussed in

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