Chapter-13

Power Quality Disturbance's (PQD's) detection and classification Using DWT and Supervised machine learning techniques

[1]S. Ramana Kumar Joga, [2]K. Swetha, [3]K. Madhu, [4]Sk.Jalaluddin, [5]S.S.M. Naidu
[1]Faculty, [2,3,4,5]Student, Dadi Institute of Engineering & Technology, Anakapalle
srkjoga@diet.edu.in, 20U45A0252@diet.edu.in

Power quality refers to the characteristics of the electrical power supply that affect the performance, reliability, and safety of electrical equipment. With the growing demand for reliable and efficient power supply, power quality has become an important area of research and development. The detection and classification of power quality disturbances through discrete wavelet transform (DWT) and machine learning is a promising approach that can improve the accuracy and efficiency of power quality analysis. DWT is a powerful signal processing technique that can decompose complex signals into different frequency bands, allowing for the identification of various types of power quality disturbances, such as voltage sags, swells, and interruptions. Supervised machine learning algorithms such as Decision Tree, SVM, KNN and Ad boost, can then be used to classify these disturbances based on their features extracted from the DWT coefficients. This paper detects and classify PQD's using DWT and machine learning and discusses the advantages and limitations of this approach. It also provides insights into the future research directions in this area, such as the development of more sophisticated machine learning models and the integration of real-time monitoring and control systems. Overall, this paper highlights the potential of using DWT and machine learning for power quality analysis and its relevance to the development of smart grid technologies.

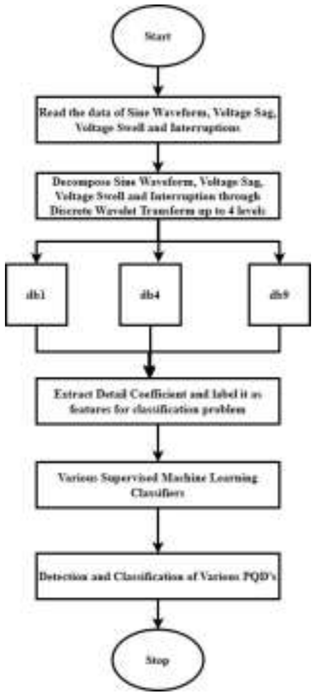

Fig 1: Block diagram

The methodology for detecting and classifying power quality disturbances through signal processing and machine learning techniques typically involves several steps:

Data Collection**:** The first step is to collect power quality data from the electrical system. This data can be obtained from various sources such as power quality meters, recorders, and other monitoring devices.

Pre-processing: The accuracy of the analysis may be impacted by factors such as noise and artefacts that may be present in the obtained data. The data need to be pre-processed so that noise and artefacts can be eliminated, and the signal quality may be improved. Pre-processing techniques may include filtering, resampling, and signal normalization.

Feature Extraction: After pre-processing, features should be extracted from the data that can be used for detecting and classifying power quality disturbances. The features may include statistical measures such as mean, variance, and skewness, spectral features such as frequency components, and wavelet coefficients.

Feature Selection: Once the features have been extracted, feature selection techniques can be used to select the most relevant features for detecting and classifying power quality disturbances. Feature selection techniques such as principal component analysis (PCA) and mutual information can be used for this purpose.

Classification: After feature selection, supervised machine learning algorithms such as Decision Tree, SVM, KNN, and Ad boost can be used to classify power quality disturbances based on the selected features. The classification model should be trained using a labelled dataset that includes different types of power quality disturbances.

Evaluation: Several different performance indicators, including precision, accuracy, F1-score and recall, should be used in order to assess the classification model's overall effectiveness. In order to evaluate the model's capacity for generalisation, it should also be validated using data that comes from a different source.

Post-processing: Finally, the results of the classification model can be post-processed to enhance the accuracy of the analysis. Post-processing techniques may include clustering, thresholding, and error correction. In conclusion, the methodology for detecting and classifying power quality disturbances through discrete wavelet transform, Daubechies as mother wavelet and various supervised machine learning techniques involves data collection, pre-processing, feature extraction, feature selection, classification, evaluation, and post-processing. The success of this methodology depends on the quality of the collected data, the effectiveness of the pre-processing and feature extraction techniques, and the accuracy of the classification model.

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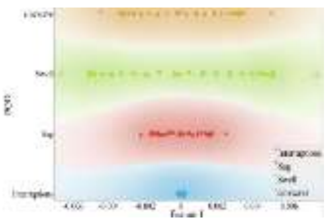

Fig 2: Results

DWT has proved to be an effective tool for signal analysis and feature extraction, enabling identification of different power quality disturbances including voltage swells, interruptions, and voltage sags. Few Supervised Machine learning techniques like Gradient Boosting, Decision Tree, SVM, Random Forest and Adaboost have been successfully applied to classify and diagnose these disturbances. It is also concluded that performance depends on the choosing of right mother wavelet. The use of these techniques has also led to improvements in the speed and accuracy of power quality disturbance detection, as well as a reduction in false alarms. Overall, the combination of DWT and machine learning techniques represents a significant advancement in power quality disturbances detection.

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