Detection and Classification of Changes in Voltage Magnitude During Various Power Quality Disturbances

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Abstract:
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 Adaboost, 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.

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Contents

I. Introduction

Power quality disturbances refer to any deviation from the normal electrical characteristics of the power supply that can affect the performance, reliability, and safety of electrical equipment. These disturbances can occur due to a variety of factors including equipment failure, environmental conditions, and electrical noise [1]. There are several types of power quality disturbances, including: Voltage sags or dips: These occur when the voltage drops below normal levels for a short period. They can be caused by faults on the power grid or sudden changes in power demand [2]. Voltage swells or surges: These are the opposite of voltage sags and occur when the voltage rises above normal levels for a short period. They can be caused by lightning strikes, switching operations, or sudden changes in power demand. Harmonic distortion: This occurs when non-linear loads (such as computers and electronic equipment) draw current in short bursts, causing the waveform of the current to become distorted. This can lead to overheating and premature failure of equipment. Transient voltage: This refers to short-term voltage spikes or dips that can damage sensitive electronic equipment. Transients can be caused by lightning strikes, switching operations, or other sources of electrical noise. Frequency variations: These occur when the frequency of the power supply deviates from its normal value of 50 or 60 Hz. This can be caused by changes in power demand or by faults on the power grid. Voltage unbalance: This occurs when the three phases of a three-phase power supply are not evenly balanced, leading to uneven voltage levels across different phases. This can cause overheating and premature failure of equipment. Power quality disturbances can have a significant impact on the performance and reliability of electrical equipment. For example, voltage sags and dips can cause sensitive electronic equipment to malfunction or shut down, while harmonic distortion can cause overheating and premature failure of equipment. Therefore, it is important to monitor power quality and take steps to mitigate the effects of power quality disturbances, such as using voltage regulators, surge protectors, and harmonic filters. Power quality disturbances are a significant issue in the electrical power industry, and various techniques have been developed to detect and analyse these disturbances [3]. This literature review focuses on the recent research in the area of detection of power quality disturbances, including the various techniques and approaches that have been proposed. Signal processing techniques such as Fourier analysis, wavelet analysis, and empirical mode decomposition (EMD) have been widely used for power quality disturbance detection [4]. Fourier analysis can be used to decompose a complex signal into its frequency components, allowing for the identification of harmonic disturbances. Wavelet analysis can decompose a signal into different frequency bands, allowing for the detection of various types of disturbances such as voltage sags, swells, and transients. EMD is a signal processing technique that can be used to decompose a signal into its intrinsic mode functions (IMFs), which can be used to identify various types of power quality disturbances. Machine learning techniques such as artificial neural networks (ANN), support vector machines (SVM) [5], and random forests have also been widely used for power quality disturbance detection. These techniques can analyse power quality data and identify different types of disturbances based on their features extracted from the data. Several studies have demonstrated the effectiveness of machine learning techniques in detecting and classifying power quality disturbances, particularly when combined with signal processing techniques such as wavelet analysis and EMD. Recent research has also explored the use of deep learning techniques such as convolutional neural networks (CNN) [6] and long short-term memory (LSTM) [7] networks for power quality disturbance detection. These techniques can automatically extract features from raw data and learn complex patterns, making them well-suited for analysing power quality data. Several studies have demonstrated the effectiveness of deep learning techniques for power quality disturbance detection and classification.

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