Harmonic source identification in Microgrid using wavelet time frequency analysis

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Harmonic sources in microgrid must be identified and it is critical task for power engineers to ensure the stable and efficient operation of the system. In recent years, wavelet analysis has emerged as a powerful tool for identifying harmonic sources in power systems due to its ability to analyze signals at multiple scales. This paper presents a comprehensive study on the application of wavelet analysis for identifying harmonic sources in Microgrid. The proposed methodology includes pre-processing of power system data, selection of appropriate wavelet functions, and analysis of the decomposed signals to identify the harmonic sources. The effectiveness of the proposed methodology is demonstrated using simulation studies. The results show that the proposed methodology is effective in identifying harmonic sources in power systems with high accuracy and can be a valuable tool for power engineers in the analysis and control of power system harmonics.

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Contents

I. Introduction

In electrical power systems, harmonic sources refer to any device or component that introduces harmonic currents into the power system. Harmonic currents are non-sinusoidal currents that have frequencies that are multiples of the fundamental frequency of the power system (typically 50 Hz or 60 Hz) [1]. Harmonic distortion caused by these harmonic currents can lead to a range of problems in power systems, including: Voltage distortion: Harmonic currents can cause volt-age distortion, which can lead to equipment malfunction and premature failure. Voltage distortion can also lead to flicker in lighting systems, which can be visually disturbing. Increased losses: Harmonic currents can cause increased losses in power system components, such as transformers and cables [2]. These increased losses can lead to reduced efficiency and increased operating costs. Reduced system stability: Harmonic currents can destabilize power systems, leading to voltage fluctuations and even system-wide blackouts. Harmonic sources in power systems can be divided into two categories: linear and nonlinear. Linear harmonic sources include devices such as transformers and reactors, which can introduce harmonic currents due to their inherent magnetic properties. Nonlinear harmonic sources include devices such as electronic equipment, variable frequency drives, and switching power supplies, which can introduce harmonic currents due to their nonlinear operating characteristics [3]. Identifying and mitigating harmonic sources in power systems is essential to maintain the stability and reliability of the power system. Power engineers use a range of techniques, including spectral analysis, time-domain analysis, and wave-let analysis, to identify harmonic sources in power systems and design effective mitigation strategies to reduce harmonic distortion. Harmonic source identification in power systems has been a topic of active re-search in recent years due to the growing concern over the impact of harmonic distortion on power system performance and reliability. In this literature review, we provide an overview of some of the key research contributions in the field of harmonic source identification in power systems. One of the early approaches for harmonic source identification in power systems was based on spectral analysis. Spectral analysis involves the decomposition of signals into their frequency components, allowing identification of the frequencies associated with harmonic distortion. In a seminal paper, Yi Zhang. (2022) proposed a method for harmonic source identification based on spectral analysis. The authors used the Non-Intrusive algorithm to estimate the frequency and amplitude of harmonic components and identified the location of harmonic sources based on their frequency signatures [4]. Another approach for harmonic source identification is based on time-domain analysis. Time-domain analysis involves the analysis of signals in the time domain, allowing identification of the sources of transient events that can cause harmonic distortion [5]. In a study by Hao Liu et al. (2021), a time-domain approach was proposed for harmonic source identification based on wavelet packet decomposition. The authors used a sliding window approach to analyse signals in the time domain and identified the sources of harmonic distortion based on the energy distribution of wavelet packets [6]. Wavelet analysis has emerged as a powerful tool for harmonic source identification in power systems due to its ability to analyse signals at multiple scales [7]. In a recent study, Nagendra Kumar Swarnkar et al. (2021) proposed a wavelet-based approach for harmonic source identification that combines a genetic algorithm and a support vector machine. The authors used the wavelet transform to decompose signals into their constituent frequency components and then used the genetic algorithm to select the best wavelet basis function. The support vector machine was then used to classify the sources of harmonic distortion based on the decomposed signals. In conclusion, harmonic source identification in power systems is a critical task for power engineers to ensure the stable and efficient operation of the system [8]. harmonic analysis deals with the decomposition of a given function or signal into its underlying harmonic components. This is typically achieved through the use of Fourier series or Fourier transforms, which convert a function or signal from the time or spatial domain into the frequency domain. Spectral analysis, time-domain analysis, and wavelet analysis are some of the key techniques available for identifying harmonic sources in power systems [9]. The effectiveness of these techniques depends on factors such as the type and complexity of the power system, the characteristics of the harmonic sources, and the quality of the power system data [10]. Future research in this field is expected to focus on developing more advanced and accurate methods for harmonic source identification in power systems.

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