Multilayer Neural Network-Driven Active Voltage Compensator for Comprehensive Power Quality Enhancement

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Abstract:

The proliferation of nonlinear and sensitive loads in modern power systems intensifies vulnerabilities to voltage disturbances, including sags, swells, imbalances, and harmonics, which degrade equipment performance and incur economic penalties. Existing solutions like Dynamic Voltage Restorers (DVRs) and Series Active Power Filters (SAPFs) address specific issues but lack cost-effective integration for simultaneous multi-disturbance mitigation. This work introduces an Active Voltage Compensator (AVC) that unifies DVR and SAPF functionalities to comprehensively regulate load voltage under diverse anomalies. A novel Multilayer Feed-Forward Neural Network (MLFFN) algorithm rapidly identifies disturbances within one voltage cycle, enabling precise reference voltage generation. Simulation results validate the AVC's efficacy in eliminating voltage sags (up to –50%), swells (+50%), imbalances, and harmonics (5th, 7th order), maintaining nominal load voltage (THD < 1%) across all test cases. The solution ensures service continuity during voltage interruptions, offering a robust, integrated approach to power quality enhancement.

Keywords:

Active Voltage Compensator (AVC), power quality, voltage sag, voltage swell, harmonics, Multilayer Feed-Forward Neural Network (MLFFN).