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Advanced Harmonic Suppression Methods Using Active Power Filters

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Abstract: *In this study, the most recent advances in AI technologies applied to active power filters are discussed. The rising interest in (APF) is a result of recent advances in power electronic technology. The active power filter is considered by experts to be more effective at getting rid of harmonic currents from nonlinear devices than is the regular reactive LC filter. APF improves the reliability and steadiness of a power grid, in addition to correcting power quality. A review of the main topics in artificial intelligence (AI) is done by exploring various books, articles and studies, with a short explanation of some main domains of AI.*

Keywords: *PWM, Artificial intelligence, Non-linear load, Harmonic distortion, Active power filter*
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I. Introduction

Many studies have focused on harmonic distortion and how to address and better the quality of distorted power. Usually, a passive LC (inductor and capacitor) power filter is used to limit harmonics in the current when connected alongside the load. Passive filters do not give a full solution as a result of parallel or series resonances. The style of the compensatory equipment is a major issue in many cases [1]. An excellent way to remove harmonic pollution from power networks is with active power filters (APFs).

Since the load harmonics can both be complicated and change very quickly, APF systems must respond fast and precisely control their output current. Experts have used pulse width modulation, neural-network theory, hysteresis band current control, , adaptive signal processing, sliding-mode control, fuzzy-logic control, and several advanced control and signal-processing methods [2]. The basic principle of an APF can be seen in Figure 1. Figure 2 presents the APF result for a diode rectifier loaded with inductance.

By injecting compensation current I_c into the source, the neutral point voltage regulator helps to cancel the harmonics to affect the load current I_l so that sinusoid current flows from the source [3]. The objective of the active filter is to get rid of the distorted portion of the current taken by non-linear loads so that only the main current frequency remains at the source. The fast change in the reference current needs to be accurately detected by the active filter and its current control.

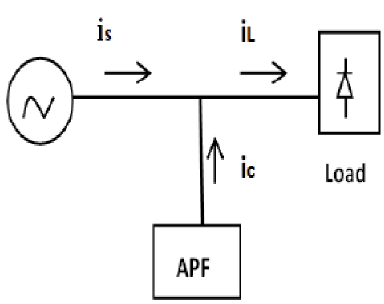

Fig 1: Basic principle of APF

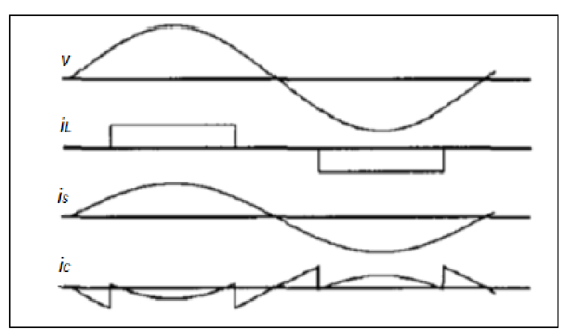

Fig 2: Theoretical waveforms

II. Harmonic Methods for Mitigation

Harmonics Filtering in Passively The most straightforward conventional approach for reducing harmonic distortion is passive filtering. This is how passive harmonic filters operate: A current acceptor is a filter that is linked in series with the inductance and capacitance and in parallel with the load. To match the circuit's resonant frequency, the harmonic frequency needs to be lowered. Thus, the harmonic current is eliminated by the network's impedance and the filter's low impedance. Figure 3 [2] displays the general types of passive filters together with their order. There are numerous drawbacks to using a passive filter, including tuning, size, and resonance issues, all of which reduce the filter devices' dependability and adaptability [1].

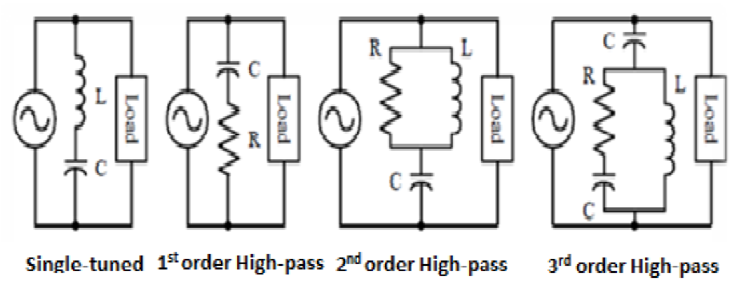

Fig 3: Passive filters and their configurations

III. Fuzzy and GA of Neural Network

A representation of APF with FNN predictive control is presented in Figure 4. To forecast future harmonic compensating current, a fuzzy neural network is used and a GA with strong search power is made to ensure the model is both accurate and compact. The dynamic reference current is tracked by the model predictive control algorithm and this tracking allows it to form the control vector u in the form of inverter switch gating patterns using the algorithm's predictions. The data show that predictive control with fuzzy neural networks and GA outperform the PI controller in suppressing distortion on the supply current and voltage.

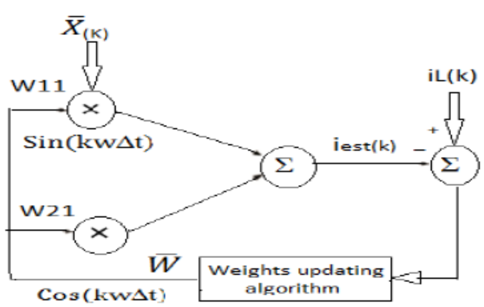

Fig 4: ANN extraction topology

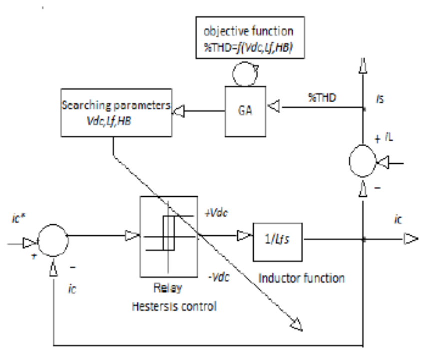

Fig 5: GA approach for APF design

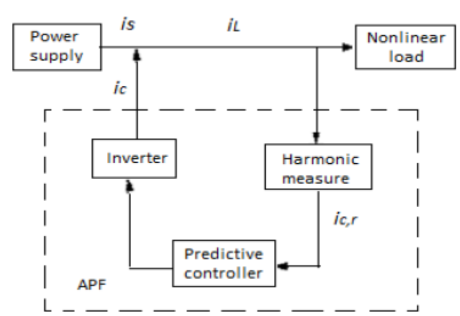

Fig 6: The APF Structure

IV. Conclusion

The emphasis of the review was the use of neural networks, FL and GAs in APF applications. This study suggests several AI techniques to help improve both power quality and the performance of systems using signal processing. To provide a broad overview of AI methods used in APF to researchers and engineers, a detailed survey of AI literature is presented. They are beneficial because they have reduced current ripple, fast responding and excellent accuracy in tracking the APF current.

Both simulations and actual application examples have shown that using AI in controlling electrical networks is both easy and highly effective at minimizing harmonics. Many of the papers reviewed here suggest that active power filters often use ANNs to check current harmonics, but control of dc bus capacitor voltage is done more commonly with FLCs. Using GA, the parameters of the APF model simulation have been optimized.

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