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Artificial Intelligence Based Control of a Shunt Active Power Filter

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Abstract

With day-by-day increasing significance of Power Electronics, the issue of harmonics being introduced in electrical systems needs to be addressed on a priority basis. Active Filters are very apt solution for reducing harmonics. Here a Shunt Active Power Filter with Artificial Neural Network(ANN) Control and Neuro-Fuzzy Control is proposed. For ANN control the concept of predictive and adaptive control has been used which helps in fast estimation of compensating current. The algorithm for predictive control is new and simulation shows quite good results. The dynamics of the dc-link voltage is utilized in a predictive controller to generate the first estimate followed by convergence of the algorithm by an adaptive ANN (*adaline*) based network. Again Neuro-Fuzzy control is used which gives still better simulation result

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Keywords: *Adaline, Predictive, Adaptive, THD (Total harmonic distortion), SRF (Synchronous Reference Frame), Fuzzy logic, DC link voltage.*

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1. Introduction

Although power electronic devices such as thyristors and power transistors have been available for twenty-five years or more, state-of-the-art semiconductor device technology is continually improving and thus providing better, reliable and economical components. These improvements combine with the efficiency and controllability advantages of equipment. New and innovative circuits are being developed at a rapid pace and clearly the trend is toward high penetration level of electrical loads.

Unfortunately, there are some problems associated with these new circuits and devices. Unlike conventional loads, they control the flow of power by chopping, flattening, or shaping the otherwise sinusoidal power system voltages and currents .These waveform distortions can cause problems for neighbouring loads, and they tend to have an overall detrimental effect on the quality of electrical “pollution”, whether it is produced by large single-source or by the cumulative effect of many small loads and often propagate along distribution feeders. In fact, distortion is usually amplified at points remote to the sources.

sensitive to pollution from other sources, power electronic loads are at the same time villains and victims from a power quality point of view

One innovative concept that has great potential is the Active Power Line Conditioner (APLC), also known as Active Power filter. It appears to be an attractive, viable method for reducing voltage and current harmonic distortion, voltage spikes, transients and flicker. It injects equal but opposite distortion thereby cancelling the original problem and improving power quality on the connected power system.

The technology of active power filter has been developed for harmonic compensation, reactive power reduction and balancing voltage in an ac power network. Active power filter dynamic performance depends mainly on how fast and accurate harmonics are eliminated from the load current. So many harmonic elimination techniques are available to us. As given in references fast estimation of current compensating is done by using methods like d–q theory presented in [5], p–q topology as in [6], [7], [8], concept of adaptive filters as said in [9], wavelet technology [10], genetic algorithm method (GA) and artificial neural network (ANN) etc. Here, combinations of predictive and adaptive controller techniques which will give faster responses have been adopted. In this there is a need of 2 ANN controllers. Whenever the change in load is detected, first of all predictive controller will do its work in part of compensating current as fast as possible in parallel with change in voltage across capacitor. Next adaline based controller will start working for faster steady state value. Single phase shunt APF is shown in below figure.1

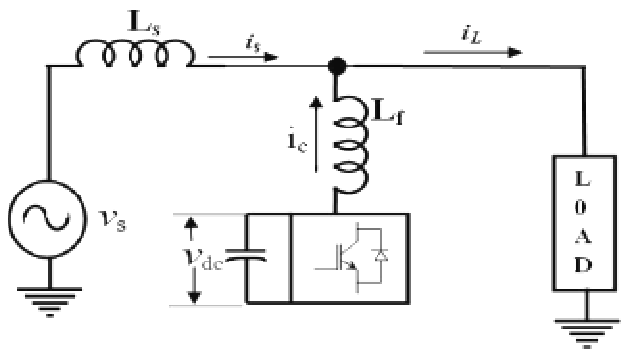

Fig.1: Single phase shunt APF

2. Reference Current Estimation[1]

APF compensation is shown in Fig. 1. The expression of the load current is,

$$i_L(t) = i_{\alpha 1}+i_{\beta 1}+i_h \quad (1)$$

$i_{\alpha 1}$ is in-phase component and $i_{\beta 1}$ is quadrature component of phase current at fundamental frequency. Except these, all the remaining included in i_h. The in phase component of the load current and the corresponding per-phase source voltage are expressed as

$$i_{\alpha 1}(t) = I_{\alpha 1} \cos \omega t \quad (2)$$