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Enhancing Power Quality with a Neuro Fuzzy-Based Unified Power Quality Conditioner Fed Induction Motor Drive

K Naresh
Department of Electrical and Computer Science Engineering, VNR Vignan University, Hyderabad
Corresponding Author: naresh@gmail.com

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Abstract *If energy is distributed from one area to a distinct collection of loads or to the grid, a unified power quality conditioner is necessary. A unified power quality conditioner that relies on neuro fuzzy technology is described in this paper. A series converter is used to address voltage sag/swell problems. The reactive power of linear and nonlinear loads is corrected using the shunt converter. The results of the experiment are compared for neuro fuzzy and artificial neural network controllers. All harmonic bias is successfully taken out when using this method. The quality of performance for the system is tested using MATLAB/Simulink.*

Keywords*: Power quality, Neuro fuzzy controller, Induction motor, Harmonic compensation*

I. Introduction

Poor power system conditions and the abundant use of nonlinear loads are causing power quality to be very scattered. More power quality is needed by the devices used to control and monitor manufacturing operations. Variations in power quality, however tiny, can cause big financial problems for these devices [1, 2]. Using power quality, the expected operation of flexible AC transmission systems is maintained, even in difficult conditions. Problems with power quality, low power factor and changes in supply voltage can all happen because of harmonics.

There is now a much greater demand for top-quality electric power than in previous years. Attention to power quality issues is growing these days because of the problems they cause for both consumers and utilities. Noise, harmonics, transient interruptions, sags, swells and under voltages are the power quality issues that happen most often. A key tool in power electronics for improving PQ is the unified power quality conditioner. To handle PQ interruptions better, performing UPQC systems at a better level is required [3]. A major device for handling problems on the source and load is unified power quality. The converter system uses series and shunt converters that share a single DC link in series.

II. Unified Power Quality Conditioner

In Figure 1, systems using shunt and series inverter UPQC are shown. The main purpose of a UPQC is to supply the adjustment voltage needed to remove harmonics. In this way, the power quality available for other loads that can be harmed by harmonics is increased [4,5]. The shunt and series inverters are connected by a single dc link. UPQC has series and shunt inverters to fix the harmonic voltage and current caused by nonlinear loads.

Combining fuzzy logic with neural networks in the Adaptive Neuro-Fuzzy Inference System (ANFIS) controller results in a strong tool for complex control systems. Thanks to neural networks, learning can be adapted, but fuzzy logic aids in handling vagueness and imitation of human-like thinking. The structure parameters of the ANFIS system are updated by neural learning, mainly via a mix of various learning techniques. As a result, it handles problems associated with uncertain, time-varying and nonlinear systems without problems. Prediction systems, process control and robotics depend heavily on it. Thanks to its ability to represent complex links and build knowledge from information, ANFIS can be called a strong and intelligent solution for control.

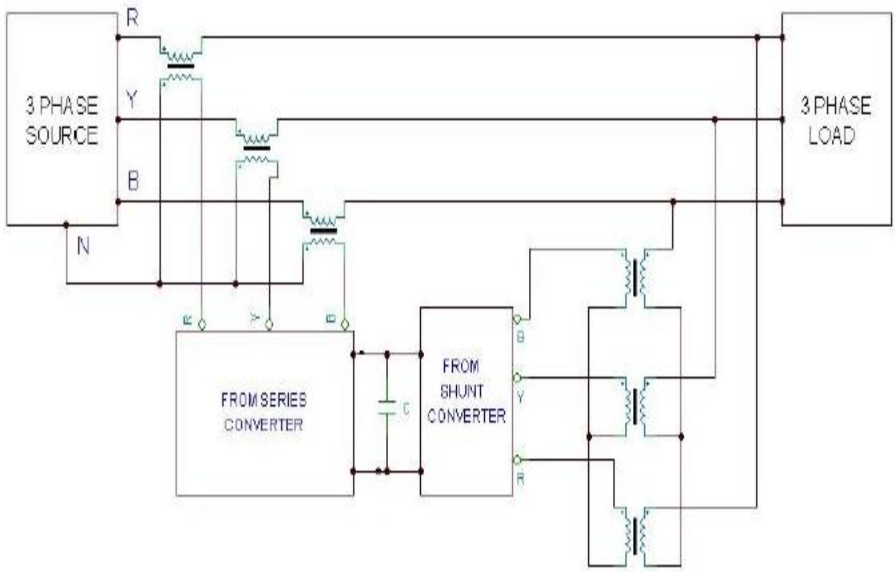

Fig 1: Unified Power Quality Conditioner

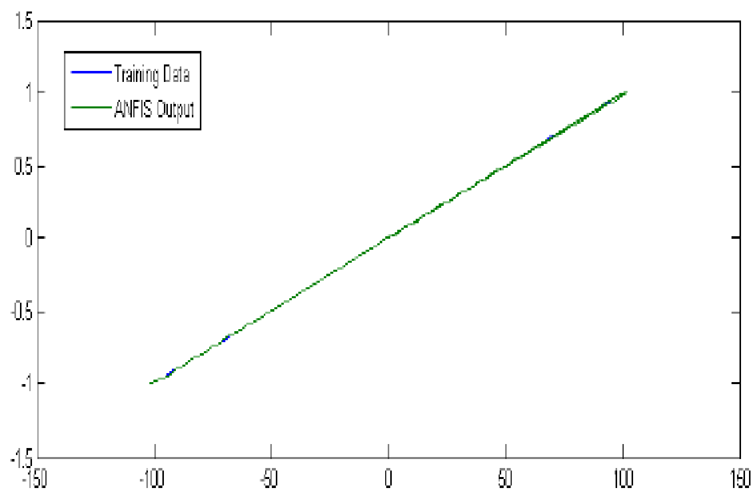

Fig 2: ANFIS Training Data and Output Data

III. Controller for Artificial Neural Networks

The way biological neural networks are built and function is what motivates the use of Artificial Neural Network (ANN) controllers in computers. Dynamic, complex and nonlinear phenomena in control systems are often managed using this approach because they are hard to simulate with regular control techniques. They are three layers made up of neurons that exchange data and learn using training algorithms.

Because ANN controllers can learn from previous data, they are well suited for both real-time and changing control needs. Because they do not have to build a complicated mathematical model of the system, they can model its unknown qualities, anticipate its future behavior and respond with useful control actions.

ANNs help increase the accuracy, stability and flexibility of systems in industrial automation, robotics, aerospace and cars. To enhance performance, a suitable controller may be used alone or together with fuzzy logic or PID controllers.

But ANN controllers depend on a strong computer and a large amount of data for training and how the data is used affects how effectively they operate. These issues do not prevent neural networks from being a valuable addition to present-day intelligent control systems because of how well they learn and respond quickly.

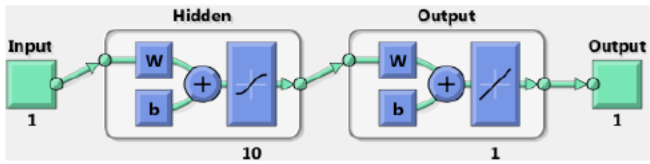

Fig 3: Neural Network Architecture

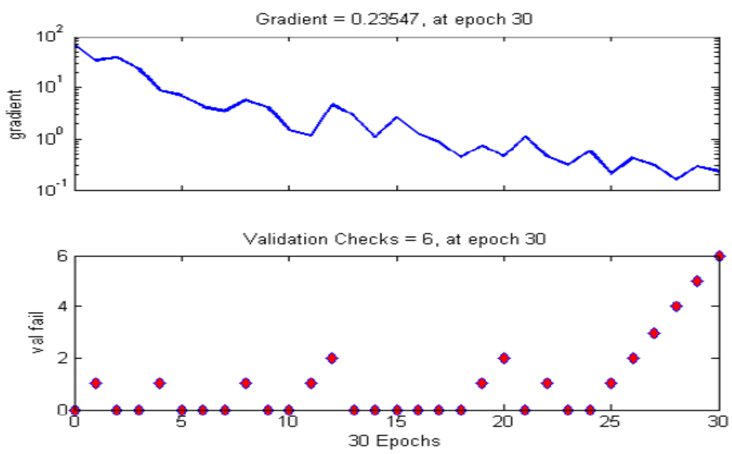

Fig 4: Different states of neural networks

IV. Results and Analysis

Neuro-Fuzzy Based UPQC improves the quality of power provided to systems with induction motor drives. The simulations indicate that harmonic distortion, sag events and maintaining the voltage are all improved by different load conditions compared to the base model. Voltage and current with stability and regular cycles are provided by the adaptive neuro-fuzzy controller as it adapts to disturbances. Its THD remains under the IEEE standards, thanks to special improvements. Areas for improvement in torque and speed response are shown by the analysis. This UPQC with a neuro-fuzzy method deals well with power quality problems in industry since it responds faster, adapts better and runs more efficiently than traditional controllers.

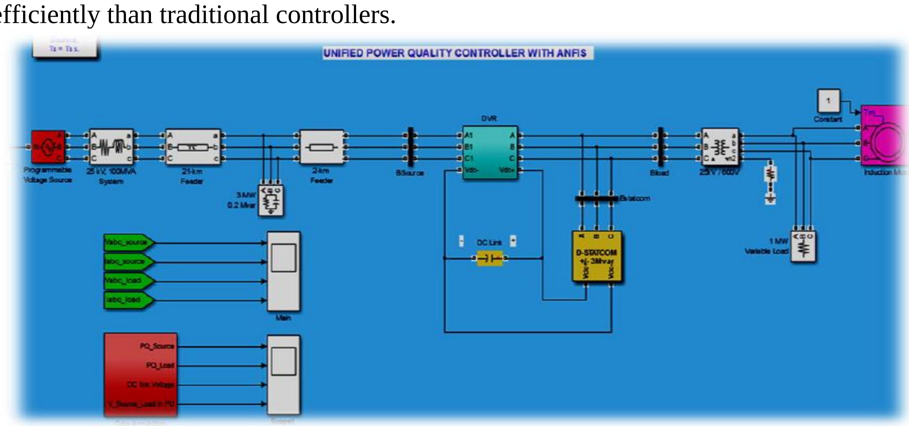

Fig 5: Simulink Model of UPQC based on ANFIS

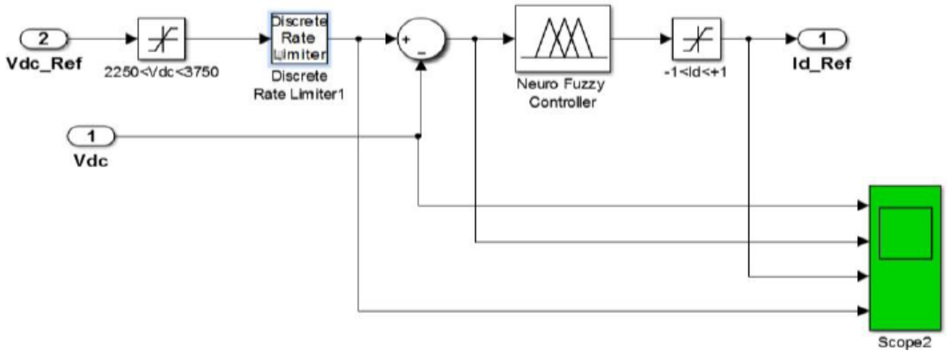

Fig 6: ANFIS Subsystem Model

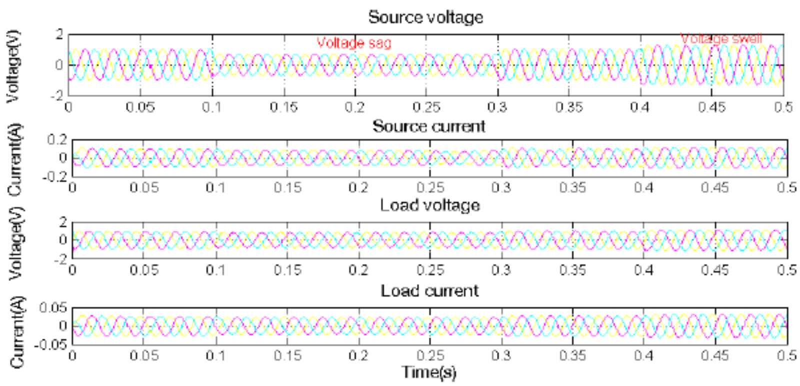

Fig 7: ANFIS Based UPQC of Source and Load Side Waveforms

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