Efficient Current Control using Hybrid Filter with ANN on Conservative Power Theory

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Abstract - Almost every electrical system utilizes the filters to improve the quality of power being delivered to the loads. But due to its aging properties and temperature makes it fluctuate in nature, so that there is need to modify the system to improve controlling of currents in the system. This work demonstrates the system with conservative power theory, which shows the system operation with hybrid filtering technique which utilizes active and passive both the filters as shunt compensator in the system along with the artificial neural network controlling of 7-level filtering arrangement. The proposed system efficiently controls the current and improved the power quality of the system.

Keywords - CPT, Artificial Neural Network, APF, Current Control.

I. INTRODUCTION

The rising interest in the use of electronic devices levies nonlinear loads to the source that draw active current, reactive current and harmonic current. Due to the reactive current and harmonic current electromagnetic interference with nearby equipment and heating of transformers occur. Power system can sop up harmonic currents with no problem. Resonant condition mainly affects the power problem.

The electrical transmission system identifies devices such as power electronic circuitry used for power conversion as non-linear load [1]. A nonlinear element in a power system is described by the introduction of a distortion due to their non- ideal characteristics.

Nonlinear loads, including; uninterruptable power supply (UPS), variable frequency drives (VFD), adjustable speed drives (ASD), and switched mode power supplies, present a special challenge to successful delivery of high quality power under all operating conditions. With the increased number of power electronic system connected to the mains, the systems have become more sensitive to supply voltage and current distortions.

Distorted voltages and currents have many harmful effects such as resonance problem arises between the supply inductances and capacitances leading to over-currents and over-voltages. Distorted current increases the I2Z heat losses in the transformer which promotes thermal and mechanical insulation stresses. Detrimental effects can also be seen in a system powering phase to neutral connected loads. For equipment where proper sequencing of operations depends on a zero crossing for timing, voltage distortion can cause miss-operation. Rapidly changing or varying industrial loads such as electric arc furnaces, welding machines, alternators, rolling mills and motors may also give rise to supply voltage fluctuations which might cause tripping of equipment.

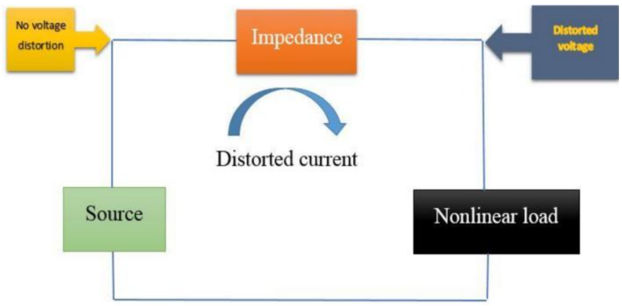

Figure 1.1 Flow of harmonic currents and generation of harmonic voltages.

Ideally, AC power systems are a pure sinusoidal wave, both voltage and current, but presence of non-linear loads modify the characteristics of voltage and current from the ideal sinusoidal wave. This deviation is reflected as Harmonics. Harmonics provide current and voltages with different components that are multiples of the fundamental frequency of the system.

In fig.1.1 the source refers to the three phase source (generator) in power system and impedance represents the line impedance. Due to the nonlinear load the current becomes non sinusoidal. As a result we are getting a distorted voltage across the load.

Most of the schemes used for harmonic reduction try for bringing the current waveform to sinusoid. The drawbacks are

As the current sharper is in series with the main path it demands higher rating semiconductor devices.

When a prevailing sharper needs to be replaced the process becomes uneconomical as it requires significant change.

Fig. 1.2 shows an active power filter connected in parallel with the main path invalidates all the harmonic current and reactive current from nonlinear loads. As the active power filter provide a fraction of total power for compensation of harmonic and reactive currents it can have low rating which is economical. Among the various control strategies of active power filters pulse width modulation scheme is an efficient one. A hybrid power filter which is a combination of passive filter and active filter improves the resonance characteristics and reduces filter rating.

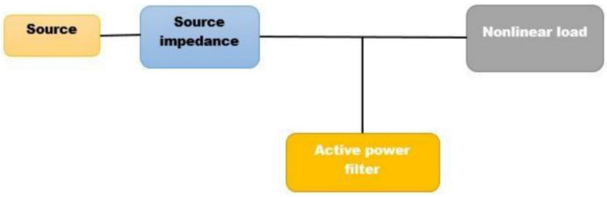

Figure 1.2 Schematics of a system with the shunt active power filter.

II. PROPOSED MODEL

Proposed system is based on the hybrid filtering technique which utilizes active and passive both the filters as shunt compensator in the system along with the artificial neural network controlling of 7-level filtering arrangement simulink model representation of proposed work has demonstrated in figure 2.1. Proposed system is efficient for the power quality control power quality improvement. As demonstrated in figure 2.1 the main blocks are

- Three Phase Source Power Supply
- Three Phase Series RLC Branch
- Universals Bridge Sub system
- ANN Based Hybrid Active Passive Filter

A. Three Phase Source Power Supply:

As Illustrated in figure three phase ac power supplies is provided to series RLC Branch in proposed model the fundamental elements of series RLC blocks are register capacitor and an inductor are connected in series. Branch type parameter is used to select element to include in branch.

B. Three Phase Series RLC Branch:

The Series RLC Branch block implements a single resistor, inductor, or capacitor, or a series combination of these. The Branch type parameter is utilized to select elements you want to include in the branch. Select the desired elements to include in the branch. The R letter defines the resistor, the L letter defines the inductor, and the C letter defines the capacitor. Select Open circuit to define an open circuit (R=0, L=0, C=inf). Only existing elements are displayed in the block icon. Default is RLC.

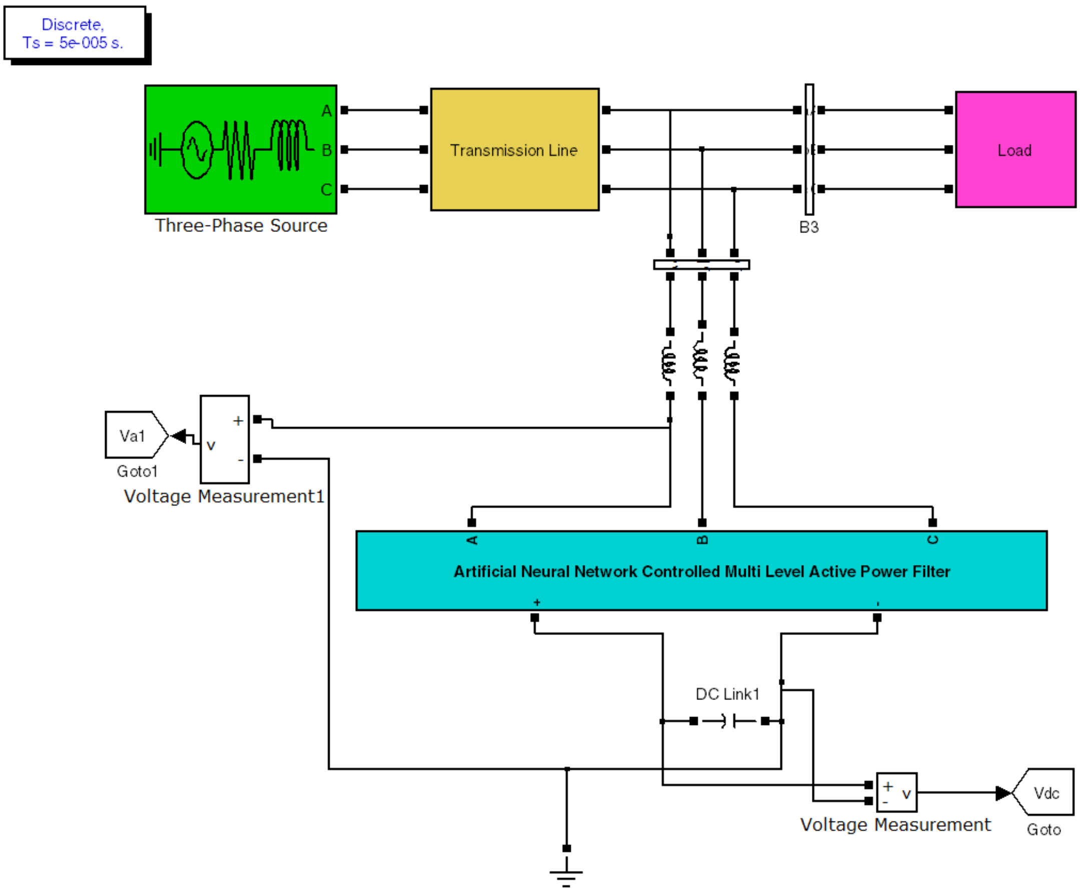

Figure 2.1 Simulink Model of Proposed work

C. Universals Bridge Sub system:

The Universal Bridge block implements a universal three-phase power converter that consists of six power switches connected as a bridge. The type of power switch and converter configuration is selectable from the dialog box.

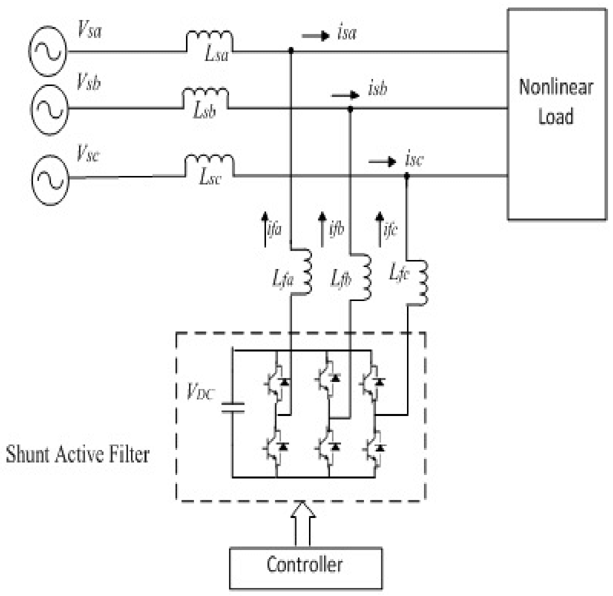

Fig. 2.2 Active Power Filter

D. ANN Based APF:

Active Power filter makes it possible to significantly reduce the rating of the active filter. The task of the active filter is not to compensate for harmonic currents produced by the thyristor rectifier, but to achieve “harmonic isolation” between the supply and the load As a result, no harmonic resonance occurs, and no harmonic current flows in the supply. The APF shown fig.2.2 provide viable and effective solutions to harmonic filtering of high-power rectifiers. However, they have difficulty in finding a good market because of the necessity of the transformer and the complexity of the passive filter. Figure 2.3 demonstrated architecture of ANN based controller. Basically PI controllers are used to control DC bus voltage. The proposed ANN based Hybrid power controller Strategy enables decision making for the Controlled hybrid filter output. it is a very efficient approach for power quality control instead of conventional schemes without ANN based controller.

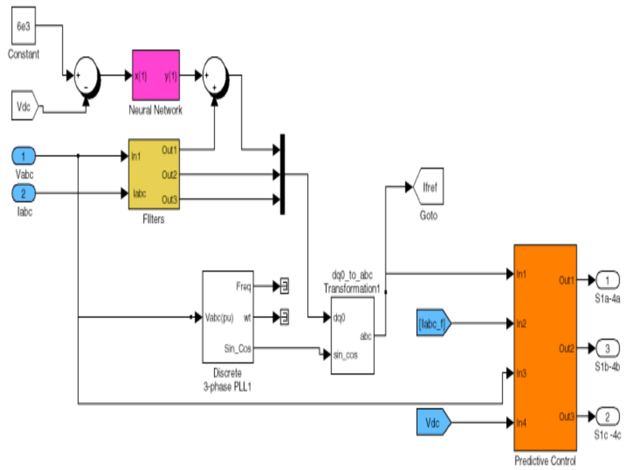

Fig.2.3 ANN based Controller Architecture

III. SIMULATION RESULTS

Implementation of proposed work has done on MATLAB ISE and synthesis of proposed work has done on Simulink outcome waveform of proposed work has demonstrated in figure 3.1 to figure 3.5 with different aspects and parameters.

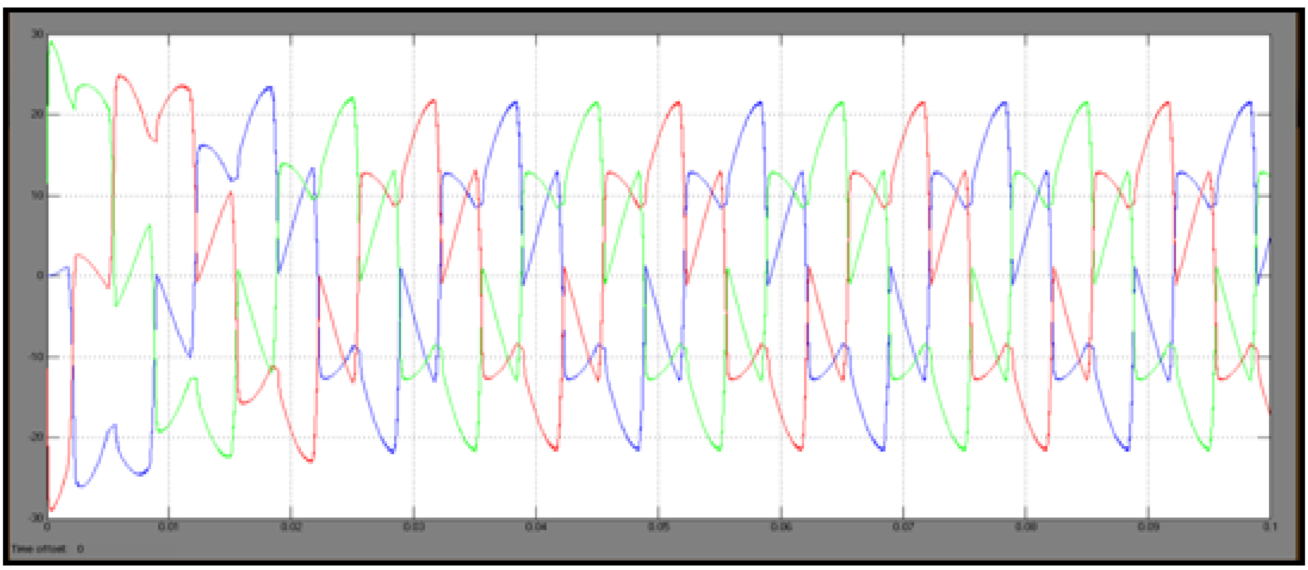

Figure 3.1 Proposed 3 phase current

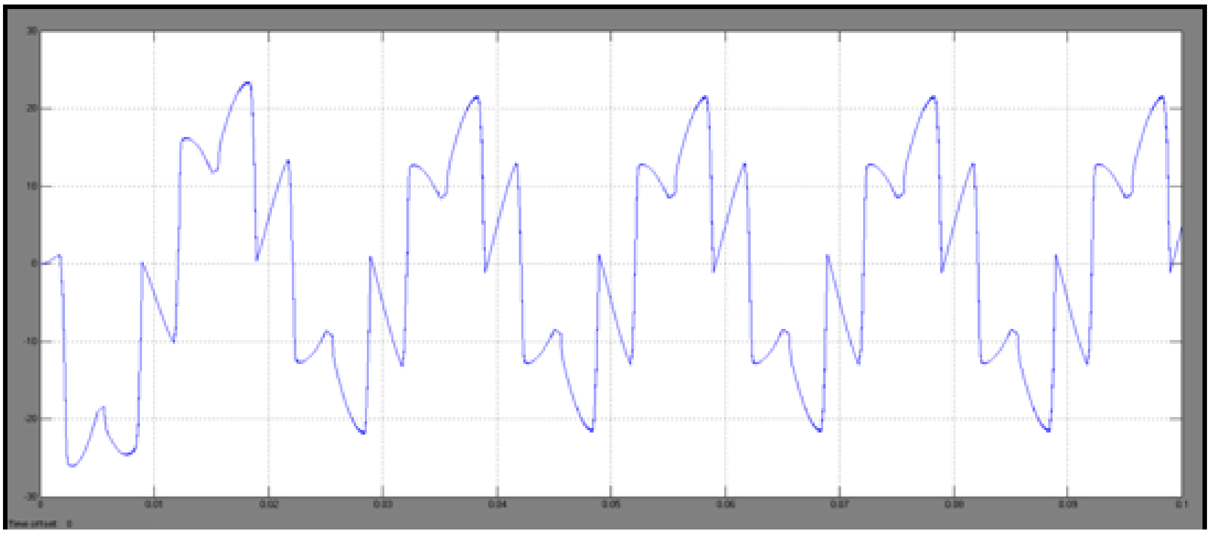

Figure 3.2 Single phase compensator waveform

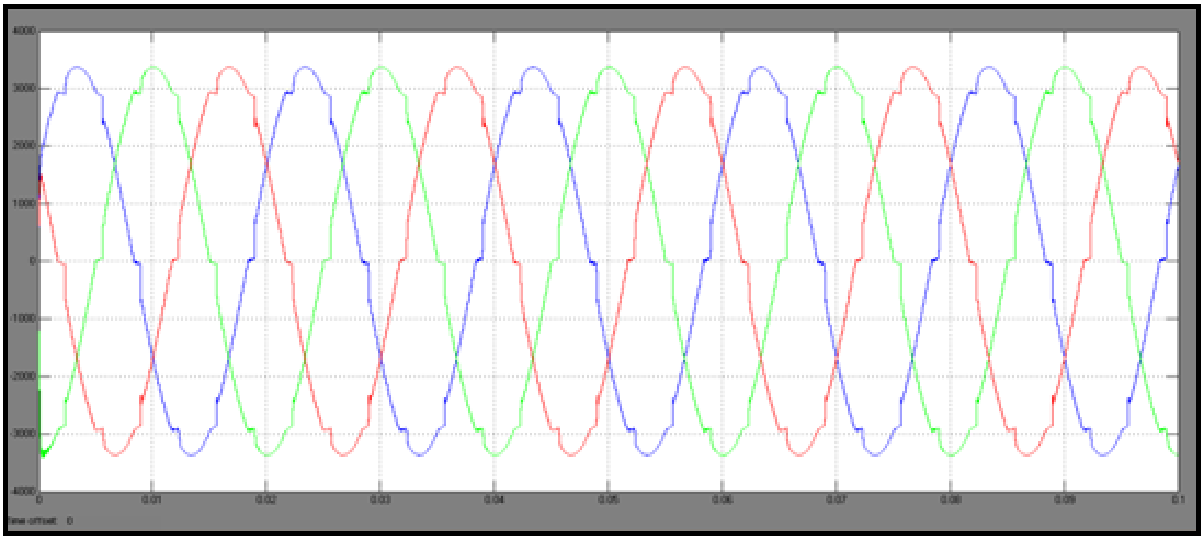

Figure 3.3 Proposed PCC voltages.

Figure 3.1 demonstrated 3 phase currents & single phase currents waveforms single phase compensator wave is demonstrated in figure 3.2 and proposed PCC voltage is illustrated in figure 3.3. Proposed 7 levels Filtering waveform outcome is represented in figure 3.4. and proposed PCC current waveform is given in figure 3.5. it is clear by observation proposed work has better outcome as compared to previous base paper work.

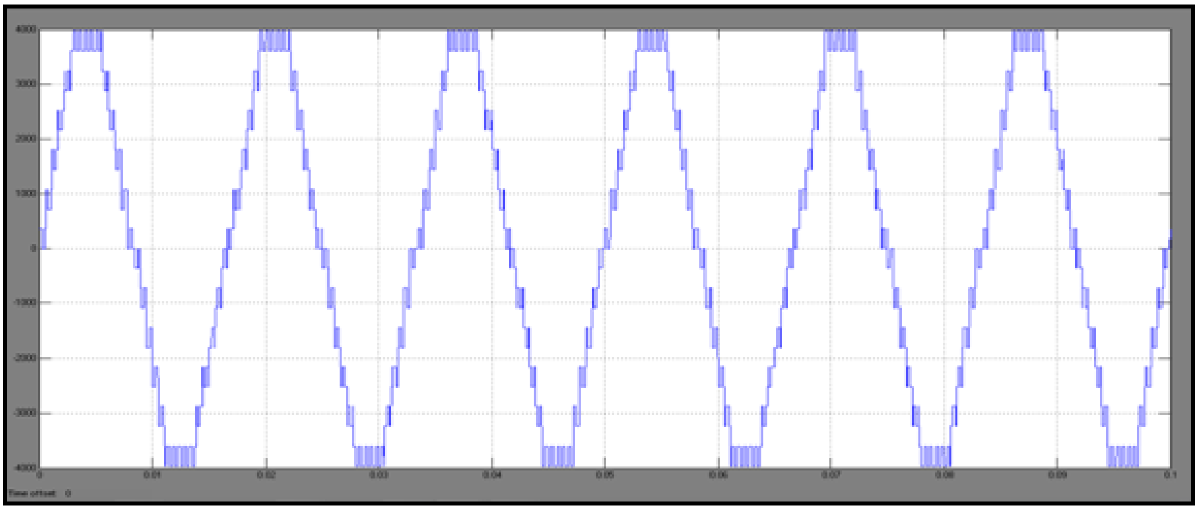

Figure 3.4 7 level active power filer outcome waveform.

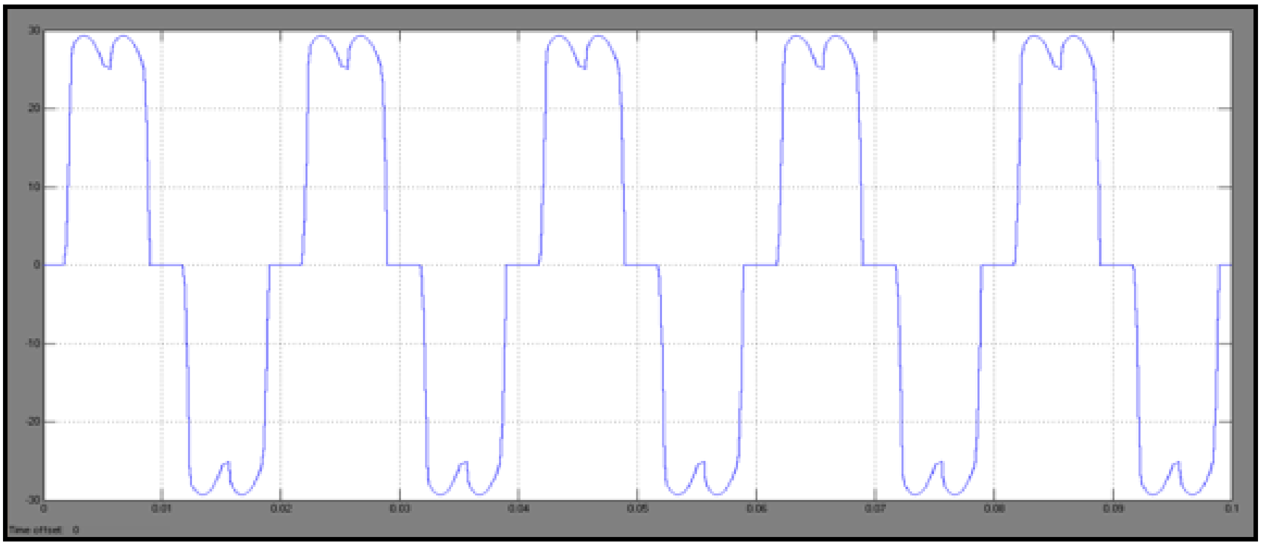

Figure 3.5 Proposed PCC current

IV. CONCLUSION AND FUTURE SCOPE

In this work 7 level active power filter enables multilevel power controlling and power quality improvement model has been presented with conservative power theory. In this work operation of proposed model has been simulated on Simulink and output waveforms are observed. From the observation of waveform it is clear that the proposed system efficiently controls the current and improved the power quality of the system. The main objective of this investigation has been to evolve different power quality improvement techniques for improving various power qualities. It has also intended to determine the extent of improvement in different power quality indices in various techniques for application. The obtained results of various circuit configurations compensator current, PCC voltages, active power filer, PCC current have demonstrated successfully fulfilling these objectives. in future the proposed configuration can be tested on hardware implementation, more advanced filtering alternative can be introduced to it for better performances.

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