A Unified Power Quality Conditioner for Power Quality Issue Mitigationer Using Neuro Fuzzy Controller

R. MANIVASAGAM (manivasagammn3@gmail.com)
K Ramakrishnan College of Engineering https://orcid.org/0000-0003-0987-5148

Research Article

Keywords: Voltage Sag, Power Quality, UPQC, Fuzzy Control, Total Harmonic Distortion, Active Filters

Posted Date: April 14th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-418873/v1

Abstract

This manuscript grants a control system for Power Quality (PQ) issues of Unified Power Quality Conditioner (UPQC) based hysteresis controller and augmentation the PQ with the help of numerous optimization methods. In numerous attractive features of UPQC, like voltage sags, voltage swells negative series current and harmonics. Foremost aim of PQ issues is the recompense of the D-FACT devices that origins an undesired effect on bearing. Optimal values for converter of UPQC its presentation can be meaningfully enhanced PQ. This paper discoursed about the UPQC physical process asserts the required meliorate the PQ at DC link integrated. The adaptive control technique for hysteresis developed by the modifying PQ with the use of the UPQC method is also briefly excused. The measurement of voltage sag and swell will be improved and sinusoidal after inoculating current and voltage to the UPQC source current and source voltage. The evaluation results inevitably show the effectiveness of the voltage sag and the voltage swell in the UPQC system based on the Neuro Fuzzy Control (NFC) controller is improved.

1. Introduction

The significant division of the distribution system vibrant is the Power Quality (PQ) related Unified Power Quality Conditioner (UPQC) devices which are established to the system as the PQ troubles moderate and PQ enhancement in dimension or actuation. In PQ troubles, they normally direct to volatility, deprived presentation and complexity among diverse regulator. The PQ trouble explains about the exploitation of entire steady FACTS devices regulators. Mainly, PQ problems can be moderate through several processes but the main explanation to moderate these troubles is FACTS devices. At this point, the presentation of PQ enhancement of the UPQC can be optimized to dropping the harmonic conflict. The entire steady series and shunt converters for UPQC device among disturbed PQ problem can be examined roughly. The reduction of UPQC system and dissimilar regulators are enhanced to optimize the PQ troubles. Therefore, several study works are used to explain about the PQ troubles lessening for the UPQC system. These are used to carry out the supreme advantage and improvement of PQ enhancement (D.Aarthi et al. 2017).

1.1 APPLICATIONS OF FACTS DEVICES WITH PQ PROBLEMS

In the broadcast and allocation systems of power contribute abundant electrical procedures are produced to obscure loads. The main electrical procedure is harmonics, which can be eradicated through the procedure of utilizing power active filters as FACTS regulator. The power electronic related circuit collection useful to AC transmission systems are the FACTS regulator. Different kind of FACTS regulator are obtainable i.e., shunt and series arrangement. The shunt arrangement supply voltage and immediate power control, the series arrangement supply current and dynamic power flow control and also the mutual shunt and series arrangement supply the entire control. The power flow difficulties are situating on through series compensator and the troubles are completely associated by the extent of line or the arrangement of the transmission network (Manivasagam.R et al 2014).

The prohibited series recompense is compulsory to accomplish above the network arrangement associated difficulty which encounter the power flow disturb and are equivalent to disk of power flow. The prohibited series capacitive recompense is employed to situate a present to voltage disintegrate through drop the ending voltage dissimilarity of the line. Through conquer the aforesaid problem power of superior eminence is produced. The superior eminence power is acquired through power active filters (Teke et al. 2011). Through approach of the DC input provided by incriminated capacitor the shunt and the series compensators which are voltage related FACTS regulator construct a group of three segment convenient productivity voltages at the power system occurrence. Since a consequence of altering the amplitude and segment angle of productivity voltage produced by means of shunt voltage resource converter. The productivity voltages of shunt voltage resource converter are contributed to resultant AC system voltage in the course of a shunt transformer (Ragavi.R et al 2015) .

The immovable of power exchange can be take place in the middle of the converter and AC system may conceivably be prohibited. In the condition of the series voltage resource converter, the amplitude and segment angle of its productivity voltage is dotted and afterward the productivity voltage is introduced in the transmission line in the course of a series united transformer. Since an outcome, the immediate power and the dynamic power exchange can be accomplished in the transmission system. During the DC link capacitors, suppose the voltage resource converter is incorporated by contribute system or through further voltage resource converter then the dynamic power will travel in the middle of their AC and DC workstation. As a consequence of this movement of dynamic power, the expansion of controllability and power eminence is attaining besides the foremost trouble all along through this is the diminution of harmonics in the power system (R.Manivasagam et al 2019).

To overcome this problem, the investigators have improved that the dynamic filters can be employed for power conditioning because they provide by the immediate power reimbursement & harmonics recompense. For illustration, every part of the power delivery systems the dynamic filters which are exploited as a declaration of harmonics. Its position from harmonics recompense of non-linear loads into harmonics segregation inserted among utilities with clients harmonics damp. In evaluation through the predictable shunt passive filters beside with SVC including capacitors bank plus thyristor prohibited reactors. These filters have offered the mandatory harmonic filtering additionally it manage presentation (Hari Prasad et al. 2011). The utilities on the PCC through elevated power clients those who accumulate their entity harmonics generating loads on power allocation systems, additionally it can as well establishment the extent of harmonics current introduced from an entity customer.

A solitary little power diode rectifier generate a mini quantity of harmonics current; in dissimilarity numerous little power diode rectifiers is competent to introduce a great quantity of harmonics into power distribution systems. A small power diode rectifier which is utilized in a convenience boundary through an electric machine is well deliberate as a private harmonics constructing load. Diminutive quantities of study researcher and engineers in power electronics with the power manufacturing region have remunerated attention on unidentified harmonic constructing loads. In elevated voltage power system the entity voltage harmonics and THD are comparatively not as a great deal as those in a standard voltage distribution system. The motive following the rigidness of elevated voltage system through the increase of diminutive circuit capability is extensive beside with inter association of elevated voltage power system (Manivasagam. R et al 2020).

2. Literature Review

Reisi et al. (2013) have broken down the quick development of nonlinear burdens prompts heaps of PQ issues, for example, sounds, unbalance operation and over the top source-end nonpartisan current in three-stage providing systems. That most Maximum Power Point Tracking (MPPT) calculation was likewise proposed to productively enhance the execution of the sun based boards. The proposed calculation was made out of two sections, set point count and tweaking. The set point figuring part, in light of the short out current strategy, first approximates greatest power. Second, correct measure of the greatest power will be followed by the tweaking part which depended on the Perturbation and Observation strategy (P&O). At that point, yield of the MPPT circuit would be associated with the DC side of the UPQC.

Shaheen et al. (2011) have assessed a Differential Evolution (DE) procedure to discover the ideal arrangement and parameter setting of Unified Power Flow Controller (UPFC) for upgrading power framework security under single line possibilities. Right off the bat, we play out a possibility examination and positioning procedure to decide the most serious line blackout possibilities considering line over-burdens and transport voltage confine infringement as an execution file.

Khadse et al. (2016) have built up the procedure of conjugate inclination back-spread based simulated neural system for continuous PQ evaluation. The ongoing voltage sag and swell location, arrangement conspire utilizing simulated neural system was displayed. The ANN was prepared in MATLAB utilizing voltage examined flag information and relating parameters of the neural system were used to actualize in Lab VIEW progressively list swell recognition and order. Information obtaining framework was utilized to gain the flag from voltage sensor. The yield of information procurement framework was given to the PC with Lab VIEW. The proposed observing framework additionally recognizes odd and even consonant parts in the voltage flicker gained utilizing FFT. Continuous equipment comes about acquired utilizing proposed PQ checking framework for discovery of voltage sag, swell and sounds asserts the reasonableness, heartiness and versatility to screen PQ issues.

Kumar et al. (2017) have exhibited a double tree-complex wavelet change based control calculation for a DSTATCOM to enhance the PQ in a conveyance framework. PQ unsettling influences like music and beginning and additionally completion of unbalancing in all stage are likewise evaluated at the same time. The contorted load current of each stage was disintegrated into different recurrence levels with that system to remove separate line recurrence part for the estimation of the reference dynamic power segment. The proposed control calculation was additionally approved tentatively on a research facility model of DSTATCOM.

2.1 PROBLEM FORMULATION

A basic purpose of the voltage sags and swells behind intrusion underway plants. By and large for end instrumentality glitches the sparing distinguishing proof will bring about interruption and crucial costs inferable from loss of creation. The anticipated procedure to increase PQ of the adaptive hysteresis control technique with UPQC is clarified in below section.

2.2 BASIC OPERATION OF UPQC

The basic structure of the UPQC is discovered by Fig. 1.

Advantages of UPQC

- There is an important increase in interest for using UPQC in distributed generation affiliated with smart grids because of availability of high frequency switching devices and advanced fast computing devices (micro controllers, DSP, FPGA) at lower cost.

3. Proposed Adaptive Hysteresis Control Technique Based Upqc Operation

This section distinguishes about the modeling and operation of the adaptive hysteresis control technique based UPQC system illustrated in Fig. 2.

3.1 PROPOSED ADAPTIVE HYSTERESIS CONTROL TECHNIQUE

This section depicts about the modeling and operation of the adaptive hysteresis technique based UPQC control algorithm illustrated in Fig. 3.In the Fig. 3 (a)and (b), the performance analysis of voltage and current reference calculation has been determined.Here,voltage and current block is calculated by the reference voltage and reference current. In the Fig. 3 (c), the analysis of NFC hysteresis band control has been illustrated.

The versatile hysteresis band current control method has ended up being most appropriate for every one of the uses of current and voltage controlled shunt and series APF in UPQC. The versatile hysteresis band current control is described by unconditioned strength, quick reaction and great exactness. The essential versatile hysteresis procedure shows likewise a few unwanted highlights, for example, uneven exchanging recurrence that causes acoustic clamor and trouble in outlining input channels. Likewise, the versatile hysteresis band current controllers have been utilized with the foundation of an appealing component that the hysteresis band is being encoded as an element of the provided parameters of the source and load to upgrade the PWM execution, which brings about the lessening of PQ issues in the UPQC control.

4. Results And Discussion

Through this section described about the implementation of the control techniques for bettering PQ by making use of UPQC linked non-linear system is described in Fig. 4.

The output performance was assessed using the ANN technique of the UPQC, defined in Figure 5. In Figure 5, the compensation of PQ problems in supply voltage, the peak value of 380V at the onset of fault occurrence, was analyzed (a). The compensation of the UPQC supply current using the ANN technique was evaluated in Figure 5 (b). The PQ problems occurred at 90A in the 0.2 seconds to 0.25 seconds here and it takes 0.25 seconds to 0.3 seconds to compensate for the PQ problems. Load voltage and load current compensation for UPQC using the ANN technique has been calculated in Figure 5 (c and d). Load voltage and current occurred here at 0.2 seconds to 0.25 seconds for voltage sag and load voltage and current takes 370V and 30A for voltage sag (Manivasagam Rajendran 2020).

The injected voltage in Fig. 6 (b) will show the position of the swells, where the voltage difference is 0.04 at 750 V to 0.08 at 200 V. In Renduchintala & Chengzong Pang (2016). In Fig. 7 (b), the injected voltage will show the position of the sag/swells, where the voltage variation is from 0.04 to 0.08 above 400V .Then equalizing the injected voltage and the source voltage can be matched and the load can get adequate load voltage without distortions.

The feedback control mechanism works immediately when the UPQC is converted to ON, forcing the dc connection voltage of different techniques are shown in Fig. 8 (a), (b), (c). The settling voltage is the 240V, 250V and 70V settling phase without the controller, FLC and NFC technique.

Table 1
The NFC, FLC and NN Dependent Controller RMS Voltages

Time instant in sec	**RMS Voltage (in Volts)**	**RMS Voltage (in Volts) after PQ enhancement**		
		NFC	**FLC**	**NN**
0.03	95	28	63	49
0.06	91	31	81	53
0.13	91	53	56	53
0.15	70	74	76	75
0.17	88	31	77	40

Table.2 Review of the results of various techniques

Solution techniques	Fault time (in sec)	Source voltage during fault (in V)	Load voltage (in V)	THD level
UPQC	0.04–0.08	400	300	4.2547
ANN	0.04–0.08	400	340	3.0125
FLC	0.04–0.08	400	360	3.5364
NFC	0.04–0.08	400	370	2.8239

In Table 1, the RMS voltages from different controllers are specified. Table 2 explains the output of the controllers listed in relation to PQ.

5. Conclusion

Dynamic loads can be considered in future work and the effect of UPQC with them can be studied. Nowadays, age of power from renewable sources has enhanced in particular. Using wind vitality and solar powered vitality as a renewable source to produce power has grown quickly. UPQC can be joined with one or a few DG system to give great quality energy to the consumers. Power produced by wind or sunlight based vitality can be nourished to the DC link through converter to make the UPQC more viable amid serious system conditions.

Declarations

On behalf of all authors, the corresponding author states that there is no conflict of interest.

References

1. Aarthi and R.Manivasagam, 2017 “Design and Implementation of UPFC Using Ten Switch Converter With Switch Reduction”, International Journal Of Engineering And Computer Science, vol.6,Issue.6, Page no. 21861-21869.
2. Hari Prasad,A, Rajasekhar Reddy,Y & Kishore,PV 2011, ‘Photovoltaic Cell as Power Quality conditioner for Grid connected system’, An International Journal of Scientific and Engineering Research, vol.2, no.10, pp.1-8.
3. Khadse, Chetan, B, Madhuri A Chaudhari & Vijay B Borghate, 2016, ‘Conjugate gradient back-propagation based artificial neural network for real time power quality assessment’, International Journal of Electrical Power & Energy Systems, vol.82, pp.197-206.
4. Kumar, Raj, Bhim Singh, Shahani,DT & Chinmay Jain 2017, ‘Dual-Tree Complex Wavelet Transform-Based Control Algorithm for Power Quality Improvement in a Distribution System’, IEEE Transactions on Industrial Electronics, vol.64, no.1, pp.764-772.

5. Manivasagam, R. and Prabakaran, R. 2020 ‘Power quality improvement by UPQC using ANFIS-based hysteresis controller’, Int. J. Operational Research, Vol. 37,No. 2, pp.174–197.
6. Manivasagam,R and Dharmalingam, V. 2014 “Power Quality Problem Mitigation by Unified Power Quality Conditioner: An Adaptive Hysteresis Control Technique”, International Journal of Power Electronics, Vol. 6, No.4, pp.No- 403- 425.
7. Raghavi, R and Manivasagam,R. 2015 “Modeling of a Grid Connected New Energy Vehicle Charging Station” International Journal of Applied Engineering Research (IJAER), Volume 10, Number 20 , Special Issues, pp. 15870-15875.
8. Manivasagam, P. Parthasarathy, and R. Anbumozhi, 2019 "Robust analysis of T-S fuzzy controller for nonlinear system using H-infinity," Advances in Intelligent Systems and Computing, vol. 949, pp. 643-651. Available at: https://doi.org/10.1007/978-981-13-8196-6_56.
9. Manivasagam and D. Aarthi, 2017 "Design of UPFC using ten switch converter with switch reduction," International Journal for Scientific Research & Development, vol. 5, pp. 490-493.
10. Reisi, Ali Reza, Mohammad H Moradi & Hemen Showkati 2013, ‘Combined photovoltaic and unified power quality controller to improve power quality’, Solar Energy, vol.88, pp.154-162.
11. Renduchintala, UK & Chengzong Pang 2016, ‘Neuro-fuzzy based UPQC controller for Power Quality improvement in micro grid system’, IEEE/PES Transmission and Distribution Conference and Exposition, Dallas, pp. 1-5.
12. Shaheen, Husam, I, Ghamgeen I Rashed & Cheng,SJ 2011, ‘Optimal location and parameter setting of UPFC for enhancing power system security based on differential evolution algorithm’, International Journal of Electrical Power & Energy Systems, vol.33, no.1,
94-105.
13. Teke,A, Saribulut, L & Tumay, M2011, ‘A Novel Reference Signal Generation Method for Power-Quality Improvement of Unified Power-Quality Conditioner’, IEEE Transactions on Power Delivery, vol.26, no.4, pp. 2205-2214.
14. Manivasagam Rajendran. "Comparison of Various Control Strategies for UPQC to Mitigate PQ Issues", Journal of The Institution of Engineers (India): Series B, 2020.https://doi.org/10.1007/s40031-020-00502-4.

Figures

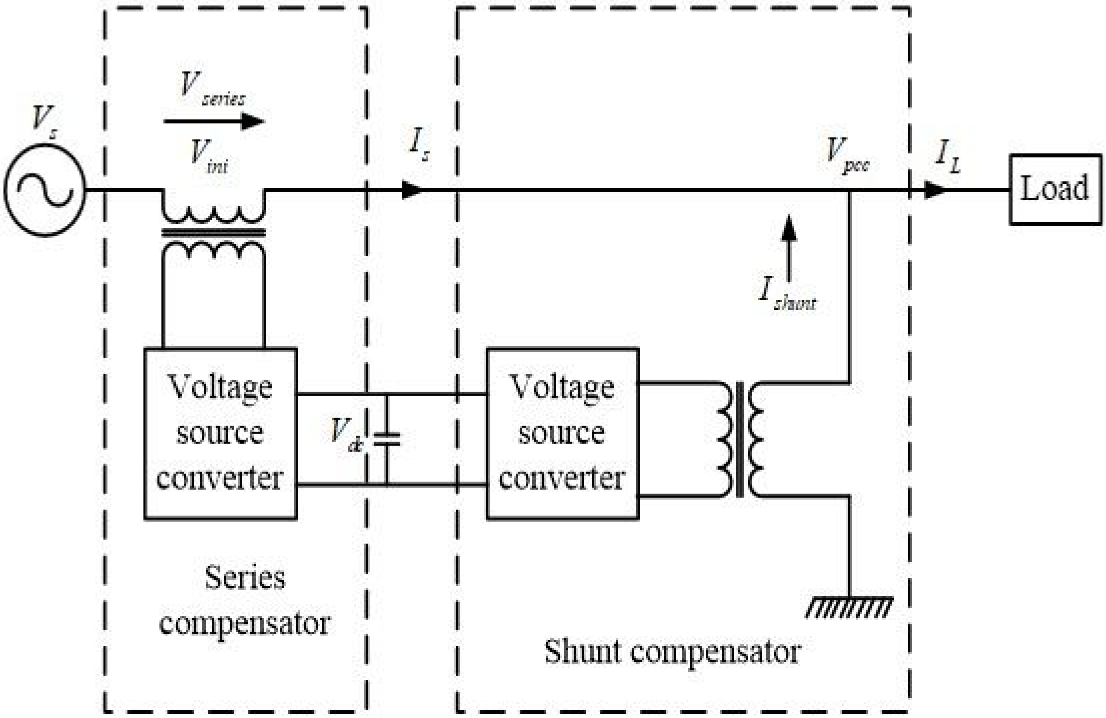

Figure 1

Basic structure of the UPQC

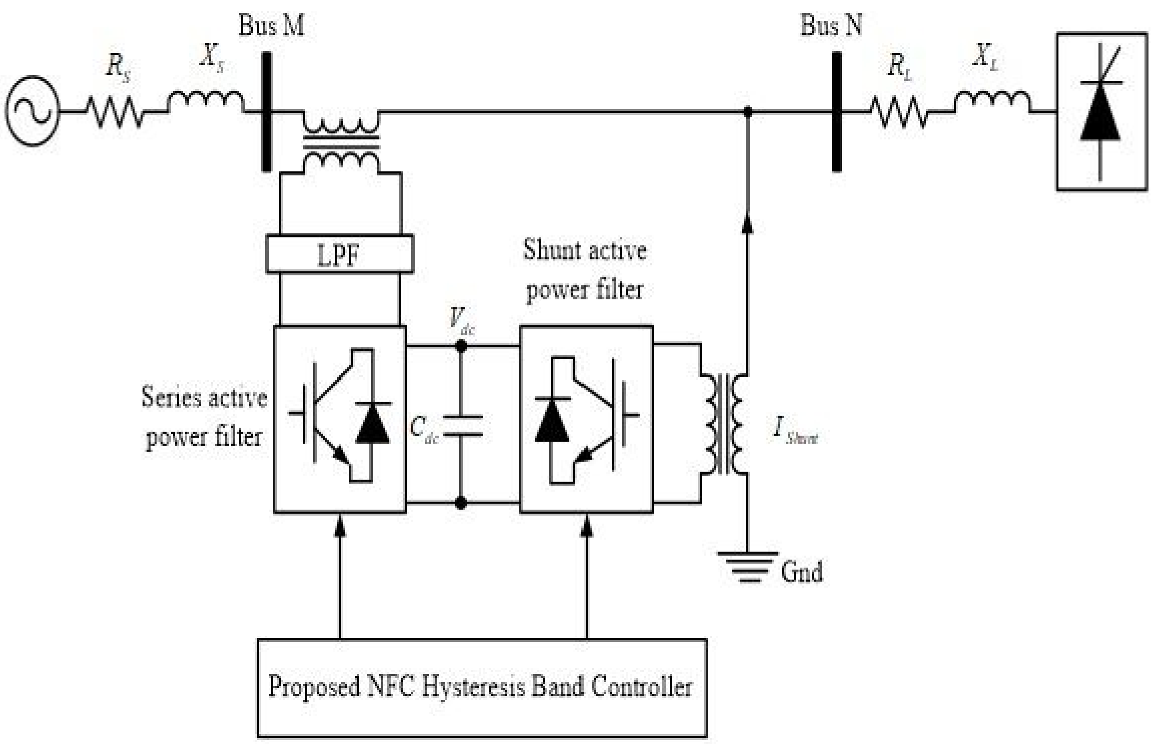

Figure 2

Proposed control technique based UPQC structure

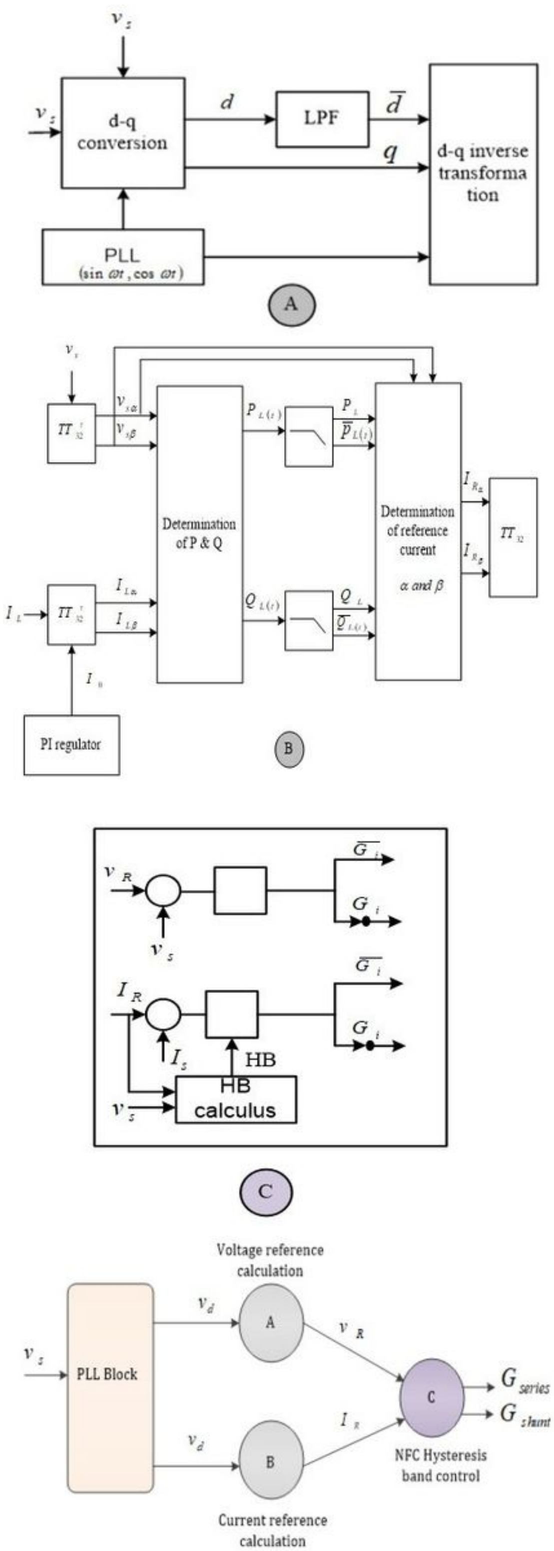

Figure 3

The block diagram for the proposed UPQC control algorithm dependent control technique

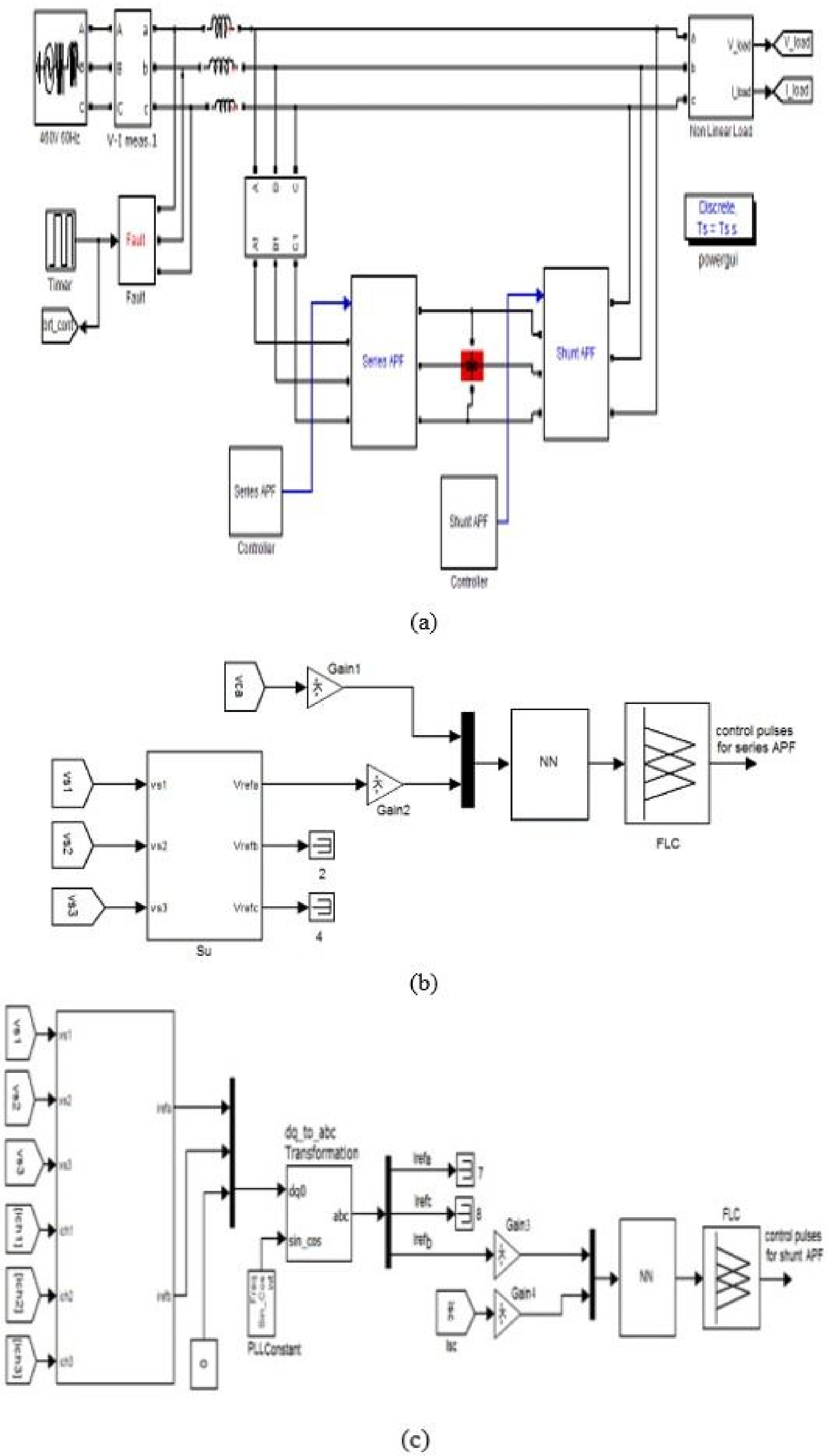

Figure 4

(a) The UPQC implementation model with the control block (b) the active filter sequence and (c) the active filter shunt

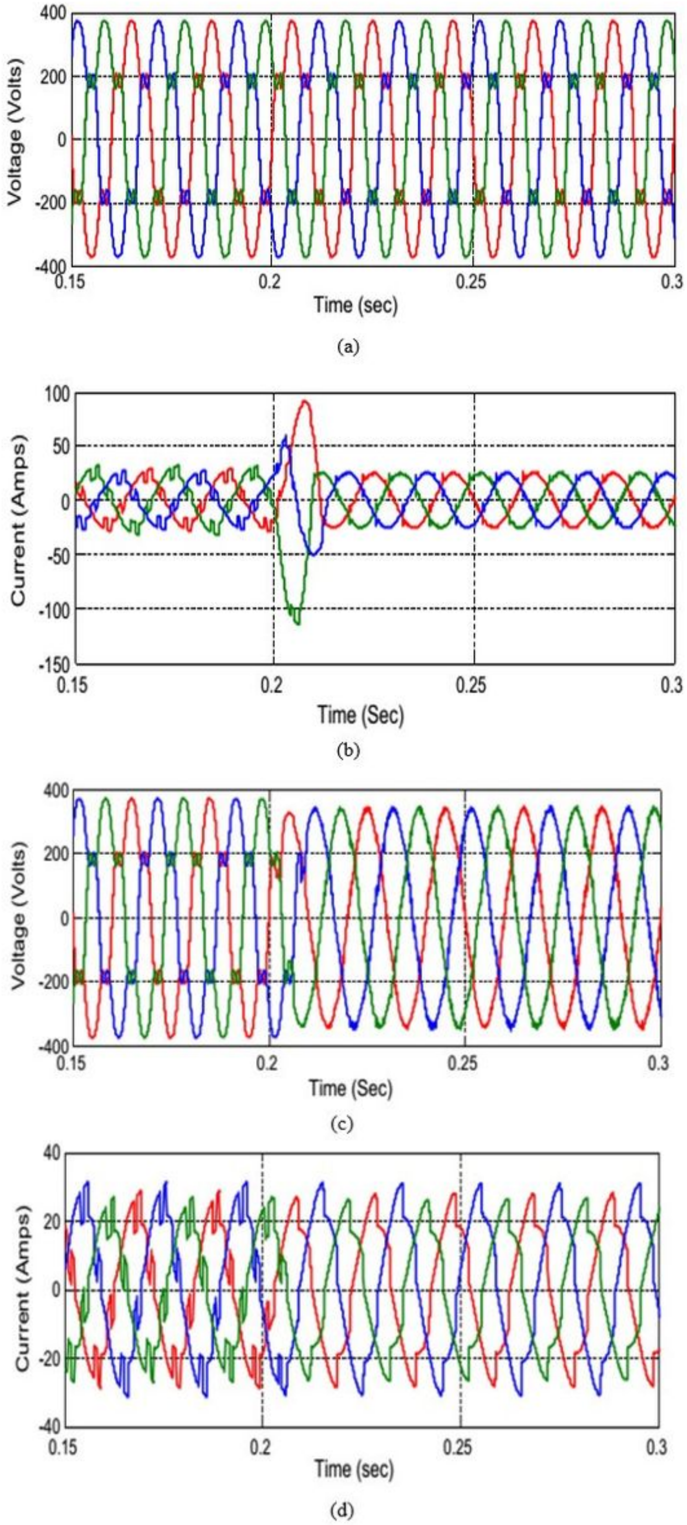

Figure 5

Compensation of a) voltage of supply, (b) current of supply, (c) voltage of load, (d) current of load with UPQC using ANN

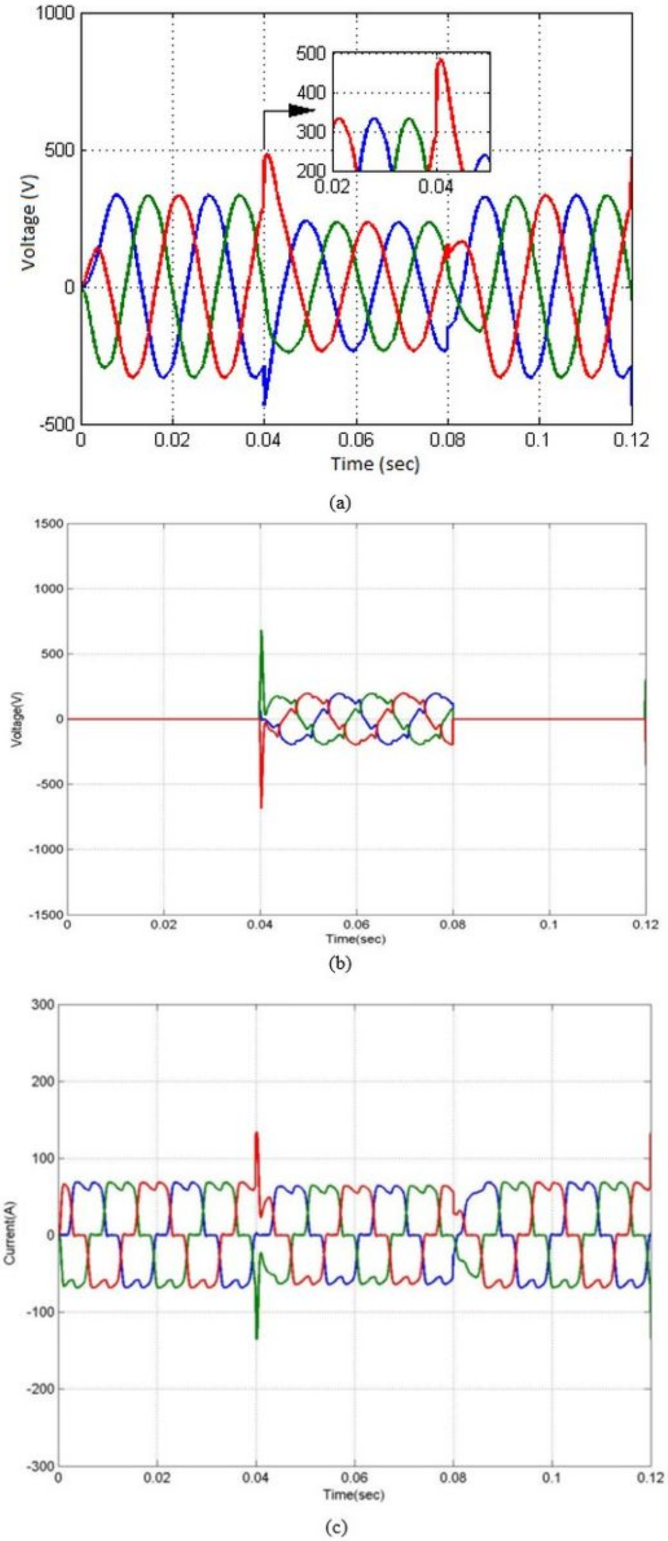

Figure 6

Analysis of the output of a) load voltage (b) injected voltage and (c) load current by FLC

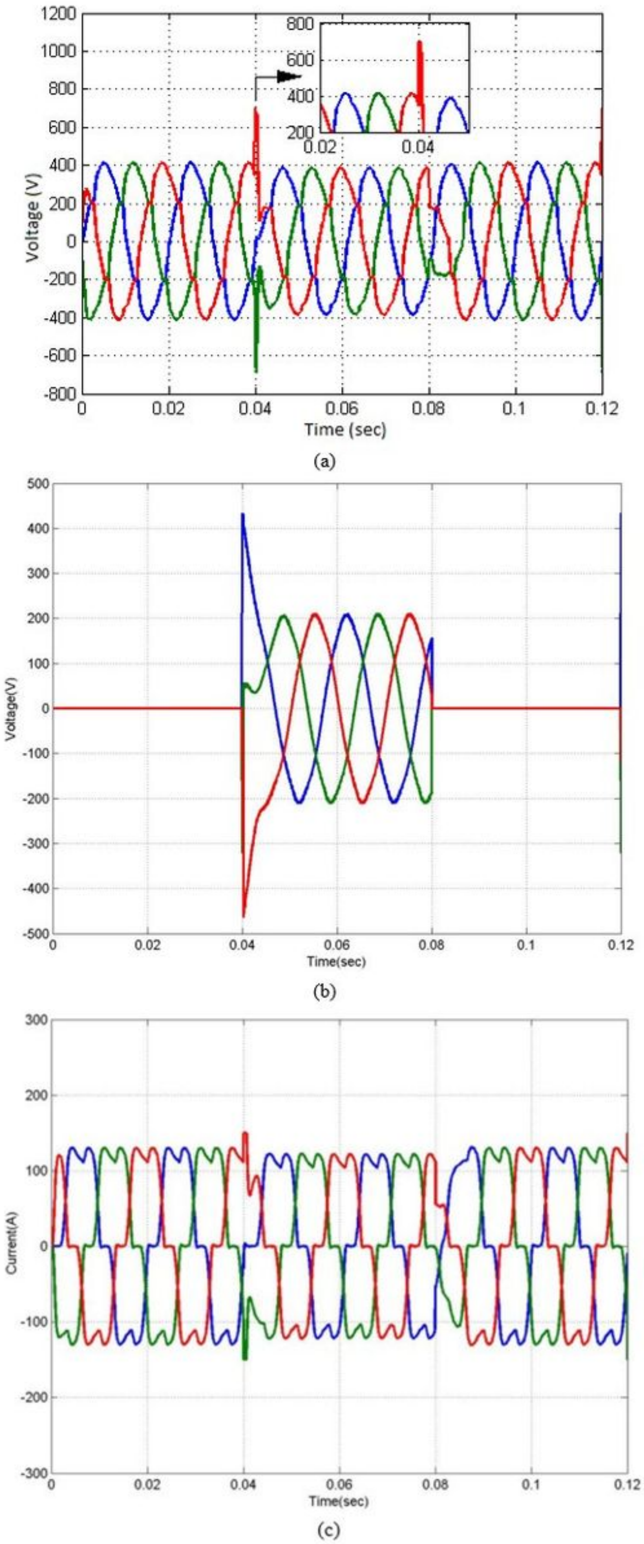

Figure 7

Analysis of a) Load voltage (b) Injected voltage (c) Use NFC to load existing

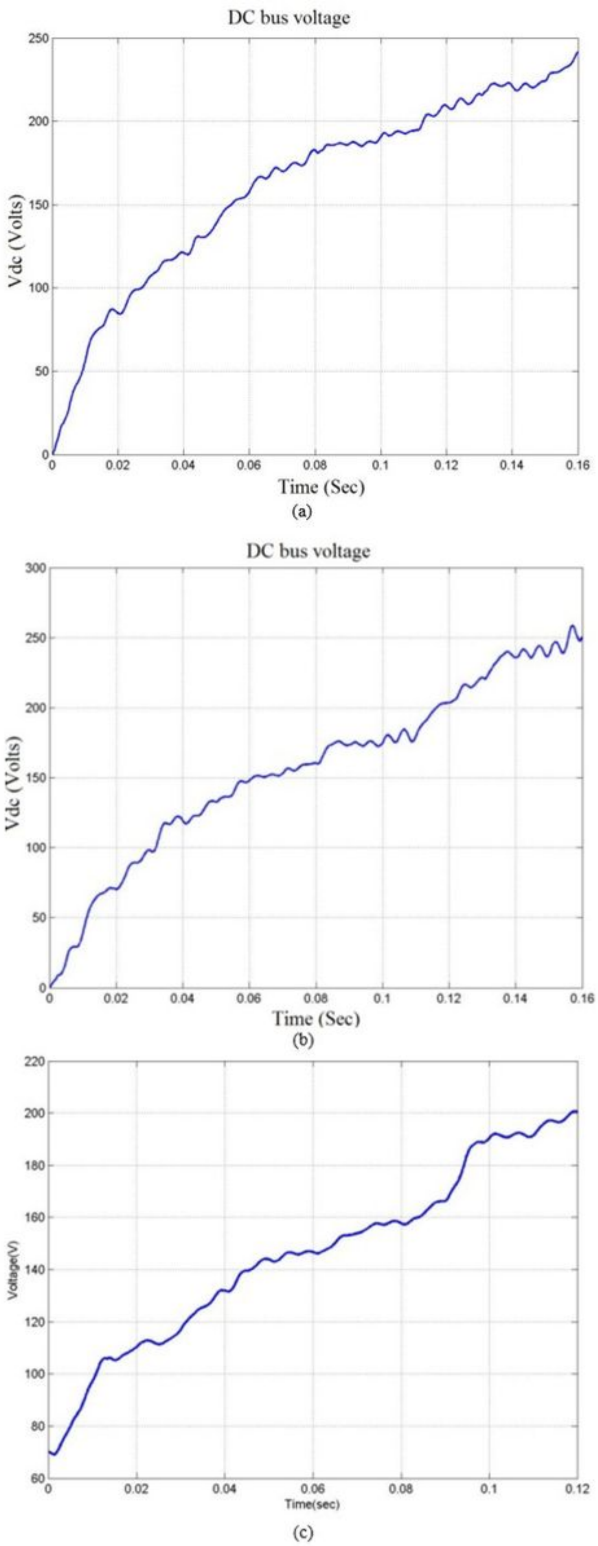

Figure 8

DC voltage analysis using a) without a controller (b) FLC (c) NFC