

Neuro Fuzzy Based Unified Power Quality Conditioner for Power Quality Improvement Fed Induction Motor Drive

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Article Info

Article history:

Received Nov 2, 2014

Revised Jan 3, 2015

Accepted Feb 3, 2015

Keyword:

Harmonic compensation

Induction motor

Neuro fuzzy controller

Power quality

ABSTRACT

The unified power quality conditioner (UPQC) plays an important role in the constrained delivery of electrical power from source to an isolated pool of load or from a source to the grid. In this paper presents neuro fuzzy based unified power quality conditioner. The series converter is used to compensate voltage sag/swell compensation. The shunt converter is used to compensate reactive power compensation present in the linear and nonlinear load. The performance of neuro fuzzy and with artificial neural network controller is compared. This approach eliminates the total harmonic distortions efficiently. The performance of proposed system is analysed using Mat lab/Simulink.

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1. INTRODUCTION

The power quality is seriously distributed due to the wide use of nonlinear loads and various faults in power system. The computerized electronics devices and controlling equipment demand higher levels of power quality. These devices are sensitive to small changes of power quality and a short time change on PQ can cause great economic losses [1, 2]. Power quality is the set of limits of electrical properties that allows electrical system to function in proper manner without significant loss of performance like flexible AC transmission system. The harmonic causes of power quality, poor power factor, supply voltage variations etc. In recent years the demand on the quality of electric power has been increased rapidly. The power quality problems have received a great attention nowadays because of their impacts on utilities and customers. Voltage sag, swell, momentary interruption, under voltages, noise and harmonics are the most common power quality disturbances. Unified power quality conditioner is one of the power electronics devices that are used for enhancing PQ. The performance of UPQC must be improved to reduce the PQ disturbances [3]. Unified power quality (UPQC) is one of the best custom power device used to compensate both source and load side problems. It consists of shunt and series converters connected back to back to a common dc link.

2. UNIFIED POWER QUALITY CONDITIONER

Figure 1 shows UPQC configurations of shunt inverter and series inverter. The main purpose of a UPQC is to compensate the voltage its eliminates the harmonics. Which improves the power quality offered for other harmonic sensitive loads [4,5]. The shunt and series inverters are shared by common dc link. UPQC

consists of series inverter and shunt inverter which compensates the voltage and current harmonics of nonlinear loads.

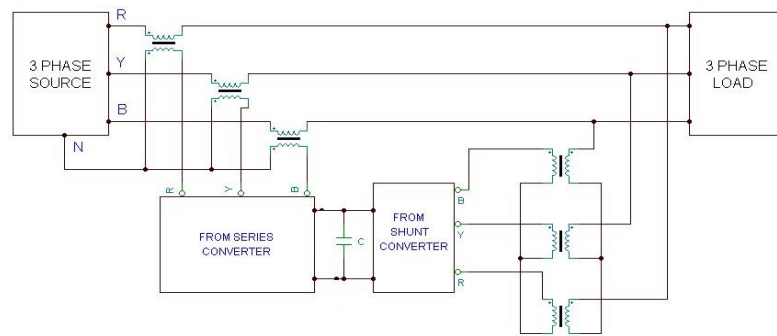


Figure 1. Unified Power Quality Conditioner Configurations

3. ADAPTIVE NEURO FUZZY INFERENCE SYSTEM CONTROLLER

ANFIS is one of the recent controllers used for regulate dc-link voltage for UPQC. In this paper ANFIS based UPQC is on produced to regulate dc link voltage. This techniques is used for generating the compensating current to eliminate the harmonics and it can be generated by the system. The membership function can be optimized by using fuzzy logic implemented network neuron. ANFIS can construct an input/output mapping and set up the data pairs based on both human knowledge (in the form of fuzzy IF-THEN rules) and simulation input output membership function and rules can be created using fuzzy logic. The various researches have been performed in the power quality maintenance. Some of the devices such as dynamic voltage restorer (DVR), uninterruptible power supplies (UPS) and many devices used for maintaining the quality power supply [7, 8]. But, these devices are capable of maintaining the power quality in the distribution network .Hence this paper, a new technique a neuro fuzzy based on Takagi Sugeno fuzzy inference system is introduced. The generated fuzzy rules can be trained by using the neural network and we get a desired output of an UPQC[6].UPQC is one of the FACTS device, designed for both compensate both source side and load side problems. The UPQC combines shunt active filter and series active filter t in a back to back connection, to reduce the power quality problems and power factor correction in a distribution network. Reactive power compensation can be performed. Hence this paper proposed Neuro fuzzy technique can be used to regulate DC link voltage of a DSTATCOM and load waveforms can be maintained as constant. The DC link capacitor voltage maintained as constant level [9].

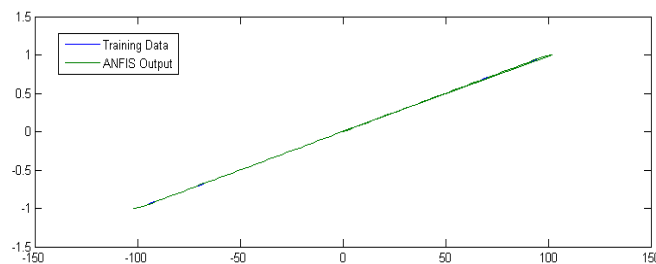


Figure 2. ANFIS Training Data and Output Data

3.1. Working Procedure

1. Initialization of the input variables.
2. Fuzzification and defuzzification is done using fuzzy operators like as AND, OR operators.
3. The membership function can be performed through the learning process.
4. The parameters of a membership function changes through the learning process.
5. Fuzzy rules can be created input and output membership function of the system.

6. After creating fuzzy rules, the results can be defuzzified to get an optimal output of a system.
7. Neural network can be trained implemented by means of fuzzy logic.
8. The error is minimized by performing various iterations in the neural network.

3.2. ANFIS Controller Information

Number of nodes: 32

Number of linear parameters: 14

Number of nonlinear parameters: 23

Total number of parameters: 37

Number of training data pairs: 69

Number of checking data pairs: 0

Number of fuzzy rules: 7

Type: Takagi- Sugeno fuzzy inference system

Start training ANFIS

1. 0.00132003

2. 0.00131659

3. 0.00131279

4. 0.00130813

5. 0.001304

Step size increases to 0.011000 after epoch 5.

6. 0.00130198

7. 0.00129743

8. 0.00129312

9. 0.00129076

Step size increases to 0.012100 after epoch 9.

10. 0.00128804

11. 0.00128393

12. 0.00128142

13. 0.00127962

Step size increases to 0.013310 after epoch 13.

14. 0.00127614

15. 0.00127375

16. 0.00127266

17. 0.00126944

Step size increases to 0.014641 after epoch 17.

18. 0.00126791

19. 0.00126705

20. 0.00126408

Designated epoch number reached --> ANFIS training completed at epoch 20.

3.3. Program

```
trnData = xlsread('Train.xlsx');
Vdc_Anfis_Train_File=strcat(pwd,'\Vdc_Anfis_Train.mat');
x=trnData(:,1);
y=trndata(:,2);
numMFs = 30;
out_fis=Anfis(trnData, Vdc_Anfis_Train,20);
Plot(x,y,x,evalfis(x,out_fis));
legend('Training Data','ANFIS output');
```

4. ARTIFICIAL NEURAL NETWORKS CONTROLLER

Artificial neural networks (ANNs) are composed of simple elements and operating in parallel. These elements are inspired by biological nervous systems. As in nature, the network function is determined largely by the connection between elements. Artificial neurons are used to represent the biological neurons abstraction carried out computer program. Figure 3 shows the neural network architecture. Figure 4 shows the training state of the graphical representation.

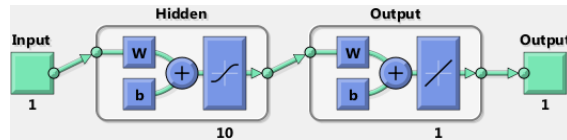


Figure 3. Neural Network Architecture

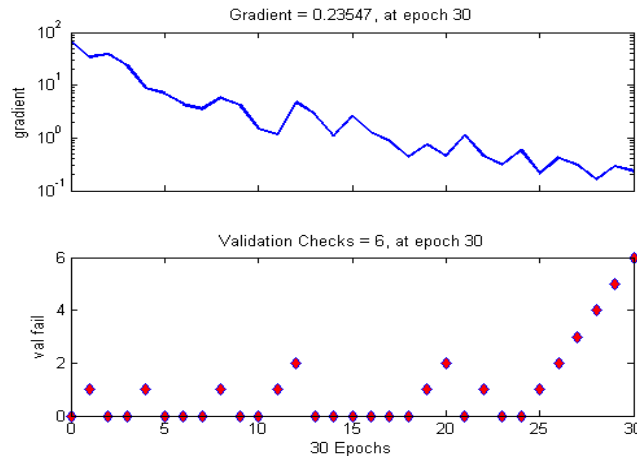


Figure 4. Training State

4.1. ANN Controller Information

Number of input: 1
 Number of input layers: 2
 Number of output: 1
 Hidden layer size: 10
 Network: feed forward network

4.2. Program

```
Test the Network:
Outputs= net (inputs);
Errors = gsubtract(targets, outputs);
Calculate the Training, Validation and Test Performance:
trainTargets = targets .* tr.trainMask{1};
valTargets = targets .* tr.testMask{1};
trainPerformance= perform(net, trainTargets, outputs);
valPerformance = perform(net, valTargets, outputs);
testperformance=perform(net, trainTargets, outputs);
```

5. RESULT AND ANALYSIS

The Figure 5 shows that Simulink model of ANFIS based UPQC. It consists of DSTATCOM and DVR shared with common dc link. The output side induction motor load and variable load can be connected. Induction motors have been widely used in the industry compare to other rotating machineries, because of the existence of the large inductances in the induction motors which could weaken their ride through capability. They are thought to be particularly vulnerable to voltage dips. The induction motors consist of electromagnetic transients and electromechanical transients. Voltage sag phenomenon is usually associated with fault and its subsequent clearance for a few cycles of the main frequency. DC voltage can be varied with the load changes. UPQC for harmonic elimination and simultaneous compensation of voltage and current, which improves the power quality offered for other harmonic sensitive loads. Dc link voltage is required to maintain the dc capacitor average voltage at a constant level. The dc link voltage of the Unified Power Quality Conditioner (UPQC) can significantly deviate from its reference during a transient event. DC voltage

can be varied with the load changes. The ANFIS controller input can be DC link error input voltage and then output voltage can be regulated DC link output voltage. The simulation results on ANN and ANFIS based unified power quality conditioner are given as below.

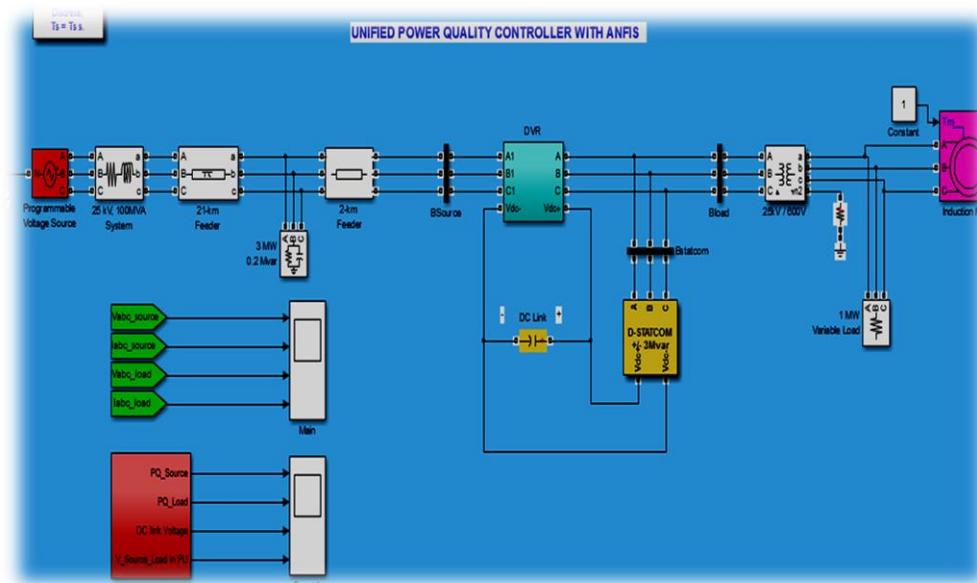


Figure 5. Simulink Model of ANFIS Based UPQC

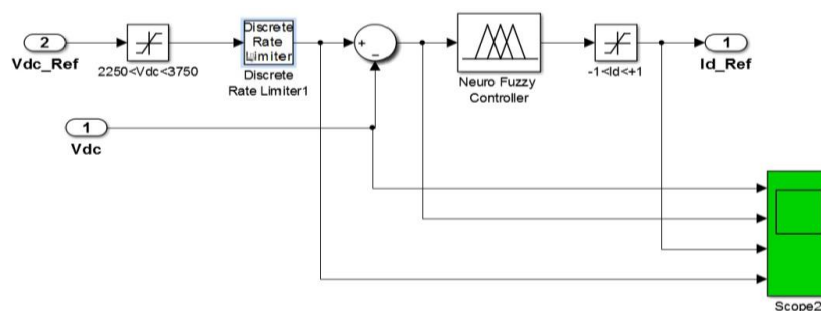


Figure 6. Subsystem Model of ANFIS

The Figure 7 shows that ANFIS based UPQC source voltage and source currents can be disturbed but load voltage and load currents can be compensated. The UPQC can be used for power quality problems can be reduced for load side. The corresponding reactive power compensation wave forms shown in the Figure 8. The reactive power source side maintained at zero. The only difference ANFIS based UPQC and ANN based UPQC THD can be varied. The proposed ANFIS method compared to ANN method, THD can be reduced for ANFIS method. The source voltage THD can be reduced 14.12% with the ANN controller and 13.91% with ANFIS controller. The load voltage THD can be reduced 10.86% with the ANN controller and 10.57% with ANFIS controller.

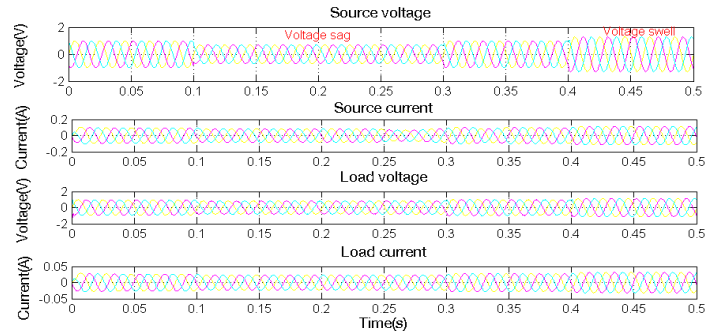


Figure 7. Source and Load Side Waveforms on ANFIS Based UPQC

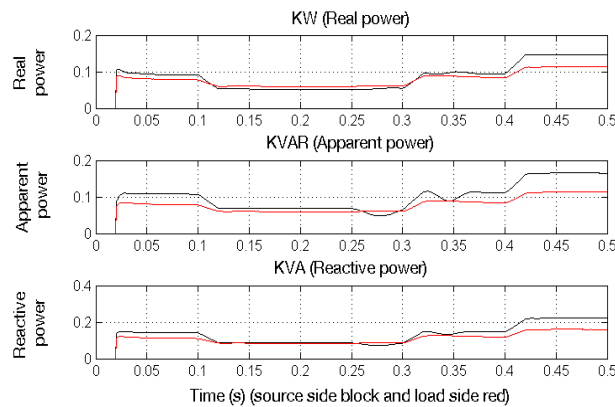


Figure 8. Reactive Power Compensation and DC Link Waveform on ANFIS Based UPQC

Table 1 Performance of the ANN and ANFIS Controller

Quantity	ANN controller		ANFIS controller	
	Magnitude	THD%	Magnitude	THD%
Source voltage	1.021	14.12	1.022	13.91
	1.02	14.93	1.02	14.79
	1.021	14.53	1.021	14.31
	0.9875	10.75	0.9872	10.76
Load voltage	0.996	10.86	0.9962	10.57
	0.988	11.12	0.9883	11.00
	1.342	9.63	1.341	9.78
Load current	1.348	9.21	1.347	9.11
	1.338	10.32	1.338	10.23

6. CONCLUSION

The Unified power quality conditioner (UPQC) is a device which can be used to solve power quality problems. It takes series and shunt active power filters to compensate both load voltage and load current. In this paper artificial intelligence of adaptive Neuro Fuzzy Inference System (ANFIS) has been used for the control of UPQC DC bus voltage. This paper is based on comparison between an ANN and ANFIS controller to regulate the DC bus voltage. The performance of the system for applications such as voltage sag, harmonics elimination has been successfully examined and analysed. ANFIS controller presents good results compared with an ANN controller. THD values are minimum for the voltage and the current, which is evident from the results.

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BIOGRAPHIES OF AUTHORS



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