JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

APPLICATION OF FUZZY CONTROLLED APF IN MICROGRIDS FOR REDUCING HARMONICS

[1] Bapanapati Kiran Babu, [2] CH.Surendra,M.Tech
[1]M.Tech PG Scholar, [2]Asst.Professor
[1,2]Deptartment Of EEE,
[1,2] SKR College of Engineering and Technology,Konduru satram (v),Manubolu(m),SPSR Nellore(dt),Andhra Pradesh.

Abstract:

In micro grid distribution systems, the load has been a sudden increase or decreases and itis like as nonlinear loads so the load drawn on-sinusoidal currents from the AC mains and causes the load harmonics and reactive power, and excessive neutral currents that gives harmonics in power systems. Most harmonic problems created in power systems are due to the nonlinear characteristics and fasts witching of power electronic devices. The Shunt active power filter as a most viable solution. This project presents the harmonics compensation in micro-grid distribution system by fuzzy controlled shunt active power filter. The technique which is used for generate desired compensation currents to reduce the harmonics in the power system. The MATLAB Systems tool has proved that the system inject harmonic currents drawn by nonlinear loads.

I.INTRODUCTION

With the development of power electronics technology, nonlinear loads in power system are increasing which generate reactive current and harmonics. Harmonic has some impacts on the safe operation of a variety of electrical equipments and can cause severe damage to the equipment and power system. Active power filter can play role on changing frequency and amplitude of harmonic and reactive current compensation it is an important trend in both harmonic suppression and the current research focus in the field of power electronics technology. In recent years, shunt active power filter (SAPF) is an effective device to implement the harmonic current in the grid and attracts more and more attention in the modern society; research studies on the APF including harmonic detection, topology studies, system modeling, and control methods become promising topics; the new type of intelligent control and adaptive control methods get a lot of development. There are many current tracking control methods, such as single cycle control, hysteresis current control, space vector control, sliding mode control, deadbeat control, repetitive control, predictive control, fuzzy control, adaptive control, iterative learning control and artificial neural network control. Rahmani et al. introduced a comparative study of shunt hybrid and shunt active power filters for single phase applications both in simulation and experimental validations.

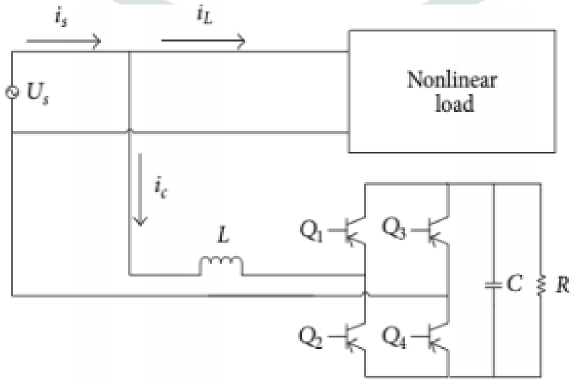

Fig.1.1. Basic circuit structure of shunt APF.

Proposed a model reference adaptive controller to control the circuit, improve the current, and reduce the current harmonics by using the approximate dynamic model of single-phase shunt APF as shown in Fig.1. Matas et a showed a feedback linearization approach of a single-phase APF via sliding mode control. Hua et al gave control analysis of an APF using Lyapunov analysis. Montero et al. compared different control strategies for shunt APF in three-phase four wire systems. Valdez et al. designed an adaptive controller for shunt active filter in the presence of a dynamic load and the line impedance. Marconi et al. developed robust nonlinear controller to compensate harmonic current for shunt active filters. Sriram et al. proposed indirect current control of a single-phase voltage-sourced boost-type bridge converter operated in the rectifier mode. Some other control methods and harmonic suppression approaches for APF have been investigated. Singh et al. presented a simple fuzzy logic based robust APF for harmonics minimization under random load variation. Bhende et al. Developed a TS-fuzzy controller for load compensation of APF.

II.POWER QUALITY

2.1 INTRODUCTION

Power quality is defined as the concept of powering and grounding sensitive equipment in a matter that is suitable to the operation of that equipment.

There are many different reasons for the enormous increase in the interest in power quality. Some of the main reasons are:

1.Electronic and power electronic equipment has especially become much more sensitive. Equipment has become less tolerant of voltage quality disturbances, production processes have become less tolerant of incorrect of incorrect operation of equipment, and companies have become less tolerant of production stoppages. The main perpetrators are interruptions and voltage dips, with the emphasis in discussions and in the literature being on voltage dips and short interruptions. High frequency transients do occasionally receive attention as causes of equipment malfunction.

2.Equipment produces more current disturbances than it used to do. Both low and high power equipment is more and more powered by simple power electronic converters which produce a broad spectrum of distortion. There are indications that the harmonic distortion in the power system is rising, but no conclusive results are obtained due to the lack of large scale surveys.

3. The deregulation of the electricity industry has led to an increased need for quality indicators. Customers are demanding, and getting, more information on the voltage quality they can expect.

4.Also energy efficient equipment is an important source of power quality disturbance. Adjustable speed drives and energy saving lamps are both important sources of waveform distortion and are also sensitive to certain type of power quality disturbances. When these power quality problems become a barrier for the large scale introduction of environmentally friendly sources and users' equipment, power quality becomes an environmental issue with much wider consequences than the currently merely economic issues.

2.2 NEED FOR POWER QUALITY IMPROVEMENT

1. Equipment has become less tolerant of voltage quality disturbances, production processes have become less tolerant of incorrect of incorrect operation of equipment, and companies have become less tolerant of production stoppages. Note that in many discussions only the first problem is mentioned, whereas the latter two may be at least equally important .All this leads to much higher costs than before being associated with even a very short duration disturbance. The main perpetrators are interruptions and voltage dips, with the emphasis in discussions and in the literature being on voltage dips and short interruptions. High frequency transients do occasionally receive attention as causes of equipment malfunction but are generally not well exposed in the literature.
2. Equipment produces more current disturbances than it used to do. Both low and high power equipment is more and more powered by simple power electronic converters which produce a broad spectrum of distortion. There are indications that the harmonic distortion in the power system is rising, but no conclusive results are obtained due to the lack of large scale surveys.
3. The deregulation of the electricity industry has led to an increased need for quality indicators. Customers are demanding, and getting, more information on the voltage quality they can expect. Some issues of the interaction between deregulation and power quality are discussed.
4. Also energy efficient equipment is an important source of power quality disturbance. Adjustable speed drives and energy saving lamps are both important sources of waveform distortion and are also sensitive to certain type of power quality disturbances. When these power quality problems become a barrier for the large scale introduction of environmentally friendly sources and users' equipment, power quality becomes an environmental issue with much wider consequences than the currently merely economic issues.

2.3 POWER QUALITY STANDARDS

2.3.1 PURPOSE OF STANDARDIZATION

Standards that define the quality of the supply have been present for decades already. Almost any country has standards defining the margins in which frequency and voltage are allowed to vary. Other standards limit harmonic current and voltage distortion, voltage fluctuations, and duration of an interruption. There are three reasons for developing power quality standards.

2.3.2 THE EUROPEAN VOLTAGE CHARATERISTICS STANDARD

European standard 50160 [80] describes electricity as a product, including its shortcomings. It gives the main characteristics of the voltage at the customer's supply terminals in public low-voltage and medium-voltage networks under normal operating conditions. Some disturbances are just mentioned, for others a wide range of typical values are given, and for some disturbances actual voltage characteristics are given.

Voltage variation: Standard EN 50160 gives limits for some variations. For each of these variations the value is given which shall not be exceeded for 95% of the time. The measurement should be performed with a certain averaging window. The length of this window is 10 minutes for most variations; thus very short time scales are not considered in the standard. The following limits for the low-voltage supply are given in the document:

Voltage magnitude: 95% of the 10-minute averages during one week shall be within ±10% of the nominal voltage of 230 V.

Phenomenon	Basic level
Magnitude variations	Voltage between 207 and 244 V
Voltage unbalance	Upto 2%
Voltage fluctuations	Not exceeding the flicker curve
Frequency	In between 49.5 and 50.5 Hz

TABLE 2.1 Voltage Characteristics as Published by Goteborg Energy

3.Principles for improving power quality

From the discussion already presented, it is evident that for improving power quality, the steps given in fig (4) have to be taken. As also pointed out, the appropriate decomposition of power for purposes of both identification and control of the distortion elimination by filters has to be achieved. Since it is essential to use clear and consistent terminology, the term non-active power filter will be used for equipment that eliminates non-active power. The actual types of these filters are to be discussed in a further chapter of this paper.

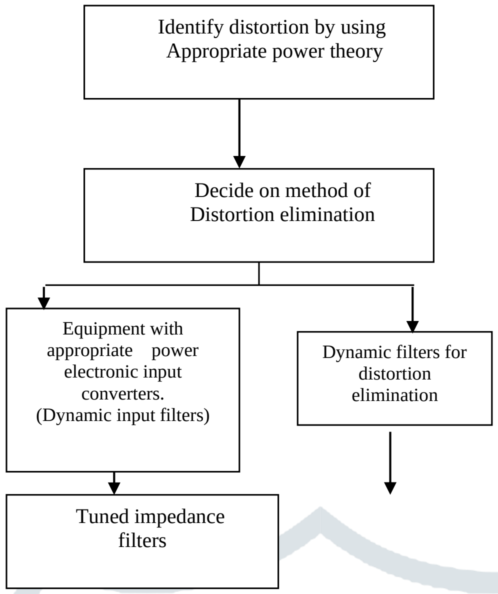

Figure 3.1: Improving power quality by distortion elimination.

IV.PROPOSED SYSTEM

FUZZY LOGIC CONTROLLER

A new language was developed to describe the fuzzy properties of reality, which are very difficult and sometime even impossible to be described using conventional methods. Fuzzy set theory has been widely used in the control area with some application to dc-to-dc converter system. A simple fuzzy logic control is built up by a group of rules based on the human knowledge of system behavior. Matlab/Simulink simulation model is built to study the dynamic behavior of dc-to-dc converter and performance of proposed controllers. Furthermore, design of fuzzy logic controller can provide desirable both small signal and large signal dynamic performance at same time, which is not possible with linear control technique. Thus, fuzzy logic controller has been potential ability to improve the robustness of dc-to-dc converters. The basic scheme of a fuzzy logic controller is shown in Fig.4.1 and consists of four principal components such as: a fuzzy fication interface, which converts input data into suitable linguistic values; a knowledge base, which consists of a data base with the necessary linguistic definitions and the control rule set; a decision-making logic which, simulating a human decision process, infer the fuzzy control action from the knowledge of the control rules and linguistic variable definitions; a de-fuzzification interface which yields non fuzzy control action from an inferred fuzzy control action.

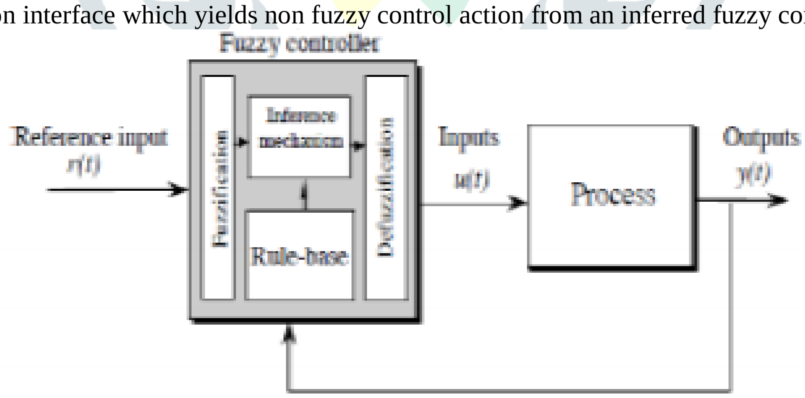

Fig.4.1 General structure of the fuzzy logic controller on closed-loop system.

The fuzzy control systems are based on expert knowledge that converts the human linguistic concepts into an automatic control strategy without any complicated mathematical model [10]. Simulation is performed in buck converter to verify the proposed fuzzy logic controllers as shown in Fig.

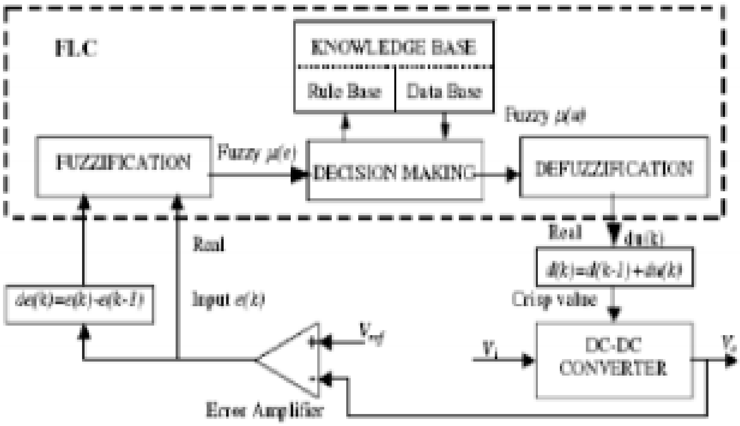

Fig.4.2. Block diagram of the Fuzzy Logic Controller (FLC) for dc-dc converters.

A. Fuzzy Logic Membership Functions: The dc-dc converter is a nonlinear function of the duty cycle because of the small signal model and its control method was applied to the control of boost converters. Fuzzy controllers do not require an exact mathematical model. Instead, they are designed based on general knowledge of the plant. Fuzzy controllers are designed to adapt to varying operating points. Fuzzy Logic Controller is designed to reduce the harmonics using Mamdani style fuzzy inference system. Two input variables, error (e) and change of error (de) are used in this fuzzy logic system as shown in Figs. to

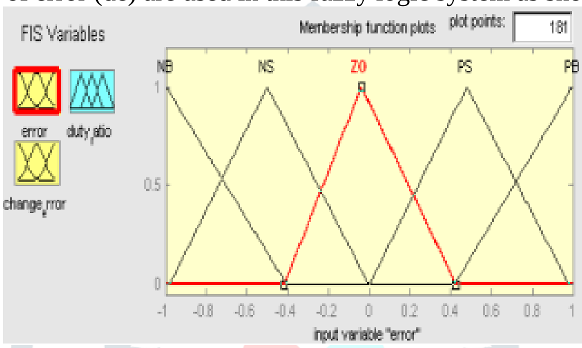

Fig. 4.3.The Membership Function plots of error.

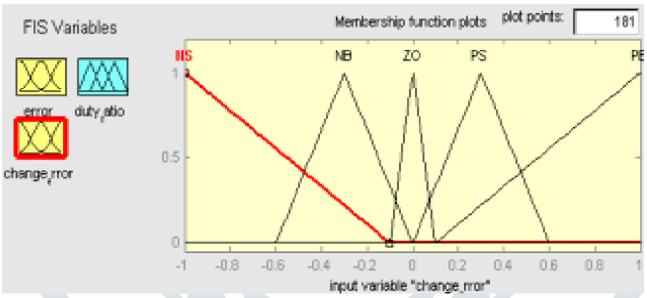

Fig.4.4. The Membership Function plots of change error.

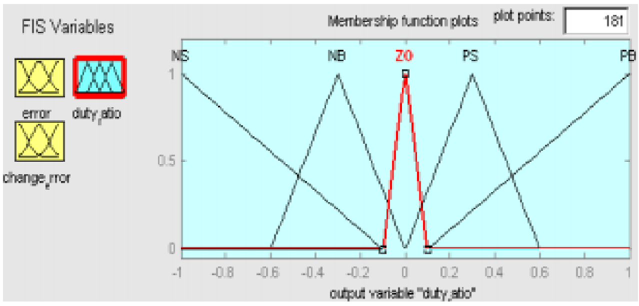

Fig.4.5. The Membership Function plots of duty ratio.

B. Fuzzy Logic Rules: The objective of this dissertation is to reduce the harmonics. The error and change of error of the output will be the inputs of fuzzy logic controller. These 2 inputs are divided into five groups; NB: Negative Big, NS: Negative Small, ZO: Zero Area, PS: Positive small and PB: Positive Big and its parameter. These fuzzy control rules for error and change of error can be referred in the table that is shown in Table I as per below:

TABLE I: Table Rules for Error and Change of Error

(de) \ (e)	NB	NS	ZO	PS	PB
NB	NB	NB	NB	NS	ZO
NS	NB	NB	NS	ZO	PS
ZO	NB	NS	ZO	PS	PB
PS	NS	ZO	PS	PB	PB
PB	ZO	PS	PB	PB	PB

Advantages:

1. Method of nonlinear control and ability to be used efficiently for HVAC systems
2. High precision
3.Rapid operation
4. Mathematical concepts are simple.

V.SIMULATION DIAGRAM AND RESULTS

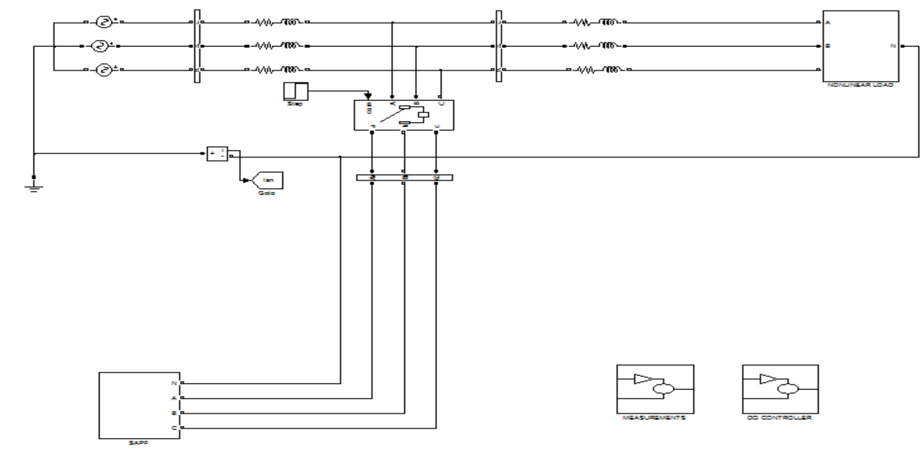

Figure 5.1 MATLAB/SIMULINK circuit diagram of the shunt active power filter topology

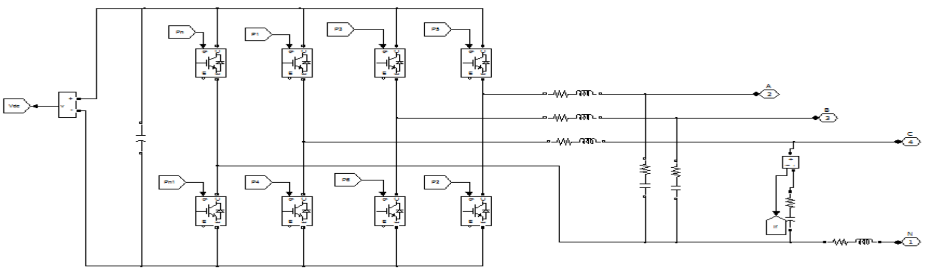

Figure 5.2 Shunt active power filter subsystem

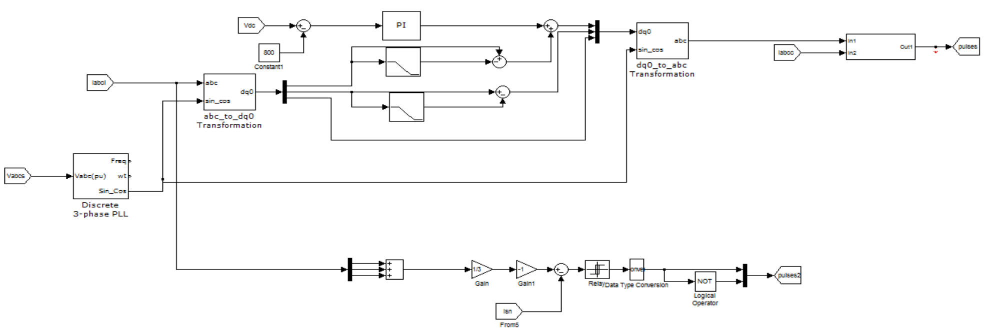

Figure 5.3 Control strategy with PI controller

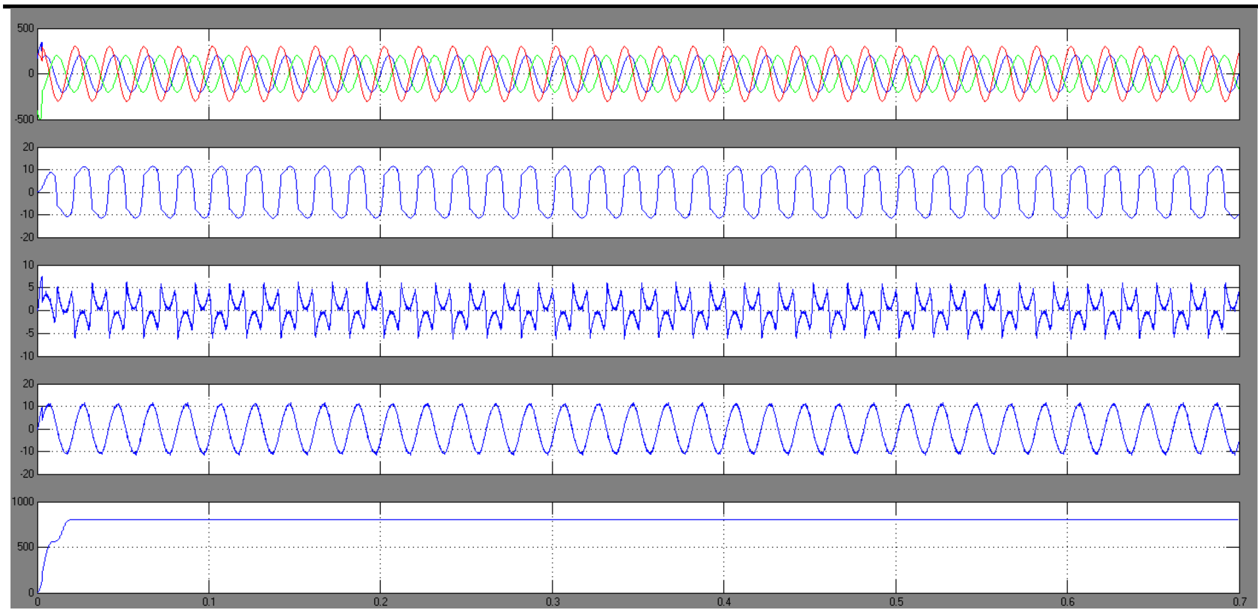

Figure 5.4 Source voltage, Load current, Active power filter current, Source current and DClink voltage

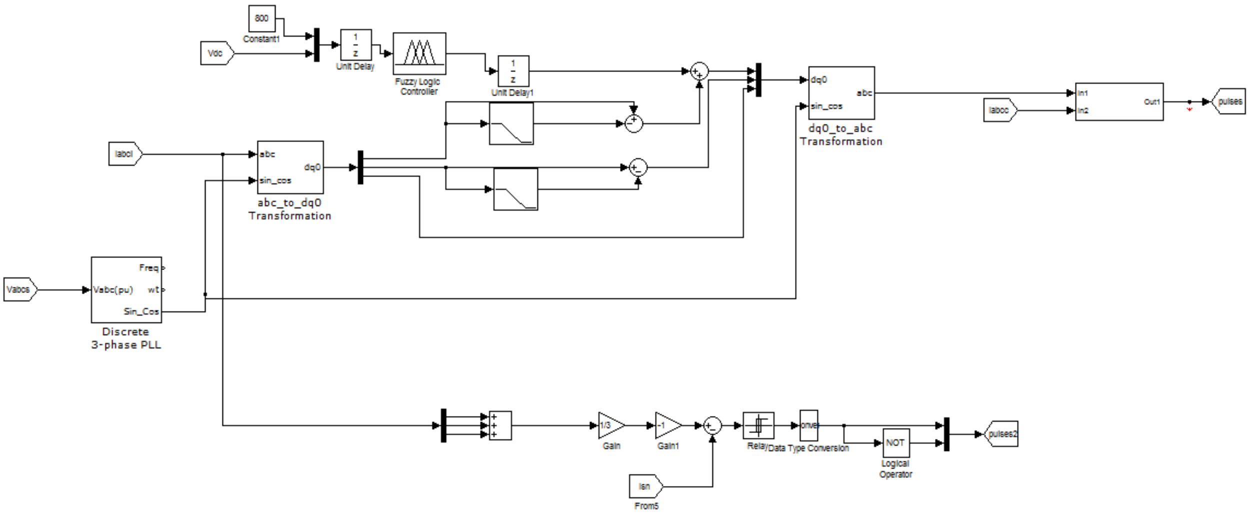

Figure 5.5 Control strategy with proposed Fuzzy logic controller

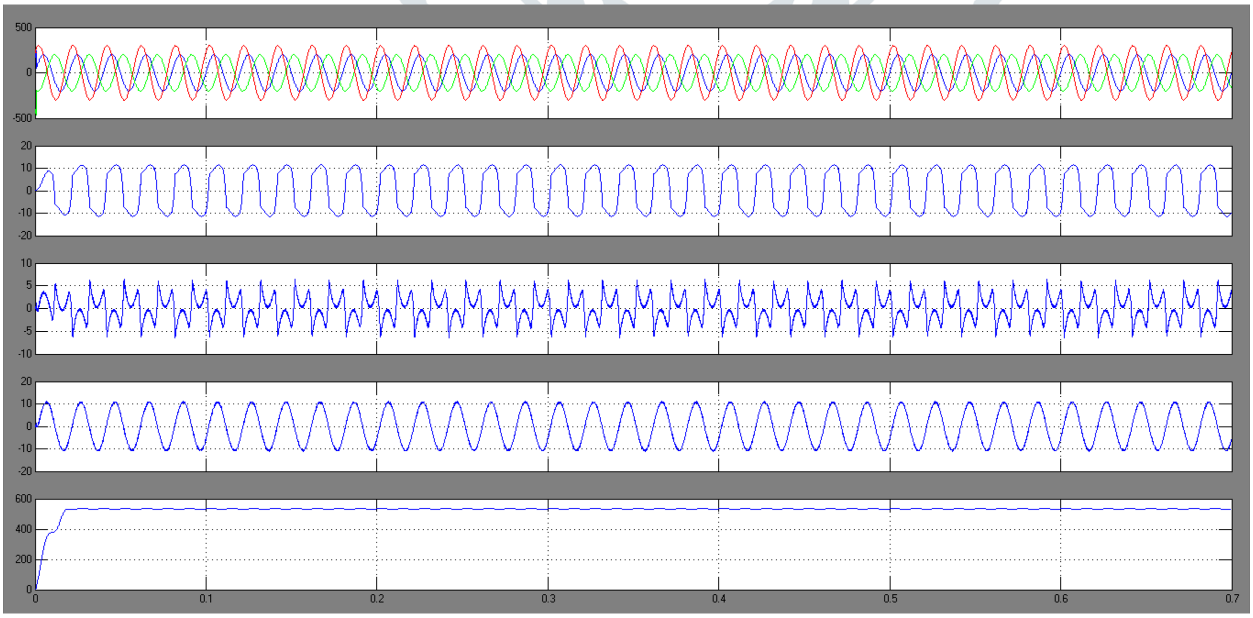

Figure 5.6 Source voltage, Load current, Active power filter current, Source current and DC link voltage

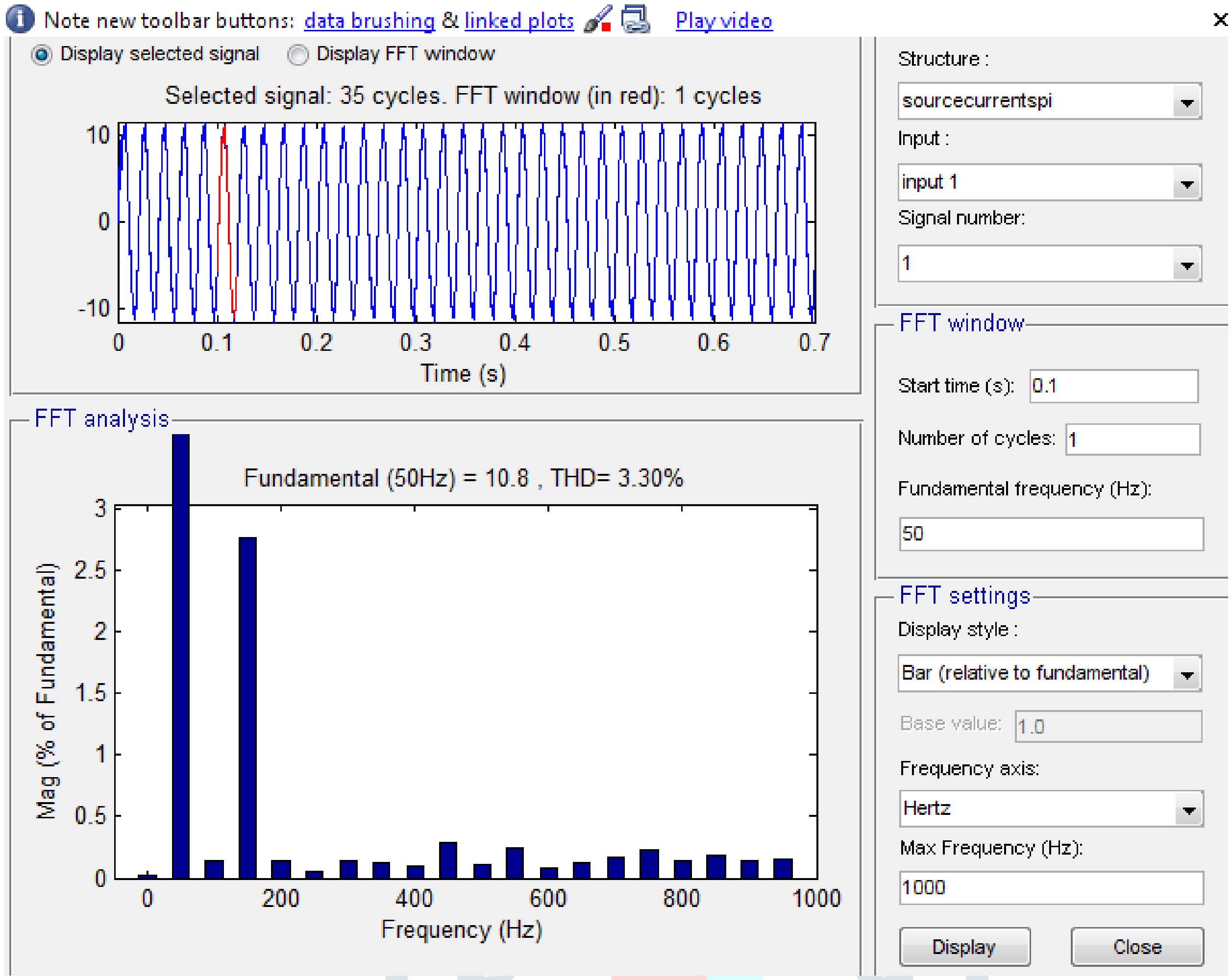

Figure 5.7THD of source current is 3.30% with PI controller

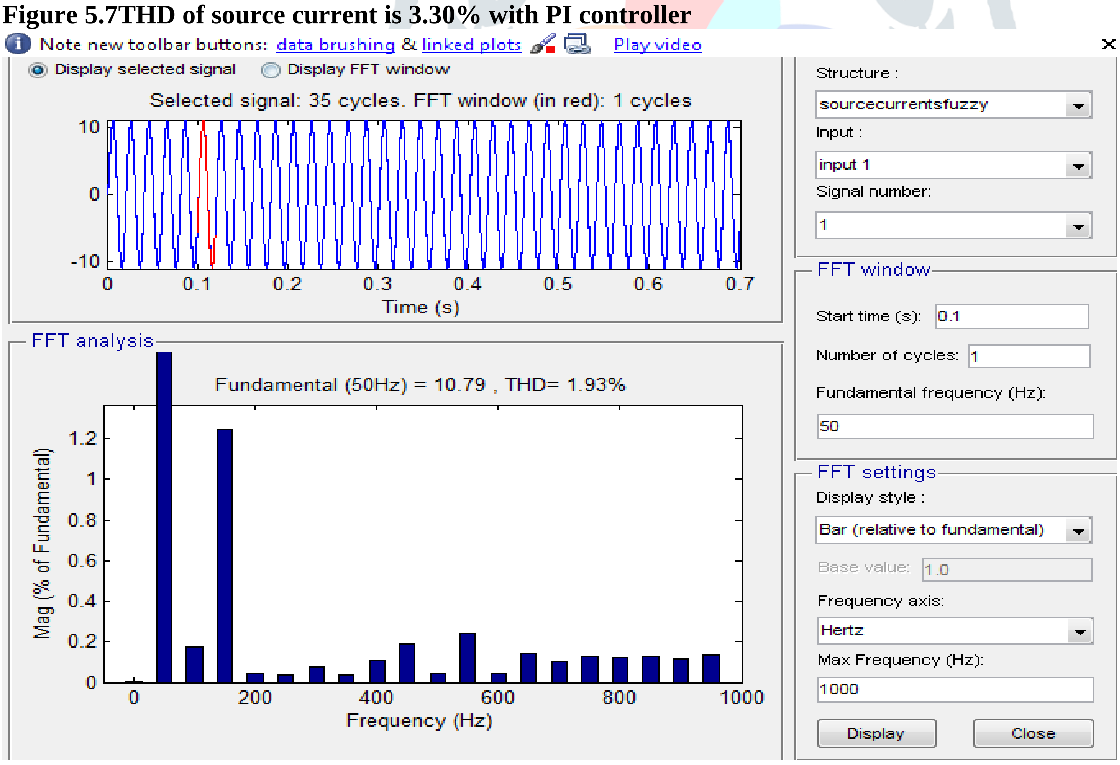

Figure 5.8THD of source current is 1.93% with FUZZY controller

RESULT:

So with the help of this circuit the harmoniccontents has been reduced in the line. The output waveforms are verified in MATLAB Simulink software.

VI.CONCLUSION

Fuzzy controller based shunt active power filter simulated in MATLAB are implemented for harmonic and reactive power compensation of the non-linear load at PCC. It is found from the simulation results that shunt active power filter improves power quality of the distribution system by eliminating harmonics and reactive power compensation of non-linear load. The Source current THD is 3.30% for PI controller and 1.93% for fuzzy controller. So we conclude that fuzzy controller has the better performance compared to PI controller.

VII.REFERENCES

[1] RASHID, I. M. (2013). Analysis of the harmonic problems in three phase transformers and solution using passive filters (Doctoral dissertation, NEAR EAST UNIVERSITY).

[2] VinodKhadkikar, “Enhancing Electric Power Quality Using UPQC:A ComprehensiveOverview” IEEE Transactions on Power Electronics, Vol. 27, No. 5, May 2012

[3] S. Orts-Grau, F. J. Gimeno-Sales, A. Abellán-García, S. Seguí- Chilet, and J. C. Alfonso-Gil, “Improved Shunt Active Power Compensator for IEEE Standard 1459 Compliance” IEEE Transactions on Power Delivery, Vol. 25, No. 4, October 2010

[4]J.A.Barrado,R.GriñóandH.Valderrama-Blavi,“Power-QualityImprovementofaStand-AloneInductionGeneratorUsingaSTATCOMWithBatteryEnergyStorageSystem”IEEETransactionsOnPowerDelivery,Vol.25,No.4, October2010.

[5] Yunwei Li, D. MahindaVilathgamuwa and Poh Chiang Loh, “Microgrid Power Quality Enhancement Using a Three-Phase Four-Wire Grid-Interfacing Compensator” IEEE Transactions On Industry Applications, Vol. 41, No. 6, November/December 2005.