Multi Objective Control Technique For Unification of DG Units to the electrical network Using Fuzzy Logic Controller

YELURI NARESH, G.SAMBASIVA RAO

***Abstract*—This paper proposes with a control method for unification of distributed generation resources using fuzzy logic controller to the utility grid.The theme is to reduce total harmonic distortion reduction using fuzzy logic controller in utility grid while delivering to non linear loads. The proposed method provides compensation for active power reactive power and harmonic load current during connection of distributed generation resources to the utility grid. The method of proposed system is first viewed in stationary reference frame then transformed in to the synchronous orthogonal reference frame. The transformed variables are used to control the voltage source converter as heart of interfacing between DG resources and utility grid.matlab simulink model of the system is done using fuzzy logic controller.Simulation results based on total harmonic distortion reduction evenly presented**

***Index Terms*— Distributed Generation Un*it,* Fuzzy Logic Controller, Voltage Source Converter**

I. INTRODUCTION

Distributed Generation (DG) technology also known as district,decentralized and dispersed generation technology is electricity generated or stored by variety of small grid connected devices referred to as distributed energy resources connected to a distribution grid rather than the transmission network. Generation capacity ranging from KW to MW level usually conneted at distributed voltages 11KV or below.

Distributed generation resources usually include small hydro bio mass gasification co –generation biogas based engines biofuel engines hybrid systems such as solar-wind

Increasing number of DG units in electrical networks requires new approach for the controlling and maintainance of the power networks for the power supply reliability and quality in the subsequent situations. As a consequence, the control of DG unit should be improved to meet the requirements for the electrical network. Therefore, design of a control method, which considers different situations of the electrical networks, becomes of high interest for interconnection of DG units to the utility grid.

Manuscript received July 2015

Yeluri Naresh*, Electrical and electronics , RVR&JC college of engineering,. Guntur, India*

G.Sambasiva rao*, Electrical and electronics , RVR&JC college of engineering, Guntur, India*

In this paper, a converter operates as an active inductor at other than fundamental frequency to absorb the harmonic current components. However, not kowing the grid inductance can reduce the performance of proposed control approach. Truely the power grids are facing disturbances with the design of a practical plug-and play converter-based DG interface.

A rugged consolidate scheme for DG converters featuring mitigation of converter grid resonance at parameter variation, distortion, and current-control parametric instabilities is presented in [1]-[7].

In this a design of a multipurpose control approach for VSC[8] used in DG system using fuzzy logic controller. The idea is to unify the DG resources to the utility grid. With the proposed approach, the proposed VSC controls the injected active power flow from the DG source to the grid and also performs the compensation of reactive power and the nonlinear load current harmonics, keeping the main source current almost sinusoidal during connection of other non linear loads to the grid.

This control method using fuzzy logic controller[9]-[11] allows the decoupling of the currents and enhances their tracking of the changes in the active and reactive power. This paper shows the simulation of the proposed method for all its aspect, i.e., active and reactive power generation along with load current harmonic current compensation .

II .FUZZY LOGIC CONTROLLER

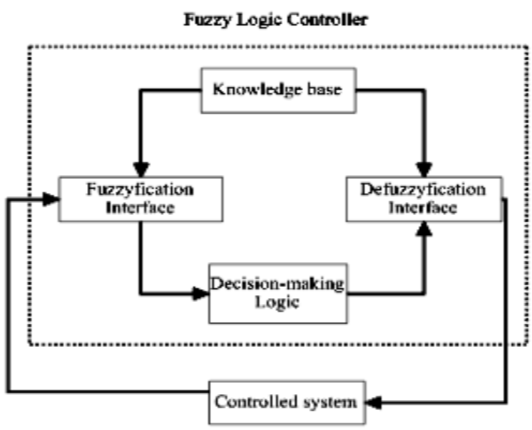

Fig. 1: Basic configuration of FL controller

Unlike Boolean logic, fuzzy logic allows states (membership values) between 0 or 1. Its major features are the use of linguistic variables rather than numerical variables. Linguistic variables, defined as variables whose

ISSN: 2278 – 7798

values are sentences in a natural language (such as small and big), may be represented by fuzzy sets [6]. The general structure of an FLC is represented in Fig.4 and comprises four principal components:

• a fuzzyfication interface which converts input data into suitable linguistic values;

• a knowledge base which consists of a data base with the necessary linguistic definitions and control rule set;

• a decision making logic which, simulating a human decision process, infers the fuzzy control action from the knowledge of the control rules and the linguistic variable definitions; and

• a defuzzyfication interface which yields a non fuzzy control action from an inferred fuzzy control action.

In this paper, FL controller block is used for error signal as shown in Fig.3. The process also same as before except the controller now is Fuzzy Logic. For block the FL controller consists of seven linguistic variables from input which is; Negative High (NH), Negative Medium (NM),Negative Small (NS), Zero Equivalent (ZE) and Positive Small (PS),Positive Medium (PM), Positive High (PH). Each parameter from linguistic variables for error signal is shown in Fig.. For delta error, there seven linguistic variables from input which is; Negative High (NH), Negative Medium (NM),Negative Small (NS), Zero Equivalent (ZE) and Positive Small (PS),Positive Medium (PM), Positive High (PH) Both variables can be depicted as in Fig.

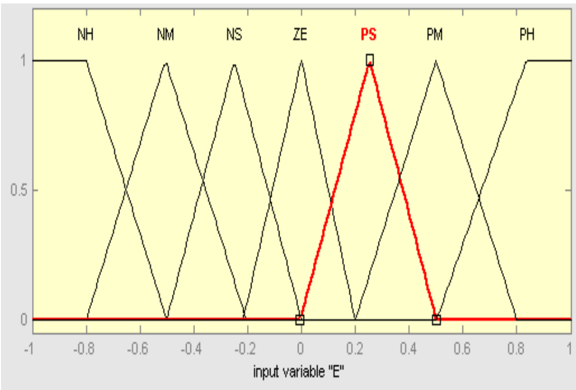

Fig. 2: Linguistic variables from error

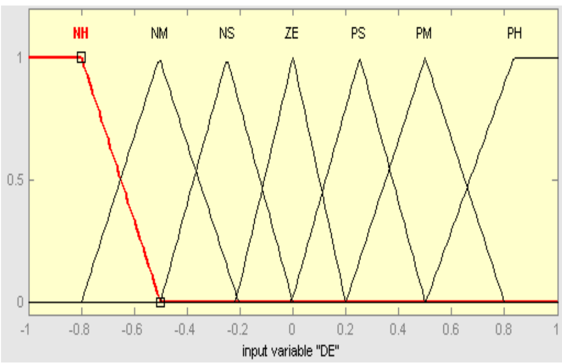

Fig. 3: Linguistic variables from delta error

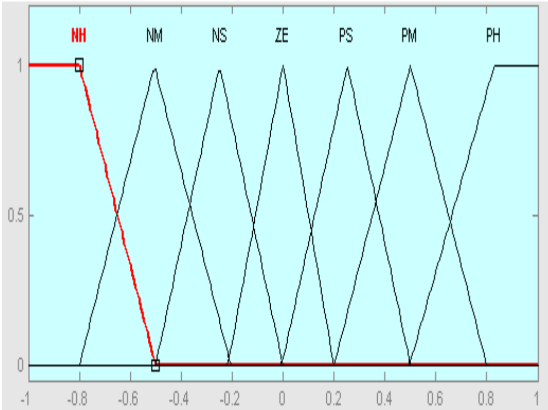

Fig.4. Shows each parameter for output signal

TABLE 1
RULE BASE

E/DE	NH	NM	NS	ZE	PS	PM	PH
NH	PH	PM	PS	PS	PS	PM	PH
NM	PH	PM	PS	PS	PS	PM	PH
NS	PH	PM	PS	ZE	PS	PM	PH
ZE	PH	PM	PS	ZE	PS	PM	PH
PS	PH	PM	PS	ZE	PS	PM	PH
PM	PH	PM	PS	PS	PS	PM	PH
PB	PH	PM	PS	PS	PS	PM	PH

III. PROPOSED DG APPROACH

Using clarke and park's transformation techniques we can convert three phase instantaneous voltages and currents in abc phases to instantaneous voltages and currents on the αβ –axes ,dq-components respectively. By means of this the control parameters become dc values ,thus filtering and controlling can be obtained easily.

Fuzzy control replaces the pi control , the role of the mathematical approach and replaces it with another that is build from a number of smaller rules that in general only describe a block of the whole system Fig-5.The method of inference binding them together to produce the desired outputs.That is, a fuzzy model has replaced the mathematical one. The inputs and outputs of the system remain the same. Fuzzy controller replaces the pi control in the control technique of dg mod el[12] .Harmonics reduced due to multi switching and output is approximately sine wave so filter design and cost reduced DC link voltage is also reduced because of splitted sources using space vector pulse width modulation technique. Before the connection of DG link to the grid, a full-controlled thyristor converter delivers a load with resistance of 20Ω and 10-mH inductance in each phase. This nonlinear load draws harmonic currents from the utility grid continuously. The DG link is connected to the utility grid at t=0.1s. continued until t=0.2s;, another full-controlled thyristor converter with non linear load of 20 ohms and 10 mH inductance is connected, and it is disconnected from the utility grid at t=0.35s.. Fig. 6 shows the load voltage(v_l), load current(i_l), grid current(i_{grid}), and DG Current (i_{DG})in one phase . As shown in this figure, after the connection of DG link to the grid at t=0.1s, the grid current becomes zero, and all the active and reactive current components and fundamental and harmonic frequencies are provided by DG link

ISSN: 2278 – 7798

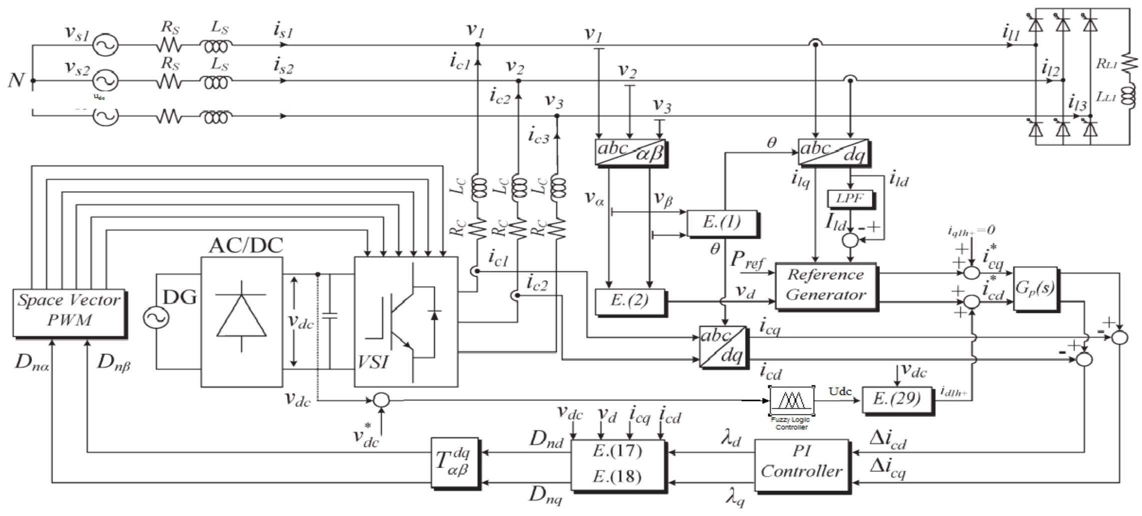

Fig-5 Block diagram of the control method for the DG systems

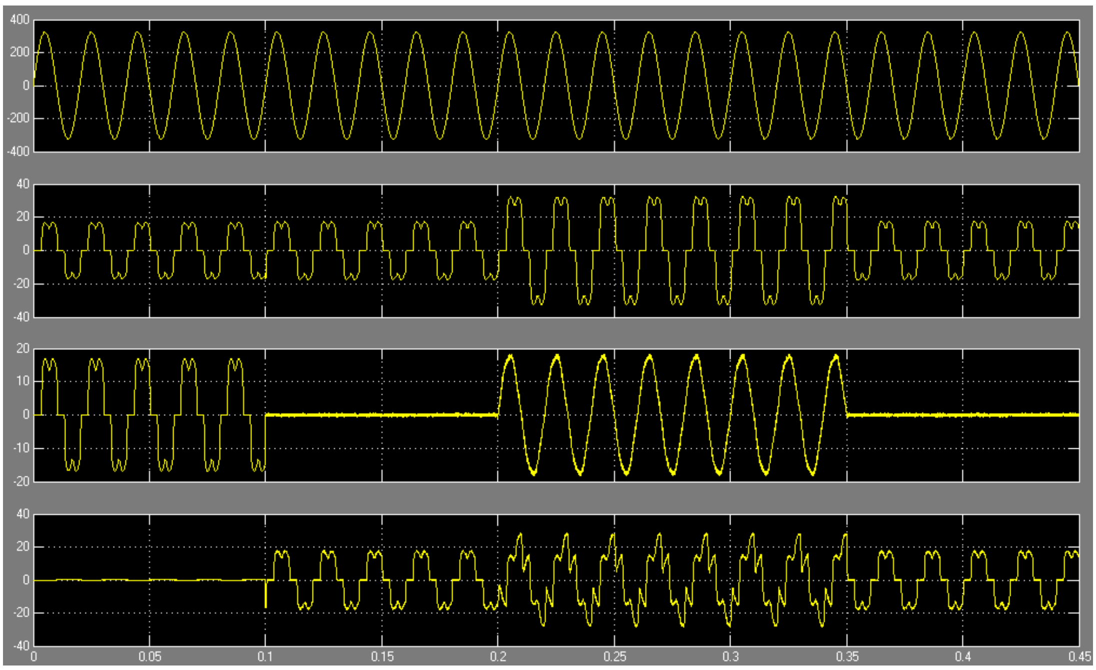

Fig-6 Load voltage load current grid current and dg current before and after connection dg link to utility grid

ISSN: 2278 – 7798

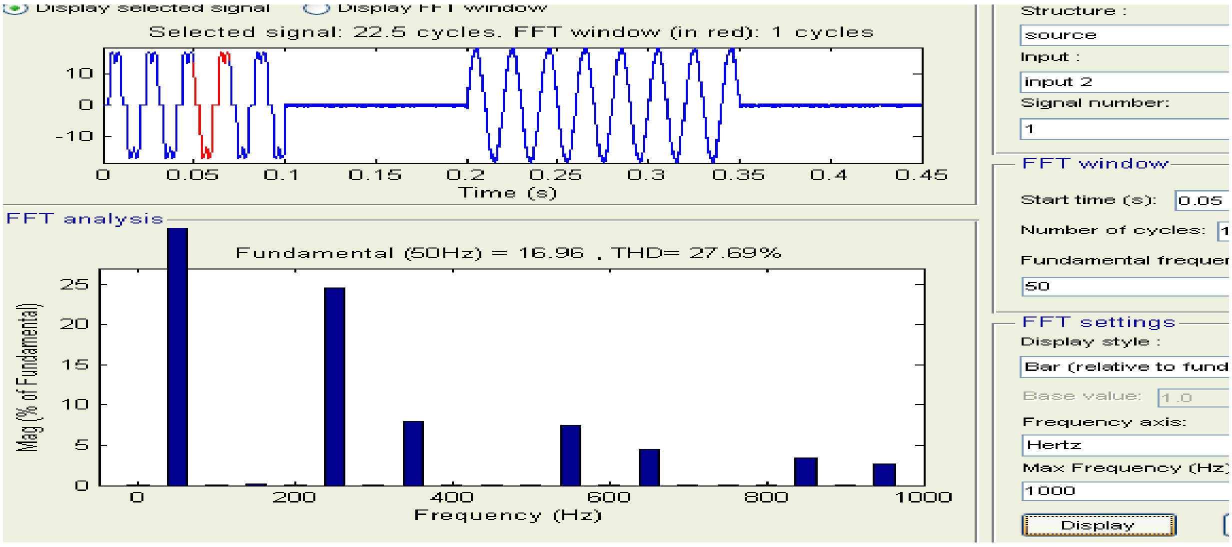

Fig-7 Before compensation total harmonic distortion

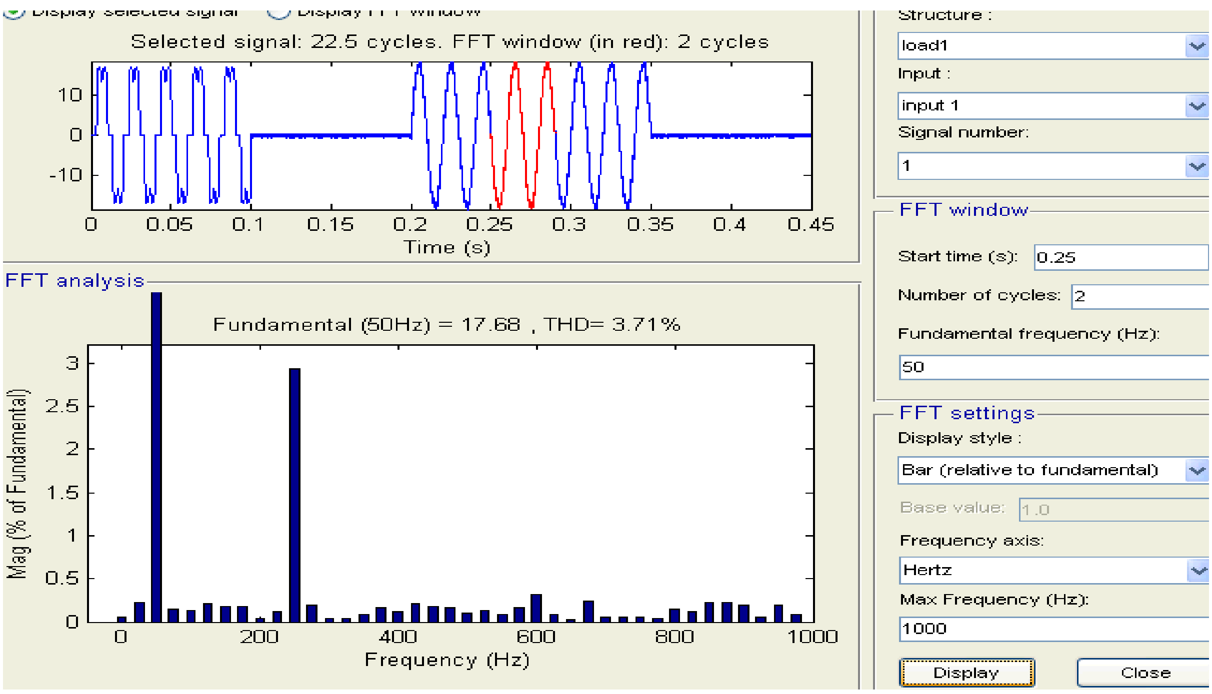

Fig-8 After compensation total harmonic distortion using fuzzy logic controller

ISSN: 2278 – 7798

IV. RESULTS

Fast fourier transform analysis results of load and grid currents indicate that the DG link can largely improve the THD of the grid currents while delivering to nonlinear loads. Thus THDs of the grid currents are reduced from 27.69%, before c ompensation to 3.71% after compensation. Result confirm the capability of the proposed DG link using fuzzy logic controller to compensate harmonic currents of the nonlinear loads and reduction in total harmonic distortion.Fig-7and Fig-8 shows FFT analysis of total harmonic distortion reduction results before and after connection dg unit using fuzzy logic controller

V. CONCLUSION

A multi objective control technique for the utility grid-connected converter-based DG unified using fuzzy logic controller has been presented in this paper. Adaptable of the proposed DG using fuzzy logic contoller in both steady-state and transient operations has been observed through simulation result., The problems due to synchronization between DG and grid will not exist, and DG link can be connected to the utility grid without any current overshoot.

By the use of the proposed control method, DG system is introduced as a new way for distributed FACTS device in distribution network. The results shows that, in all conditions, the load voltage and source current are in phase and power factor at the point of decoupling is improved DG systems can act as power factor corrector devices. The results shows that proposed DG system using fuzzy logic controller can provide required harmonic load currents in all situations compared to propotion integral control . Thus, by reducing THD of source current, acting as active filter. The control approach technique can be used for different types of DG resources as power quality improvement devices in distribution network.

REFERENCES

[1] R. Teodorescu and F. Blaabjerg, "Flexible control of small wind turbines with grid failure detection operating in stand-alone or grid-connected mode,"IEEE Trans. Power Electron., vol. 19, no. 5, pp. 1323–1332, Sep. 2004.

[2] M. Kazmierkowski, R. Krishnan, and F. Blaabjerg, Control in Power Electronics—Selected Problems. New York: Academic, 2002.

[3] E. Twining and D. G. Holmes, "Grid current regulation of a three-phase voltage source inverter with anLCLinput filter," IEEE Trans. Power Electron., vol. 18, no. 3, pp. 888–895, May 2003.

[4] M. K. Ghartemani and M. Iravani, "A method for synchronization of power electronic converters in polluted and variable-frequency environments," IEEE Trans. Power Syst., vol. 19, no. 3, pp. 1263–1270, Aug. 2004.

[5] U. Borup, F. Blaabjerg, and P. N. Enjeti, "Sharing of nonlinear load in parallel-connected three-phase converters," IEEE Trans. Ind. Appl., vol. 37, no. 6, pp. 1817–1823, Nov./Dec. 2001.

[6] Y. A.-R. I. Mohamed, "Mitigation of grid-converter resonance, grid induced distortion and parametric instabilities in converter-based distributed generation,"IEEE Trans. Power Electron., vol. 26, no. 3, pp. 983–996, Mar. 2011.

[7] A. Junyent-Ferré, O. Gomis-Bellmunt, T. C. Green, and D. E. SotoSanchez, "Current control reference calculation issues for the operation of renewable source grid interface VSCs under unbalanced voltage sags," IEEE Trans. Power Electron., vol. 26, no. 12, pp. 3744–3753, Dec. 2011.

[8] Muhammad H Rashid "power electronics circuits devices and applications" Eastern Economy Edition

[9] Jelena Godjevac "comparison between pid and fuzzy control"

[10] H.-J.Zimmermann,"Fuzzy sets Theory-and its applications" Kluwer Academic publishers 1990

[11]C Naga Bhaskar and G Vijay Kumar "Neural Networks and Fuzzy Logic " BS publications

[12] Edris Pouresmaeil, Carlos Miguel-Espinar, Miquel Massot-Campos,Daniel Montesinos-Miracle, and Oriol Gomis-Bellmunt " a control technique for integration of DG units to the electrical network"IEEE Transactions on Industrial Electronics,vol.60,no 7 July 2013

YELURI NARESH currently pursuing his M.Tech in Power system engineering RVR&JC college of engineering, Guntur, Andhra Pradesh, India.He has completed his B Tech in Electrical and Electronics Engineering in 2012. He had done his B.Tech degree from RVR&JC College of Engineering ,Guntur, Affiliated to Acharya Nagarjuna University, Guntur in 2012 and his fields of interest power systems.

GUDAPATI SAMBASIVA RAO, has completed his B.Tech. Electrical and Electronics Engineering, in 2000 from Andhra University of Engineeering, and M.Tech in 2006 from Satyabhama Institute of Engineering, Chennai,He has received his Ph.D J.N.T.U Hyderabad in 2014 . Currently working as Associate Professor in Department of Electrical & Electronics Engineering RVR & JC College of Engineering, Guntur, Andhra pradesh, India. His area of interest includes Power electronics and Drives.

ISSN: 2278 – 7798