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A Novel Method to Improve Power Quality Using Fuzzy Logic Controller and Reducing Harmonics Using Filters

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Abstract: ***This paper presents A novel method to improve the power quality for distribution system using fuzzy logic controller. a grid connected interfacing system that compensates power quality problems and reducing the harmonics in the system. The system of inverter is effectively utilized for power conditioning. And it may be used for the Active power transfer from the renewable resources and it can support reactive power demand at load and to compensate the harmonic current at Pcc and to compensate the unbalanced current and neutral current. The fuzzy logic controller to handle the unpredictable data in the real world and made is suitable to a wide range of variety applications. By using simulation either it may be MATLAB/ SIMULINK are carried out and check the performance of proposed controller.***

Keywords: Distribution system, interconnection of grid, Active filter, fuzzy logic, MATLAB/SIMULINK

1. Introduction

In recent years, the traditional method in the reduction of current harmonics involves passive LC filters; these are low cost and very simplicity. However, the passive active filter includes several drawbacks those are size in large and risk in resonance and tuning problems. The severity is increase in harmonic pollution in electrical networks has been reducing the attention and to develop of the power system and power electronics engineers to provide wide solutions to the power quality problems is generally treated as the active power filters(APF's)[1].

Active filters were considered for DC filtering to meet the stringent requirements from the power utilities in limiting telephone interference. The use of passive filters alone can increase the costs substantially. In 1991 a test installation was established at the HVDC link. The active filters are commercial and were first established in 1993 by balastic cable HVDC link in1994.

An active filter used in DC filtering is actually a hybrid active filter – that is an active filter in series with a passive shunt filter. The configuration of the DC active filter is doubled tuned filter (12^{th} and 24^{th} harmonics) is connected in series with a VSD – Based active filter. IGBT devices are used as switches in the VSC with pulse width modulation (PWM). The transformer provides galvanic separation between the VSC and the HVDC line. It can also helps in raising the voltage injected to the desired level.

The control strategy of the active filter is to inject the required harmonic voltages of appropriate magnitudes and phase angles to cancel the harmonic currents flowing in the line. Active filters are installed at both stations; each filter is connected in series with the passive filter (12/24). The active filters are designed to operate in the range of 350-2500Hz. There are four active filters in all. The use of active filter replaced an additional passive filter branch in each pole compared to a purely passive solution. The disturbing current was found to be 170 mA in bipolar mode of operation, carrying full load of 1500MW [2].

In power quality, there has been an increased emphasis of power quality (PQ) in the basis use of sensitive and nonlinear loads in the electrical power systems and rapid growth in the renewable energy resources. The most common power quality disturbance in a power system is voltage sags but other disturbances those are voltage imbalances and harmonic voltages can negatively impact a facility's electric distribution system [3].

In modern method the use of LC filters involves in the current harmonic reductions, and these are simple and with low cost. the use of Fuzzy logic controller is use in certain good applications. Because it handle the non-linearity in the system. Those imprice the more technologies in robust constructions in modern systems and in modern applications like speed-drive motors, and in computers.

An increase in such nonlinearity results in various undesirable features such as: increased harmonics in current from AC mains, low system efficiency and a poor power factor, cause disturbance to other consumers, interference in nearby communication networks, unexplained computer network failures, premature motor burnouts, etc. Therefore thermal trip devices (circuit breakers and fuses) could active to remove the loads on the path from the lines. These are only a few of the damages that power quality problems may bring into home and industrial installations. This may seem like minor quality problems but may bring wholr factories to a standstill [6].

Recently, shunt active filters based on current controlled PWM converters have been widely found and identified as an effective solution [4]. However, most of their working is based on sensing harmonics generated by the nonlinear load, which require complex control. A scheme had been proposed by Duke and Round [3].

In which, the compensating current is required by finding with using a simple method of synthetic of the sinusoid generation. The power converter can be to inject power generation from renewable energy resources and to the shunt type of APF in inverters can utilize for the unbalance currents and compensate with harmonics in the load currents with review of reactive power at load demand and neutral current at the load point. The entire functional of this accomplished by either using separately and simultaneously.

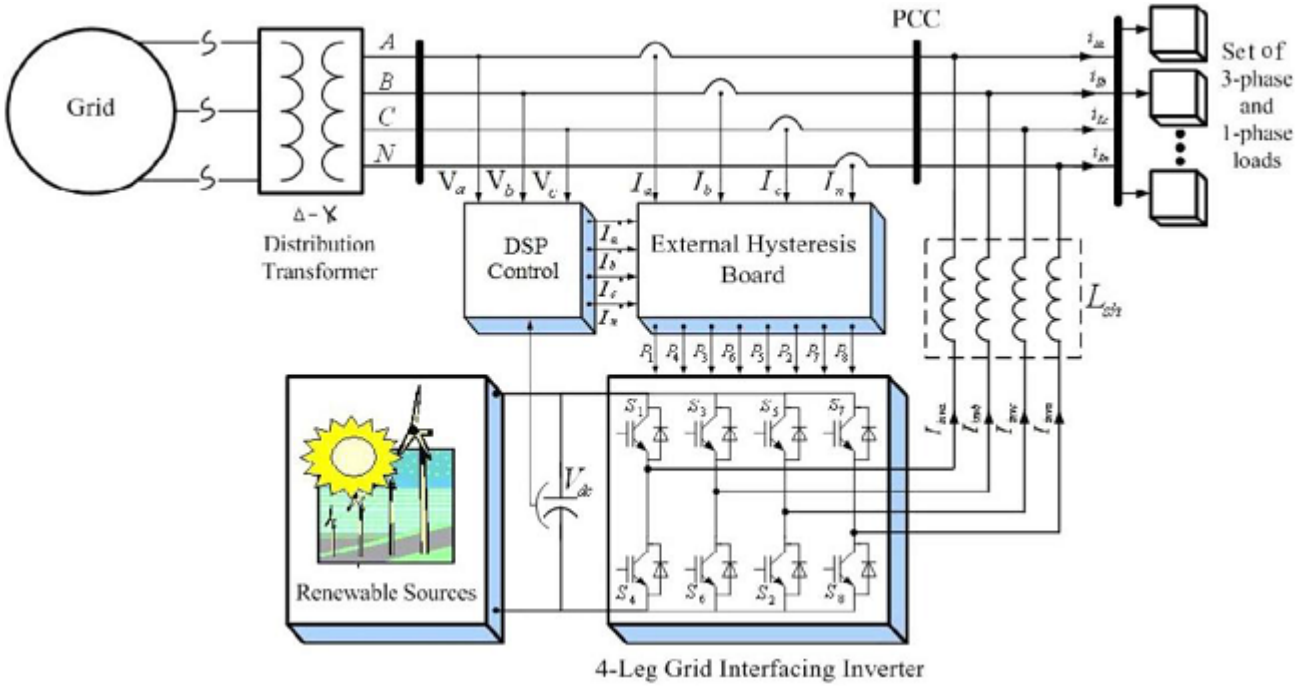

Figure 1: Scheme of proposed renewable based distributed generating system

2. System Description

The active power filter is controlled to draw/supply the compensating current i_f from/to the utility to cancel out the current in phase with source voltage thus improving the power factor. Fig.2 shows the basic compensation principle of an active power filter.

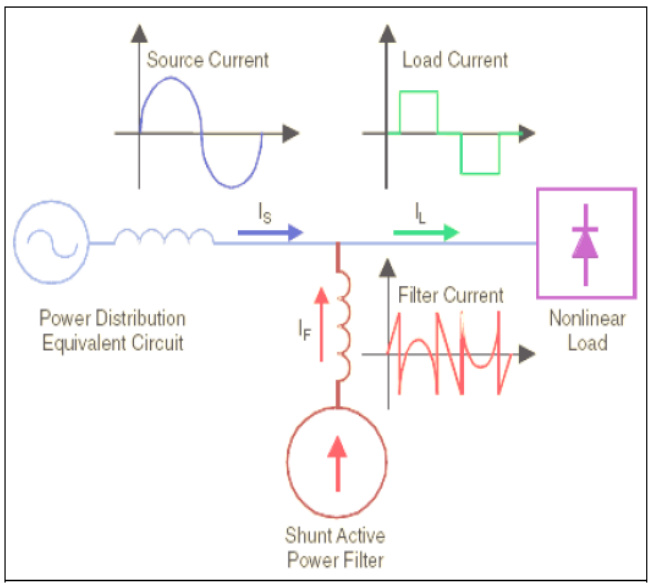

Figure 2: compensation principle

In this paper, it is shown that using an adequate control strategy, with a four-wire grid interfacing inverter, it is possible to mitigate disturbances like voltage unbalance. The topology of the investigated grid interfacing inverter and its interconnections with the grid is presented in fig. 1. It consists of four leg four-wire voltage source inverter. The voltage source inverter is a key element of a DG system as it interfaces the renewable energy source to the grid and delivers the generated power. In this type of applications, the inverter operates as a current controlled voltage source .Fourth leg is used for neutral connection. The RES may be a DC source or an AC source with rectifier coupled to DC-Link. In this paper wind energy is used as a RES, the variable speed turbines generate power at variable ac voltage. Thus, the power generated from these renewable sources needs to converts in DC before connecting on DC-Link [7] – [9]. The simulink model of wind form is given in fig.3.

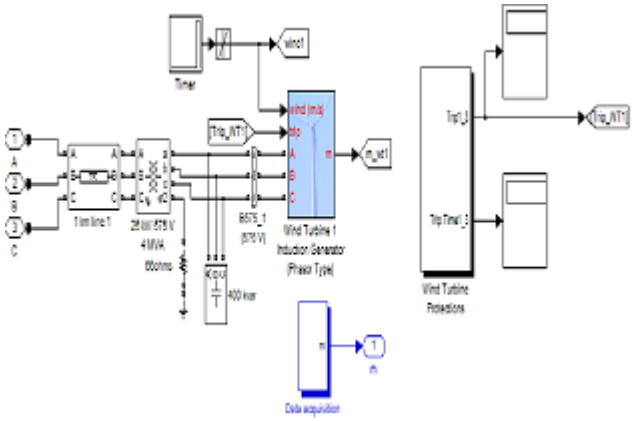

Figure 3: Simulink diagram of wind form

3.1 Control Strategy

The controller requires the three-phase grid current and three-phase voltage at the PCC and DC-link

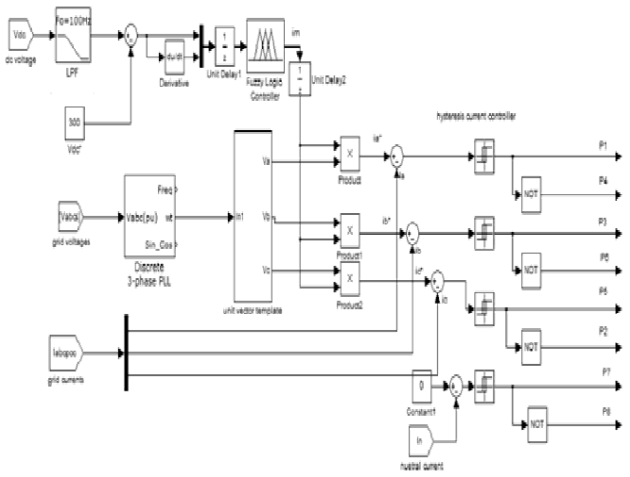

Figure 3: Simulink diagram of wind form

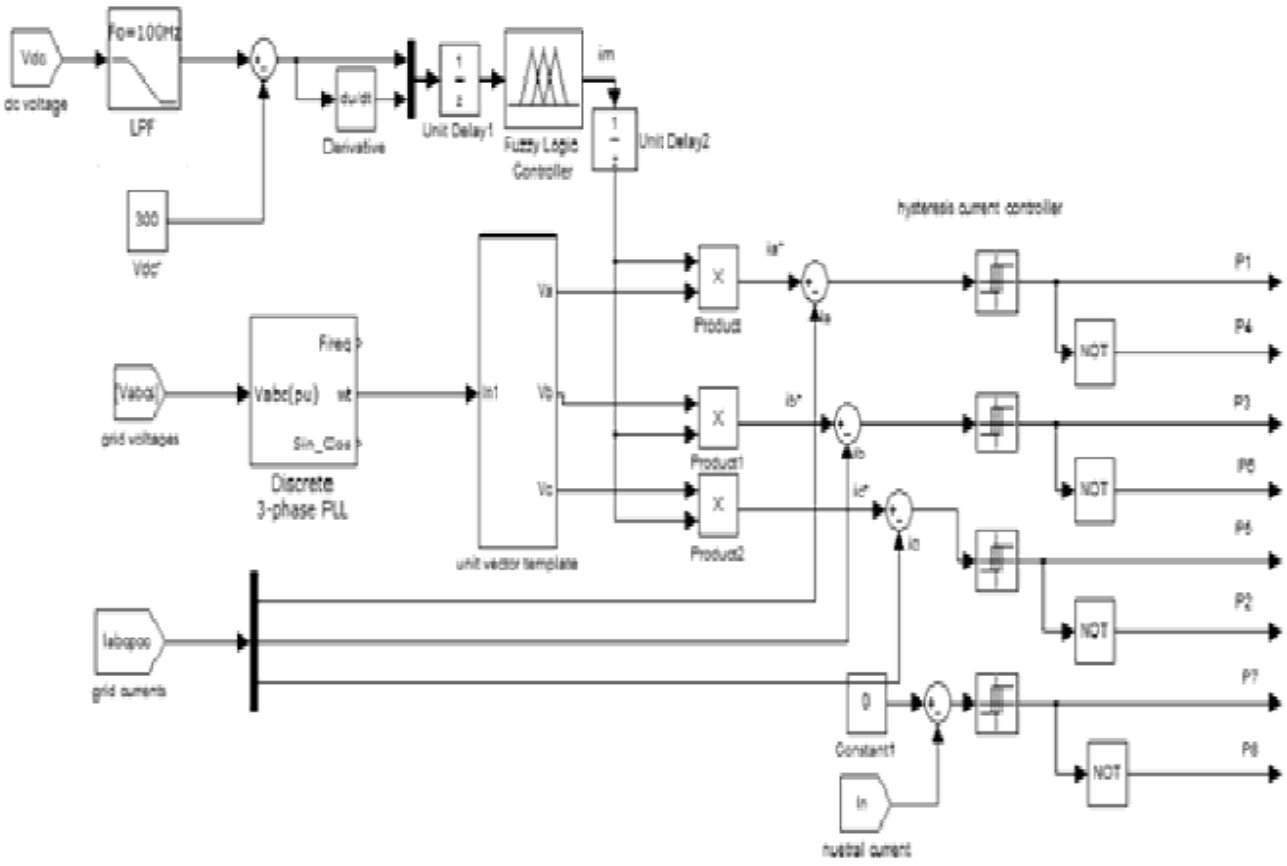

Figure 4: Representation of grid interconnecting system

Voltage as shown in figure 4.

3.2 DC Capacitor

The DC capacitor has two main purposes: During steady state period it maintains a DC voltage with small ripple and in the transient period it behaves as an energy storage element to supply the real power difference between load and source. When the load conditions changes there will be disturbances in the real power balance between the load and the source. This difference in real power is to be the compensated by DC capacitor and hence the DC capacitor

voltage changes away from the references voltage. For the satisfactory operation of the active filter, The peak value of the reference source current must be adjusted to proportionally change in the real power drawn from the source. It is in this way that, by regulating the average voltage of the DC capacitor the references source current can be obtained. The real power is charged/discharged by the capacitor compensates the real power consumed by the load. If the DC capacitor voltage is recovered and reaches the references voltage then, the real power supplied by the source is supposed to be equal to that consumed by the load.

3. Fuzzy Logic Controller

The inability due to the disadvantage of this controller in the system and it can changes abruptly due to the error signal, because this can capable of while finding the values of error signal and changes in rise of system and finding the output values.

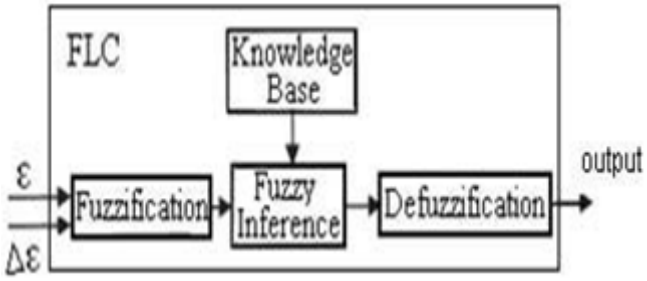

Figure 5: Simple representation of FLC

In mathematical terms is the derivative of the error. To solve this problem Fuzzy logic control is proposed as shown in Fig. 5.

The determination of the output control signal, is done in an interface engine with a rule base having if-then rules in the form of

"IF ε is…..AND Δε is……THEN output is ……."

With the rule base, the value of the output is changed according t the value of the error signal and the ratio of the error. The structure and determination of the rule base is done trail-and-error methods and is also done through experimentation. All the variables' fuzzy subsets for the inputs are defined as (NB, NM, NS, Z, PS, PM, PB). The membership function of inputs is illustrated in Fig. 6 & 7.

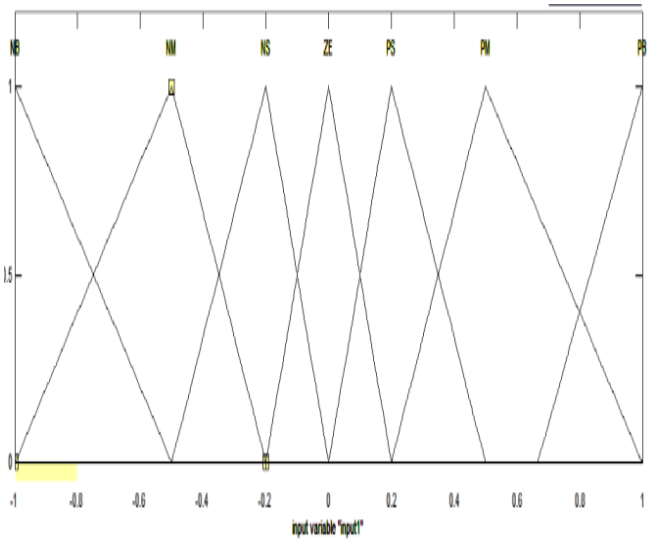

Figure 6: Membership function of input ε

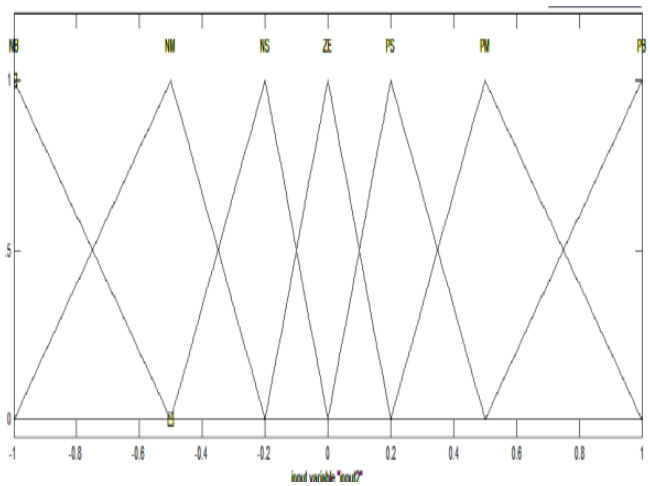

Figure 7: Membership function of input Δε

4. Simulation Results

An extensive simulation study is carried out using MATLAB/SIMULINK in order to verify the proposed control strategy. To achieve balanced sinusoidal grid currents at unity power factor, the 4-leg grid interfacing inverter is actively controlled under varying renewable generating condition. The wave forms of grid voltages, grid currents, unbalanced load currents as shown in Fig. 8.

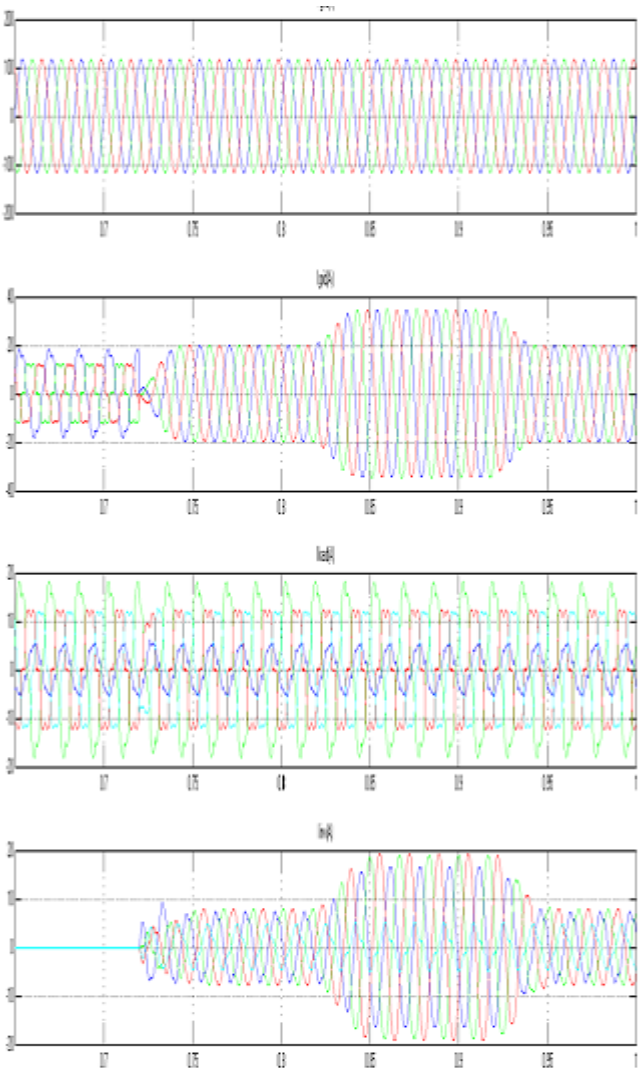

Figure 8: Simulation results: (a) grid system voltages, (b) grid system currents , (c) load currents in grid systems, (d) inverter currents in grid systems.

5. Conclusion

This paper has presented a novel method to improve power quality by using fuzzy logic controller and reducing the harmonics using filters with grid connected interfacing system. The performance of a fuzzy logic controller and PI controlled harmonic has been studied. And the system with fuzzy logic controller has been observed as superior in providing harmonic compensation. This approach is to eliminate the harmonics using filters in this system. Simulation results has shown that the fast response, high accuracy.

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